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Abstract

The availability of the Internet, online Social Networks and mobile devices, associated consequential increase of personal images published online and the rapid developments within the fields of computer vision and image processing lead to open questions: "What are the possibilities for the analysis of personal images published online using currently available technological means?" and "Is there awareness in today's society, especially among children and teenagers, for these possibilities, for their exploitation, resulting risks or consequences and hence for a responsible handling of their personal pictures online?" The "digital natives" generation is characterized by their skillful use of new media but also by their lack awareness concerning benefits, risks and responsibilities induced by the handling of personal data. Examples for questionable trends are "sexting" or "cyberbullying". Further, once published, digital images can spread quickly over the Internet and are difficult to be removed. Consequences of these trends can be disastrous for the involved persons, yet pupils still lack a critical evaluation of their own behavior.

This work is focused on the possibilities, risks and impacts of the application of computer vision and image processing technologies within the context of online available pictures as well as the acquisition and processing of large amounts of unconstrained image datasets. It aims at developing an interdisciplinary project concept with the following characteristics: It combines state of the art research of sociology and computer science to develop a profiling software tool and to collaboratively implement the project. The overall objective is to improve media literacy and the awareness among children and teenagers for a responsible handling of their own data online. Furthermore, it includes current related work focusing on media use and media education as well as image analysis for facial attributes within the context.

This thesis focuses on:

- How do children and teenagers use the Internet and Social Networks within the context of image data? Where are their personal pictures published online and how can they be accessed and acquired?

- Image Processing in unconstrained environments and large datasets: State of the art approaches within the context of Face Detection, Recognition or retrieval of similar faces is researched. It includes current challenges and pitfalls within the context as well as application possibilities within the context of an image-based person-profiling tool.

- The Profiler: Design and parts of implementation as well as evaluation of an interdisiplinary project concept aiming at improving media literacy and awareness for the benefits, responsibilities and consequences evolving of the use of the Internet and Social Networks

with focus on image-based data. Target user group comprise children and teenagers of age 10 onwards. Main focus is the design, parts of development and evaluation of animage-based person-profiling software implemented collaboratively by the project team, which creates profile-style descriptions of individuals based on acquisition and content-based analysis of online available images.

This results in the following methodology: The starting point is a comprehensive state of the art research on *Internet- and media use of children and teenagers of age 10 onwards* as well as *related projects and initiatives aiming on media education and critical media use among them*, *Face Recognition in unconstrained environments and face databases* and *Social Network Analysis*. This is followed by the design of the project approach and the profiling tool as well as its collaborative implementation. In parallel, workshops are designed and implemented for the pupils addressing overall aim and covering relevant topics, such as image processing, legal aspects, scientific work and studies, as well as a user test to evaluate and later-on optimize the software. Within the context of this work the evaluation is focused on the implementation of the overall project, the user interface and usability based on the user tests as well as an impact assessment with respect to the awareness of the participating children and teenager based on the conducted research and workshops.

Kurzfassung

Die Verfügbarkeit von Internet und Sozialen Netzwerken sowie Smartphones und Tablets, die damit verbundene Zunahme von online veröffentlichten (personenbezogenen) Bilddaten und die rasanten Entwicklungen in den Bereichen Computer Vision und Bildverarbeitung führen zu einem Spannungsfeld, welches Fragen aufwirft: “Was ist im Kontext der inhaltsbasierten Verarbeitung von personenbezogenen online Bilddaten aus technologischer Sicht möglich?” und “Wie ist das Bewusstsein in der heutigen Gesellschaft, insbesondere von Kindern und Jugendlichen, dafür und für einen verantwortungsvollen Umgang mit personenbezogenen Bilddaten”? Die selbstverständliche Mediennutzung insbesondere der jungen Generation, sogenannter “digital natives”, steht einem mangelnden Bewusstsein für Chancen, Risiken und Verantwortung im Umgang mit personenbezogenen Bildern im Internet. Schattenseiten und Konsequenzen sind “Cybermobbing”, “Sexting” oder eine unkontrollierte Verbreitung einmal veröffentlichter Bilder, welche drastische Auswirkugnen insbesondere auf Kinder und Jugendliche haben können. Trotzdem sehen Schüler/innen ihr eigenes Verhalten oft als unproblematisch an.

Die Arbeit beschäftigt sich mit dem Spannungsfeld der Möglichkeiten und Auswirkungen von Computer Vision und Bildverarbeitungstechnologien im Kontext online verfügbarer Bilddaten, Zugriffsmöglichkeiten zur Gewinnung derer sowie Verarbeitung solcher großer heterogener Bilddatensätze. Sie zielt auf die Entwicklung eines interdisziplinären Projektkonzeptes ab: Dieses verbindet State of the Art Forschung in den Bereichen Soziologie und Informatik in der Entwicklung einer Profiling-Software sowie in der Durchführung und Evaluierung des Konzepts mit dem Ziel der Bewusstseins- und Medienkompetenzförderung von *digital natives* in diesem Kontext. Themen wie der aktuelle Stand der Medienkompetenzförderungslandschaft sowie der Mediennutzung von Kindern und Jugendliche sowie Bildanalyse zur Gesichtserkennung und Analyse personenbezogener Merkmale werden im Kontext beleuchtet.

Diese Arbeit konzentriert sich auf folgende Punkte:

- Wie nutzen Kinder und Jugendliche das Internet und soziale Netzwerke im Kontext von Bilddaten? Wo sind persönliche Bilder online veröffentlicht und wie kann ein Zugriff auf solche zum Zweck einer Bildakquise erfolgen?

- Mit Face Detection und Recognition als exemplarisches Beispiel wird der State of the Art erörtert: Was sind aktuell Anforderungen und Herausforderungen bei der Analyse großer und heterogener personenbezogener Bilddaten, insbesondere im Hinblick auf eine Anwendung in einer bildbasierten Personen-Profiling-Software?

- Entwicklung, Implementierung und Teil-Evaluierung eines interdisziplinären Projektkonzepts mit dem Ziel der Förderung von Medienkompetenz sowie einem Bewusstsein für Möglichkeiten, Verantwortung und Folgen, welche aus der Nutzung von Internet und Sozialen Netzwerken resultieren. Die Zielgruppe sind hierbei die 10-15jährigen. Schwerpunkte dabei sind das Design, Teile der Implementierung sowie eine Evaluierung der im Zuge des Projekts entwickelten Profiler-Software zur Erstellung von Personenprofilen durch Akquise sowie inhaltsbasierter Analyse von online verfügbaren Bilddaten.

Daraus ergibt sich folgende Methodik: Die Basis bildet eine umfassende State of the Art Recherche zu den Themenbereichen *Internet- und Mediennutzung von Kindern und Jugenlichen sowie existierende Projekte und Initiativen zur Medienkompetenzförderung und kritischen Mediennutzung*, *Face Analysis in unconstrained environments und Face Databases* und *Social Network Analysis*. Dem folgt das Design des Projektkonzepts und des zu entwickelnden Profiler-Tools sowie die im Projektteam kollaborative Implementierung. Parallel dazu erfolgt die Konzeption und Durchführung von Workshops für die Zielgruppe zu Themen im Projektfokus sowie ein User Test zur Evaluierung und Optimierung der Software. Die Evaluierung im Rahmen dieser Arbeit bezieht sich auf die Gesichtspunkte der Implementierung des Gesamtprojekts, das User Interface und Usability mittels User Tests sowie eine Folgenabschätzung zur Bewusstseinsförderung bei den teilnehmenden Kindern und Jugendlichen im Projekt auf Basis der Workshop-Ergebnisse.

Abbreviations

AHS Allgemeinbildende Höhere Schule

API Application Programming Interfaces

AU Action Unit

BMBF Bundesministerium für Bildung und Frauen

BSD Berkeley Software Distribution

CBIR Content Based Image Retrieval

CK Cohn Kanade

CK+ Extended Cohn Kanade

CSS Cascading Style Sheets

DARPA Defense Advanced Research Project Agency

DAU Daily Active User

DNN Deep Neural Network

EER Extended Entity Relationship

EMFACS Emotion Facial Action Coding System

FACS Facial Action Coding System

FD Face Detection

FR Face Recognition

GCSE Google Custom Search Engine

HMM Hidden Markov Model

HOG Histogram of Oriented Gradients

HTML Hypertext Markup Language

HTTP Hypertext Transfer Protocol

ICT Information and Communication Technology

ISPA Internet Service Providers Austria

JAFFE Japanese Female Facial Expressions

JSON JavaScript Object Notation

LFW Labeled Faces in the Wild

LBP Local Binary Pattern

LASRC Linearly Approximated Sparse Representation Classification

LFW Labelled Faces in the Wild

MORPH Craniofacial Longitudinal Morphological

OIAT Austrian Institute of Applied Telecommunication

REST Restful State Transfer

SNS Social Network Service

SRC Sparse Representation Classification

SSL Secure Sockets Layer

SVM Support Vector Machine

URL Uniform Resource Locator

Contents

CHAPTER 1

Introduction

Use a picture. It's worth a thousand words.

ARTHUR BRISBANE

Originated in the 1920's, this quote seems to be more valid than ever before: Digital cameras, ubiquitous Internet accessibility, the development and increased importance of online Social Network Services (SNSs) as well as mobile devices equipped with cameras and WiFi-connectivity make it easier than ever before to take and share pictures, to upload, browser and search, to analyze and further process them. Motivated by the availability of the aforementioned devices, technologies and services, this trend results in a vast amount of image data published online, especially in SNSs as illustrated by the following examples: The online picture sharing platform Flickr[1] announced in their weblog that by May 2015 they host more than 10 billion images[2] uploaded by the users. Facebook reported an average of 890 million daily active users Daily Active Users (DAUs) for December 2014 [25] with 300 Petabytes of user data stored in their network and a total number of 400 billion photos uploaded to the platform as per April 2014[3]. In Snapchat[4] 700 million photo messages were sent every day in July 2014[5].

1.1 Online Digital Images - a Playground for Computer Science Research

From a technological perspective these trends have motivated research in the fields of data mining, web crawling and unconstrained image processing as well as image analysis in context of

[1] `http://www.flickr.com` accessed 05/2016

[2] `http://blog.flickr.net/en/2015/05/07/flickr-unified-search/`, accessed: 07/2015

[3] `http://expandedramblings.com/index.php/by-the-numbers-17-amazing-facebook-stats/15/`, accessed: 07/2015

[4] `https://www.snapchat.com/`, accessed: 05/2016

[5] `http://www.statista.com/statistics/257128/number-of-photo-messages-sent-by-snapchat-users-every-day/`, accessed: 07/2015

the analysis of personal attributes in web-scale image datasets, e.g. [87].

Results of these developments are, for example, advertisements embedded in websites or online stores making recommendations based on the users' browsing behavior. In SNSs or personal image collections name-labels, so-called *tags*, for persons in photos can be suggested automatically. Applications entertain users with finding their celebrity lookalike picture[6], which can be shared and commented on SNS platforms. The latter two examples rely on image processing techniques. Considering the online *image floods* in the Internet and the possibilities resulting from the technology developments in the fields of online data retrieval and image processing, it could be argued, that it is possible to create a detailed person profile solely based images as input data rather than text-based or meta information. In addition, if all data types were combined and finally, assuming full access to the data in terms of user permissions, as a consequence, even more detailed and precise descriptions of persons could be composed. This leads to the following research question:

I. What is the current state of the art in computer-assisted (semi-)automatic analysis of online SNSs utilizing text-based information, metadata and/or means of image processing to analyze personal attributes in online photos? Special focus is set to face recognition as it constitutes the basic analytical task for other face-related analysis (e.g. age, gender or emotion). And further, how do facial image analysis methods for age, gender and emotion classification perform facing unconstrained web-scale datasets?

1.2 Internet Use Behavior of Children and Adolescents - an Area of Conflict?

The aforementioned trends affect the young generation: Recent surveys conducted in the context of media and Internet use have shown that smart-phones, the Internet and SNSs have become an integral part of the everyday lives of children and adolescents:
The KIM study[7] is an annual survey researching the media use of children age 6-13 in Germany. According to the most recent edition KIM 2014 [27], cell phones, smart-phones, Internet access, computers and laptops are available in almost any household in Germany. Almost half of the children and teenagers call a mobile phone their own. Among adolescents of age 12 to 19 years, 88% possess a smart-phone, according to JIM 2014 [26], the pendant survey to KIM for adolescents. KIM 2014 also reveals an increase in cell- or smart-phone possession and in surfing in the Internet on their own with increasing age. In addition, a significant jump is noticable in both aspects around the age 10-11 years of age (see also 2).
According to KIM 2014 communication-related activities are the most popular. Almost half (48%) of the Internet users among the survey users use the Internet for activities in online communities followed by 40% for Internet chatting. Almost half of the surveyed children have their own account in a SNS. SNS use rapidly increases from less than 10% among 6-9 year-olds via

[6] `http://www.faceplusplus.com/demo-search/` accessed 05/2016
[7] `http://mpfs.de/index.php?id=462`, accessed 07/2015

one third of 10-11 year-old to 70% of 12-13 year-old users. This results in an average age of 10.4 years at registration date. Facebook is still the most popular SNS used mainly for chatting, sending messages, posting at the timeline. 40% upload photos or videos at last once per week.

For the 12-19 year-old the results are similar: Communication is the most important activity online and with 23% Facebook is the most used platform in that context. Eight out of ten chat at least several times per week, almost two thirds (62%) use SNS' to regularly send messages, to chat, to "like" other content [26].

II. Considering the Internet use of 10-15 year old children and teenagers and technical feasibility referring to supported interfaces and data access for image acquisition: Which online resources are most relevant to acquire personal images from the target users and how can it be realized? Based on the acquired images – how could a software tool be specified and designed which describes a person solely based on the analysis and synthesis of image-based information?

These developments, particularly in the fields of social media, image retrieval, image processing and mobile devices, as well as young peoples' natural way to use the Internet (so-called *digital natives* [70]) but with questionable media literacy skills oppose each other. This can lead to scenarios, such as the following:

Jennifer is fourteen years old. Since she has been twelve she had wanted to own a smartphone. One like her best friend Sarah owns, with a camera, an Internet flat rate and access to Whatsapp, Facebook, Snapchat and similar Apps. For her last birthday her parents surprised her with a brand new smart-phone. Since then she has become a passionate everyday-life photographer and an active SNS member. Finally she has been able to share pictures from her recent beach holidays with her peers and friends at Facebook and to keep in touch with them at almost any time of the day. Jennifer has been excited whenever she had received a like or a comment to them. The last photo she uploaded made her particularly proud as she had never expected such an impact – within a week it gained more than 100 likes and 30 comments and it became more and more since then. Until that one day when she received emails, Whatsapp messages and comments from persons she had never heard from nor known. That day when other students at school started to mock her about photos she had never shared with them. First, Jennifer hoped that after a while this would cease, but instead it has been increasing ever since. She has no clue who gained access to her private photos, nor how that could happen. And even worse, she has no idea how to ever stop all that.

1.3 Questionable Trends and Risks

Researchers state that dangers or problems online might not be unique to that environment [52] and not more dangerous than in offline environments [28]. They are rather extensions of social interactions or media problems from the non-cyber world or across different environments [83, 106]. There is a correlation between endangered adolescents online and offline [52] and it is encouraged to focus on reducing risks caused by peers [74]. Actual consequences and dan-

gers might be less immediate online than offline [28]. Examples for questionable trends in this context are *cyberbullying* or *sexting* and can be similar to the scenario as described above:

Cyberbullying refers to the repetitive being cruel (e.g. by sending or posting harmful content or engaging in any other forms of social cruelty) to others using cyber-communication, the Internet or other digital technologies [39, 80, 84]. An online-survey ofthe Institute for Interdisciplinary Research on Conflict and Violence Bielefeld [82] states, that this also includes (sexual) harassment, reputation damage, or targeted threats, happy slapping or social isolation in the online world. Examples of such activities are e.g. the sending or posting of harmful messages or images, or engaging in other social cruelness via digital means [52, 85]. Online platforms provide "almost absolute anonymity" and therefore a safe position for cyber-harassment - free of charge, due to the provision of large scale diffusion for the communication of the cyberbullying by the information society [16]. Similarly, an Austrian survey with pupils of one secondary vocation school (Höhere Bildungslehranstalt, HBLA) [58] showed that cyberbullying often happens without their own parents noticing it, 24/7 and independent of time or location. Once published in the Internet, the information is difficult to be removed or rectified [13, 16, 76]. According to Ybarra et al. [106] in almost half of the cases the cyberbullying victims have known the person who bullied them already before the incident, e.g. often they are peers [46, 74, 98]. Sitzer et al. argue that there is a relation between bullying and cyberbullying, stating that in the conducted survey [83] among 11 to 24 year olds' 71% of the victims of cyberbullying were also conventionally bullied within the previous three months. The survey also reveals that sharing compromising photos or videos or receiving nude pictures involuntarily were perceived the most disturbing and upsetting.

Buttarelli [16] finally warns, that cyber-harassment constitutes a breach with the data protection legislation as it is personal data of individuals being published or shared without consent. He warns that also individuals publishing information about third parties on e.g. SNSs is a violation of the same legislation.

Sexting The term describes the sending and receiving of sexual – explicit [73, 74, 77] or suggestive nude or near nude [44] – content, such as messages or photos, via cell phones or other electronic devices [5, 61]. It also includes sharing, posting or communicating such content via smart phones or Web2.0 services, for example SNSs. This happens rather between peers than strangers [74, 77]. Referring to Feierabend, Plankenhorn and Rathgeb [26] an average of 27% of 12-19 year-olds' in Germany have experienced someone of their peer group sendingsexually suggestive images or videos via mobile phones or the Internet. According to these surveys as well as e.g. [9, 46, 52], sexting or receiving age-inappropriate sexual-related content may constitute a risk to children or adolescents upsetting them or have legal implications.

Despite warnings about "an over-reaction in the technology safety area" [28] the trends stated above are not only upsetting or disturbing the young generation significantly to severely [26, 49, 82]. In combination with a lack of awareness these can lead to drastic consequences, including intimidation, depressions, emotional damage or even suicide [16, 63].

Ignorantia legis non excusat

ROMAN BROCARD

Furthermore, and not only limited to these trends, the handling of pictures online means responsibility in terms of legal aspects: Terms and regulations have to be accepted when registering in SNSs. Privacy, copyright or data protection laws apply also in the cyberworld, such as the Directive 95/46/EC of the European Parliament and of the council on privacy and data protection [24]. They might be violated without being aware of it [16]. "Privacy by default" or "privacy by design" might be encouraged by directives, such as by the Opinion 5/29 on online social networking by the Article 29 Working Party [1] but it is criticized that the opposite happens [16, 75]: Privacy requirements are rather "balanced" to the core business goals. Major parts of the responsibility is shifted to the users by giving them extensive control what information they share with whom. In the end, it basically is up to the users' to be aware for their ownresponsibilities online [16].

There is no privacy — deal with it.

ROGER CHESLEY

Considering the processing of personal image-based online data a prominent example is the identification or verification of persons via image processing, particularly through face recognition algorithms. In that context the NSA surveillance revelations through whistle-blower Edward Snowden have raised questions about the real level of privacy of private and personal data [42]. This case serves as a prominent example and depicts that society is between the priorities: On the one hand there are the technical possibilities, risks and consequences evolving from the application of image processing, data mining and social media analysis. On the other hand, new media and technologies are integral parts of the lives of *digital natives*, who though lack sufficient media literacy and awareness with respect to deal responsibly personal images online.
The European Data Protection Commission [16] encourages activities to raise awareness among children and teenagers as early as possible for their responsibility in handling their data online. Also Finkelhor [28] suggests to respond to questionable trends with a "generic education about life skills, social interacting, emotional intelligence, and media literacy". Facing the challenge of the digital divide between generations, the work aims at empowering children and teenagers, rather than protecting by trying to prevent. Hence, it follows the principles of the emphSafer Social Networking Principles for the EU [23] applied with respect to the context of this thesis: "1) Raise awareness of [...] users, parents, teachers and carers in a prominent, clear and age-appropriate manners, [...] 3) empower users through tools and technologies, [...] 6) [...] encourage users to employ a safe approach to personal information and privacy". Therefore, the third research question focuses on the improvement of media literacy:

III. How can media literacy and awareness of todays 10-15 year old children and teenagers be improved and a responsible way of dealing with personal images online be encouraged with an interdisciplinary educational concept including the development of and hands-on-experience with a software tool that confronts them with their own online image-based footprint?

1.4 Structure of this Thesis

The remainder of this thesis is structured as follows: Chapter 2 researches the state of the art and related work onto media literacy and media education in Austria and Germany as well as the media and Internet use of children and adolescents using the examples of the representative German KIM [27] and JIM surveys [72]. From a technical perspective it provides an overview of the state of the art in computer-aided SNS analysis, unconstrained face detection and recognition in web-scale datasets as well as of face database used for training and benchmarking of algorithms for facial analysis.

In Chapter 3 the methodology and implementation are presented. It comprises the involved research and application fields, the sociological research, the *Profiler* software tool development as well as the didactic concept and the user test experiment. The focus of the softwaretool development is put on the user interface and visualization design. In addition, it includes an overview on how the education concept is implemented. Finally, it briefly covers the implementation of the user test experiment focusing an evaluation of the usability of the *Profiler* software.

The Chapters 4, 5 and 6 present the results, provide a brief discussion using the three aspects *sociological research*, the *Profiler tool* and the overall *project concept* and conclude the thesis with a brief outlook on potential future work.

The main contributions of this thesis are:

- the development and implementation of an interdisciplinary education concept for media literacy education for pupils of age 10+ using the methodology of a school project based on the context of image analysis and synthesis as well as the retrieval of personal pictures from SNSs
- the user interface design concept to support an age-appropriate and intuitive handling of the software tool
- the high-level technical specification of the *Profiler* tool: This includes the conceptual design of a modular architecture and the workflow of the image analysis pipeline, the selection of respective image sources and image analysis attributes and methods to be integrated as well as their interaction. It also contains the design and structure of the output person profile report containing synthesized image analysis results and their statistical evaluation.
- an evaluation of the holistic project and education concept, its methods and implementation
- an evaluation of the *Profiler* software tool with respect to its usability and user-related aspects, implemented as a user test workshop in course of the school project.

CHAPTER 2

State of the Art & Related Work

This section starts with an overview on media literacy and its role in Austrian school education. It is followed by a brief summary about related projects, programs and initiatives for media literacy improvements in the related context. The geographical focus is put on Austria and Germany. In addition, this section briefly summarizes related research findings on media and SNS use and awareness among the target audience. Following the concept context of image analysis and SNS analysis, respective subsections are included, as well as concerning computer-assisted SNS analysis and media crawlers. Finally related work in image processing in unconstrained environments with main focus on face detection and finding similar faces is presented.

2.1 Media Literacy

Various different approaches and attempts to define media literacy exist [31]. The meaning of the term itself has changed with the developments of different media types – from "traditional" mass media (e.g radio or television) to the "new media" types related to the Internet [3, 31, 92]. In the German-speaking countries Baacke's discourse and description of media literacy [3] has been prominent since the 1990's: He criticizes the term to be unspecific and empirically "empty": It is not concretely specified neither the scope of the concept described. Baacke continues by describing media literacy as comprising the aspects: media analysis, media reflexion and media ethics as well as informative and instrumental-qualificatory media studies – all of them referring to the dimensions of instrumentality, goal orientation, communication and action. It takes into account receptive, utilizing as well as interactively, providing media use and innovative and creative media design [3]. He also suggests to include the dimensions of education into the term media literacy in a way, which leads also to discussions about how to impart it.

2.1.1 Media Literacy and Media Education in the Austrian School Curriculum

As the target user group pupils of age ten to fifteen are selected, because with ten years they start to use media extensively and with fifteen they are natural and independent users of Internet and

Social Media [26, 27]. Therefore, the focus is put on the curriculum for Secondary Academic Schools (Allgemeinbildende Höhere Schule, AHS) [14]. This is completed with briefly outlining the differences or additional aspects concerning media literacy and media education in other Austrian school forms, where applicable.

Media literacy and media education as part of the educational objectives and curricula for Austrian schools covers all aspects as described by Baacke: It includes on the one hand aspects of media design and production and on the other hand aspects of media use, impact assessment, critical use of media and of the relation between media, society and the individual [14].

In its guidelines and educational objectives[8] the Austrian Federal Ministry for Education and Women emphasizes the importance of media literacy. It is emphasized, that there is special needneed for it in order to exploit the whole potential of the Internet without limits and competently, with respect to the risks, possibilities and media.

For Secondary Academic Schools (Allgemeinbildende Höhere Schule (AHS)) the interdisciplinary educational objectives in terms of media literacy state that education has to stay abreast of changes in the fields of innovative technologies. Following the Austrian Federal Ministry for Education and Women's Affairs (Bundesministerium für Bildung und Frauen (BMBF)) didactic potential of new Information and Communication Technologys (ICTs) should be exploited in a way that provides relevant experiential spaces for the pupils and also allowing for a critical and rational examination of their mechanisms in economy and society at the same time. [15]. Referring to §17 Austrian School Education Act[9] it also encourages to consider interdisciplinary aspects, an orientation to scientific research, to link to the experiences, skills and living environments of the pupils. In addition, considering practical and state of the art educational goals, it is encouraged to include also external experts. Pupils should be prepared for their private and public lives by a.o. taking risks and possibilities of new technologies into account in school education. The curriculum suggests to use communicative and cooperative work forms to a.o. leverage sources of information and to work on different forms of information, to structure content and present it using multimedia. Finally, this should be completed by constantly challenging the results and its interpretation as well as by assessing and reflecting the impacts and consequences on both the individual and society [15].

Comparing to Baackes definition of media literacy the BMBF states all aspects he described as particularly relevant: The perception of one's own rights, interests, constraints and needs, the open and goal-oriented cooperation with persons and systems, the critical and creative attitude in thinking and acting, the critical evaluation of media content and media design as well as a safe and critical use of ICT and problem solving [14].

2.1.2 Improving Media Literacy Among Children and Teenagers

In addition to the school curricula, on a country and state governmental level, initiatives and programs have been started to improve media literacy among children and teenagers. These and funding programs for research and school projects have provided a fertile ground for activities

[8] `https://www.bmbf.gv.at/schulen/unterricht/uek/medien.html`, accessed: 08/2015

[9] `https://www.ris.bka.gv.at/Dokument.wxe?Abfrage=Bundesnormen&Dokumentnummer=NOR40100897` (Schulunterrichtsgesetz) accessed 08/2015

around the topic: Following, examples for such programs, initiatives and projects in Austrian and German aiming to improve media literacy among children and teenagers are presented briefly.

Mediamanual

Mediamanual[10] is an interactive platform for active media relations by the Federal Ministry for Education and Women. As an interface and communication platform it provides information, lectures and workshops around the general topic of "media". *Mediamanual* describes 21 competencies related to media education and media literacy [79], which overlap with the aforementioned goals and objectives of the Austrian school curriculum. For the scope of this work, especially competencies related to critical media design and use, reflective communicative and peaceful actions, media law and individual's rights as well as responsibilities, critical and safe use of ICT are relevant.

Furthermore, the *Mediamanual* team researches and develops teaching and learning processes and documents as well as knowledge-production networks. It hosts events and supports teachers and school projects in the context. The platform provides the option to European pupils to present their projects and media productions with the aim to encourage a reflective and responsible use of media. It also offers a collection of examples on how to implement media relations at schools. One example focuses on the online personality of Internet users[11] and recommends discussing topics in context of the Internet, such as online representation of oneself and others, privacy[12] and a encouraging a critical perspective on virtual identities, roles and behaviors online.

InMeLi

InMeLi[13] (*Entwicklung eines Instruments zur Erhebung und Reflexion der Medienkompetenz und des Medialen Habitus an Schulen*) is an ongoing National Sparkling Science Project coordinated by the University of Vienna, Faculty for Philosophy and Education[14] in cooperation with the University of Teacher Education Vienna (Pädagogische Hochschule Wien)[15], wienXtra media centre[16] and four schools in Vienna. The objective of the project is to research the Media Habitus of young people and to let young people experience, reflect and consciously handle it in order to evaluate and improve their own media literacy. This is done by letting the pupils develop a media habitus test in cooperation with the scientific team and by working out exercises together with the teachers for its application in course of school lessons. Compared to this work, *InMeLi* uses a different approach by letting pupils develop a test to evaluate their media literacy and to reflect

[10] `http://www.mediamanual.at/` accessed 08/2015

[11] `http://www.mediamanual.at/mediamanual/leitfaden/medienerziehung/lehrplan/ost/ost_031.php` accessed 05/2016

[12] `http://www2.mediamanual.at/themen/kompetenz/recht_und_links_bilder_berger.pdf` accessed 05/2016

[13] `https://www.sparklingscience.at/de/projects/show.html?--typo3_neos_nodetypes-page%5Bid%5D=816` accessed 08/2015

[14] `https://philbild.univie.ac.at/` accessed 05/2016

[15] `http://www.phwien.ac.at/` accessed 05/2016

[16] `http://www.wienxtra.at/` accessed 05/2016

their own Media Habitus, whereas in this work the focus is put on digital images in social media and by developing and applying a software tool, which confronts them with their own online self-representation to provoke and initiate self-reflection, discussions and impact assessment.

The Profiler

The Profiler [17] is an ongoing research project of the Sparkling Science program [18] partly funded by the Austrian Federal Ministry for Science, Research and Economy.

Sparkling Science started in 2007 and aims at promoting young scientists in an unconvential way, which is unique in Europe, applying the research method of "Citizen Science": They are integrated as active participants, or "junior scientists" into scientific research projects and work side by side with researchers.

The Profiler is positioned between the conflicting poles: On the one hand there is an increasing flood of digital images online and the skilful use of media of 10 to 15 year olds. On the other hand, children and adolescents lack awareness for consequences, risks and responsibilities in handling personal data online on the other hand. In course of the interdisciplinary project the Internet use behavior with special focus on image data, of 10 to 18 year olds is researched. It takes into account the awareness for possibilities and risks resulting from handling their personal pictures online. The project includes research, implementation and evaluation of state-of-the-art algorithms for detection, recognition and classification of persons (based on faces), age, gender and emotions in large and unconstrained image datasets. Finally, as part of the project a software-tool is developed for pupils to explore and evaluate their own personal online-profile based solely on analysis and synthesis of digital images retrieved from image search engines and SNSs. Following the Sparkling Science objective the students participate actively in the project during all project phases. This includes workshops on context-related topics, such as image analysis, copyright and data protection, and sociology. They gain hands-on experience in user interface design and evaluation, quantitative and qualitative research methods and by visiting a research facility of Vienna University of Technology. The project aims on rising awareness for a critical media, Internet and SNS and for the possibilities and consequences of applying current technologies, such as image analysis, within the context.

Netkompass

Similar to this work, the Sparkling Science project *Netkompass*[19] is positioned in the area of conflict emerging from the possibilities and chances and the problematic aspects of the Social Web. The two-years project was carried out 2012 to 2014 by the interdisciplinary consortium of the University of Applied Science Upper Austria, University Klagenfurt, the Austrian Institute for Applied Telecommunication and three Upper Austrian Upper Secondary Education schools. The approach of the project is to provide an information platform[20] for adolescents centered

[17] `http://www.theprofiler.at`, accessed 06/2016

[18] `https://www.sparklingscience.at/`, accessed 06/2016

[19] `https://www.sparklingscience.at/en/projects/show.html?--typo3_neos_nodetypes-page%5Bid%5D=692` accessed 08/2015

[20] `http://www.netkompass.at/` accessed 08/2015

on the topics of privacy and data protection in this context. Following the Sparkling Science objective the platform is developed and implemented in a close cooperation between scientists and adolescents with the latter being actively engaged in the research and development phases. Awareness is raised during the project for the involved students by hands on experience in creating informative material on the topic for peers and through stepping into the role of being didactic designers.

Following similar overall aims and being positioned in the same general topic the approaches and means used are rather different. Whereas in *Netkompass* the approach is to develop multimedia information material about privacy and data protection in the Social Web and make it available for the public, this work has a clear focus on images online and their automatic analysis and uses these research fields and the technological means and applications as basic approach motivation.

Saferinternet.at – Austrian Awareness Centre

Saferinternet.at is an Austrian initiative with the aim of supporting Internet users, a.o. especially children and teenagers in developing a safe use of media digital media. The lead of the information and coordination center is the Austrian Institute of Applied Telecommunication (OIAT)[21] in cooperation with the Internet Service Providers Austria (ISPA)[22]. Activities of the initiative are for examples websites, workshops and support services, free school resources and networking with relevant players and journalists. *Saferinternet.at* also offers workshops, presentations, school projects and conferences for pupils, parents, teachers, social workers, etc. in Austria[23]. It is co-funded by the Safer Internet Programme of the European Commission, the Austrian Federal Ministry and industry sponsors and it is a member of the European network of Awareness Centres *Ins@fe*[24], which is promoting safe, responsible Internet and mobile devices use among young people as part of the *Strategy for a Better Internet for Children*[25]. *Saferinternet.at* provides Q&A, tipps, material and multimedia content to various topics related a responsible use of Internet and new media as well as users' responsibility and potential risks, such as cyberbullying, digital games, data safety, mobile devices, online-shopping, Internet and sexuality, privacy, copyright, virus, spam and online fraud. Examples for school and information material for children and youth the context of this work:

- Copyright: "Copyright in 24bits" [26]
- Brochure about pictures and videos online[27]

[21] `http://www.oiat.at/` accessed 05/2016

[22] `https://www.ispa.at/` accessed 05/2016

[23] `https://www.saferinternet.at/veranstaltung-buchen/` accessed 08/2015

[24] `http://www.saferinternet.org/` accessed 08/2015

[25] `http://ec.europa.eu/digital-agenda/en/creating-better-internet-kids` accessed 08/2015

[26] `https://www.saferinternet.at/fileadmin/files/Materialien_2013/Ratgeber_Urheberrecht.pdf` accessed 08/2015

[27] `https://www.saferinternet.at/uploads/tx_simaterials/Flyer_Bilder_Videos_01.pdf` accessed 08/2015

- "My profile in my online community": Exercise for a critical reflective analysis of online self-presentation by user-profiles in SNS, their possibilities, potential risks and consequences[28]

Similarly to *mediamanual.at*, *Saferinternet.at* also encourages a critical reflective analysis of online self-presentation by user-profiles in SNSs. In contrast to this approach, *SaferInternet* though uses "Fake" profiles in "Fake" SNSs as a basis for discussions and does not work on the real profiles of users. In addition, and though included, the focus is no set on digital images in detail but rather covers all types of content.

Bildungsserver "Medienkompetenz macht Schule"

Bildungsserver "Medienkompetenz macht Schule"[29] (Education server: "Media literacy goes school") is a program by the government of Rheinland Pfalz, Germany, addressing the developments and changes in the media landscape by improving media literacy. The working group has developed a 10 points program to improve media literacy. The primary focus is on pupils at schools from elementary school onwards and on encouraging the use of new media in schools by forcing the expansion of media-related infrastructure and by providing advanced training for teachers. It additionally focuses on an intensive integration of parents and provides different educational materials to be used in school lessons, initiates pilot projects and is active in partner networking. Participating in a 3-years project with semi-annual workshops about the program and under different main focus every year, schools can be awarded a "Medienkompetenz macht Schule" project school. Currently 550 secondary schools of Rheinland-Pfalz participate in the supervised program.

2.2 Media Use of Children and Adolescents

The German (bi-annual) KIM study researches the media and Internet use among 6-13 years old children. Similarly, the annual JIM survey focuses on 12-19 years old adolescents. Both surveys are carried out by the German media pedagogical research cooperation southwest (Meidienpädagogischer Forschungsverbund Südwest). Context-relevant results of the latest KIM 2014 [27] and JIM 2015 [72] surveys are briefly summarized below. Further, similar surveys in Europe are for example studies conducted by the EU Kids Online multinational research network[30], e.g. [50, 51].

2.2.1 KIM

The KIM study [27] researches the media use of children of age six to thirteen years in Germany using questionnaire-based telephone interviews with 1.209 pupils. The latest survey from 2014 shows, that almost all of the children have access to a mobile phone or smart-phone and to

[28] `https://www.saferinternet.at/fileadmin/files/web_2.0/Arbeitsblatt_zu_Uebung_5.pdf` accessed 08/2015

[29] `http://medienkompetenz.bildung-rp.de/gehezu/startseite.html` accessed 08/2015

[30] `http://www.lse.ac.uk/media@lse/research/EUKidsOnline/Home.aspx` accessed 05/2016

the Internet (both 89%) an that there is a strong upward trend – the number tripled within two years as compared with KIM 2012 [71]. Ownership of a mobile or smart-phone increases with increasing age from 10% among 6-7 years olds to 83% of 12-13 years olds. A similar age-specific jump is also noticeable concerning the use of the Internet on their own: A fifth of the 8-9 year-old surf in the Internet. Among the 10-11 year old children it is already more than half of them and 69% of the 12-13 year-old. 40% of children age 6-13 use the Internet on a *daily* or *almost daily* basis. Among adolescents more than eight out of ten use their mobile phone or the Internet daily in their spare time. Mobile use of media and the Internet has gained importance and according to the survey there is a jump in Internet use between children of age 8-9 years and 10-11 years from 20% to 69%. More than one third (37%) of them use the Internet mainly alone, whereas the most popular activities are related to communication.

The majority of the children (>87%) uses cameras and two thirds of the 12-13 years old use the Internet and Apps. More than 26% sends or shares pictures or videos using mobile phones and mobile devices have become the central mean for communication for them. Almost half of the children are registered in at least one SNS, the average age at registration is 10.4 years. This is remarkable as SNSs, such as Facebook state in their Terms of Use a minimum required age of users of 13 years upon registration. The most popular activities are chatting, sending messages, publishing status messages and 40% of the users upload at least once per week media content. Whatsapp is relevant for children of age 10+, this explains also the increase of the number of children owning a smart-phone. And the other way around 82% of mobile phone owners who use Apps have Whatsapp installed on their phone. Concerning privacy and data protection aspects the study reveal that almost half of the children is registered in a SNS using a nickname for the registration, whereas only 29% use their real names. In average, their network counts 62 so-called friends. Further, the top three of personal information published online are their own photos or videos (37%), photos of friends or family (24%) followed by their email address (20%). Three out of four pupils share their content only with their friends, and still 13% do not protect their data. 11% are not aware about their access rights settings. More than one tenth had encountered upsetting content online, mostly not age-appropriate or strangers getting in touch with them. The majority (84%) of parents thinks that the Internet bears dangers to children, though almost half of the children (46%) are allowed to use the Internet alone.

Already half of the participants in the survey is able to access the Internet without support, one quarter is able to upload images from the smart-phone to the computer, to download files or Apps. The survey also evaluates that these skills are formed starting from an age of approximately ten years. On the long term it shows that despite the omni-presence of media in childrens' everyday lives the technical skills are only developed partially.

2.2.2 JIM

The majority of the 12-19 years old adolescents surveyed in JIM 2014 [26] own a smart phone (88%) and almost all have access to one (94%). Internet, smart phones and online media have gained very high relevance for their everyday lives and for the first time mobile phones are the first-ranked mean to access the online world. Among the online activities of teenagers communication (44%) and entertainment (25%) are top-ranked, whereas 80% chat at least several times and almost two thirds use SNSs several times per week. Hence, most popular apps installed

on smartphones are messenger Apps (86%, e.g. 84% Whatsapp) or SNSs apps (46%; e.g.43% Facebook or 21% Instagram). Almost all adolescents (94%) have Whatsapp installed on their smart-phone and 86% use the app at least on a daily basis for communication, which has become an alternative to sending SMS. Also the App Instagram for publishing, sharing and commenting to photos has gained popularity compared to the previous JIM survey 2013 [60]. Adolescents regularly send messages, chat and 'like' contents published by others, browse user profiles. 8% of the teenagers upload photos or videos to online platforms at least several times per week.

Concerning negative trends 17% have experience with wrong or insulting content of them being shared online, 14% stated that embarrassing or offensive videos or photos of themselves have been shared without their consent. Finally, more than one third (38%) know someone who has been cyberbullied, 7% stated having been a victim of cyberbullying. There is awareness for risks arising from the use of (online) media and smart-phones: For example, 80% now about GPS-based tracking using smart-phones. 14% have had experience having received inappropriate (violent or pornographic) content. More than one quarter (27%) know someone who sent sexting photos or videos from himself or herself via smart-phone or the Internet, growing with increasing age. The overall sense of security concerning their data in online communities is ambiguous – and almost equal for *feeling safe or very safe* and *not so safe or not safe at all*. Altogether, the study revealed that sensitivity for security aspects has increased as well as the number of users with critical attitude.

2.3 Computer-Aided SNS-Analytics

With the existence and growth of SNSs, SNS analytics has become a research hot topic: Conducted manually, computer-aided or automatically, information published in SNS, user behavior and user networks have been analyzed and utilized for research in different fields, such as psychology and sociology, e.g. [34, 86, 91], or technical fields, e.g. [11, 17, 18] .

With respect to computer-aided SNS analytics, Irani et al. [37] measure the size of the users' online social footprints and investigate the difficulty of reconstructing a user's online social footprint based on prior knowledge either of a pseudonym or the person's name . For that they crawled through an identity management site and collected 54.600 users' online identities from different SNSs. They show that – depending on the method and the reference information used – up to 40% of the person's other social networking sites can be found based on the information utilized from one SNS. They argue, that the outcome of their work shows an example for the possibility of leveraging information of a person, which could be also exploited in terms of online threats, such as stalking, compromising personal accounts or customized spam or phishing. Similar to this work, the authors research, evaluate and confront with the power of algorithms to describe persons based on online available information acquired and exploited from SNSs. Though, they do not focus their research on online images and their exploitation in order to compose person descriptions.

As part of the facebot project Mavridis et al. [57] research context-assisted visual recognition, and take into account the social context for SNS-based face recognition following their basic idea of a strong correlation between co-occurrences of faces in photos and the respective social relation of the persons . They base the training and recognition on a combination of photos

derived from a camera, of online photos published on Facebook and meta-information posted with the Facebook images. The authors utilize tags in pictures and friendlists to improve the accuracy of face recognition in SNS and create their dataset by crawling through first-level friends of the robot, downloading all photos in which he or she was tagged and discarding erroneous pictures, followed by splitting the dataset in a test and training set of similar size. Face recognition is implemented by Mavridis et al. based on the Viola Jones Facedetector and Embedded Hidden Markov Models. They show in their work that a person recognition performance can be increased through utilization of social information presuming a reliable seed for the social information. The authors demonstrate, how the use of context gained from a social network relations can improve Face Recognition (FR) accuracy especially for the task of recognizing multiple faces within the same image, and vice versa how image sets with recognized faces can assist in the evaluation and prediction of online relations between individuals. They determine two faces appearing in an image together have a likelihood of approximately 80% likelihood to be friends.

The idea of PhaceBinder in [10] is to identify people captured with a mobile phone by combining face recognition technologies and tagged images available in SNSs usuing a mobile App as well as leveraging meta-information from SNSs to research the social relation between two users. The authors contribute a methodology for image acquisition from one SNS (Facebook) and construction of a face database for Face Recognition (FR) as well as a method for modeling social relations between users. Their approach starts with the user granting application permissions and is followed by crawling users and their friends' photos and contextual information of the primary user and their direct friends. They consider pictures with manual tags and detected faces based on the OpenCV[31] face detector and a minimum of four face images per user. To improve the recognition accuracy, furthermore the gender is stated before the analysis to limit the search space. For face recognition they use Hidden Markov Models (HMMs) and return the top three persons with an accuracy of 60% without gender information and 64% when providing gender information.

Compared to the approach of this work the starting point of recognizing persons using unconstrained images in the context of SNSs, but [10] build a database of annotated faces and they crawl friendlists in addition to the users' own photos uploaded in the SNS. Furthermore, they require at least four images per face for the face recognition and take into account gender information, which is not feasible in the context of this thesis.

2.4 Unconstrained Face Detection and Recognition in Web-Scale Datasets

Main focus with respect to the software development aspects is a comprehensive image analysis based on state-of-the-art image processing algorithms. The characteristic of the application to pictures downloaded from the Internet and SNSs is that the pictures are taken in so-called unconstrained environments. Opposite from restricted lab-settings, pictures are taken uncontrollably, in different surroundings and using different camera types and settings, which results indifferent

[31] `http://opencv.org/` accessed 05/2016

quality, resolution and compression , [64]. The picture content is exposed to variable lighting conditions of the scene [88]. Furthermore, persons might be captured in different poses, not limited to frontal views. They may change their appearance due to time intervals between the pictures were taken or due to aging, hairstyle, accessories, make up or facial hair and mimics.

The description of images is achieved on two different levels – perception and semantics. Perception-based features, such as color histograms or textural properties are commonly used in the field of Content Based Image Retrieval (CBIR) [19]. Other features base on know-how from the field of photography [105], for example the Rule of Thirds or depth of field. CBIR systems detect images in image databases using feature similarities. Image classifiers such as to distinguish between graphics vs. Photography, day vs. Night or indoor vs. Outdoor can be extracted reliably [100]. FR with standard algorithms are e.g. based on Eigenfaces [94], Fisherfaces using holistic or feature-based methods as well as hybrid methods and are presented in a survey work as well as evaluated in [8, 110].

SIRE is a multi-modal large-scale social image retrieval engine [35]. Its aim is to close the semantic gap between high-level concepts and low-level features by querying image- and text-based data and integrating feedback mechanisms. Torralba et al. [90] research the development of efficient algorithms with respect to image search and matching-techniques for large-scale image databases for the purpose of recognition. Liu et al. [48] present a comprehensive research on local features and kernels for texture- and object classification.

The presented concept includes a Software tool, *the Profiler*, which aims at closing the gap between SNS analysis and image processing by performing image processing methods onto unconstrained web-scale datasets of images acquired from SNSs. Image-based detection, recognition or classification of age, gender and affective attributes are included in the *Profiler* software. They presume a Face Detection (FD) applied to the acquired images. Therefore, these analytics methods infer challenges in context of FD, identification or verification techniques on unconstrained images. Within this context, Ortiz and Becker [64] as well as Pinto et al. [69] research the application of FR techniques within the context of SNSs and underline in their work the specific challenges to the algorithms deriving from the large datasets to be analyzed, from its acquisition as well as due to the heterogeneity of the pictures themselves. Performing unconstrained face recognition in large datasets in the context of SNSs scaling with low training times as well as fast classification rates and high identification performances with reliable rejection of unknown persons are crucial as otherwise response times for the users are unacceptable or they are faster in labeling faces themselves [64].

Ortiz and Becker introduce within the context the term *open-universe face identification* [64]: *open-universe* refers to scenarios where a new test face does not have to be known, but can also be from unknown identities. Consequently, *open-universe face identification* describes the task of evaluating if a new test face is known in the dataset of known faces and if so, what the most probable identity is.

Support Vector Machines (SVMs) are supervised learning models for classification and have the advantage of fast classification and have become popular in FR also with application on small real-world subsets [102]. Despite the advantages, the training is time consuming with increasing number of training samples in order to gain competitive classification results [64].

In contrast, algorithms for **Sparse Representation Classification (SRC)** follow the approach that a test image can be represented by a linear combination of a small subset of images from a large database or dictionary [103]. The authors present in their approach a sparse corresponding coefficient vector containing only few elements different from zero which are obtained with l1-minimization. Different approaches exist which address the drawbacks of requiring aligned faces (e.g. by aligning and classifying test images in parallel with respect to pre-aligned training sets [67] or by overcoming lighting or pose related influences [66]) and of slow classification times, e.g. [45, 93, 109].

Least square (ℓ^2) solutions loosen the sparsity constraints by using an ℓ^2 norm instead of ℓ^1 and are proposed within the context by e.g. [62, 104, 108]. They are faster concerning coefficient vector recovery, though show weak performance when used with real-world data, following [64].

2.4.1 Linearly Approximated Sparse Representation Classification (LASRC)

Ortiz and Becker finally combine SRC and least square solution [64] to exploit their respective benefits, such as the speed of least-squares and the robustness for real-world datasets of SRC (see Figure 2.1). The workflow is depicted in 2.1:

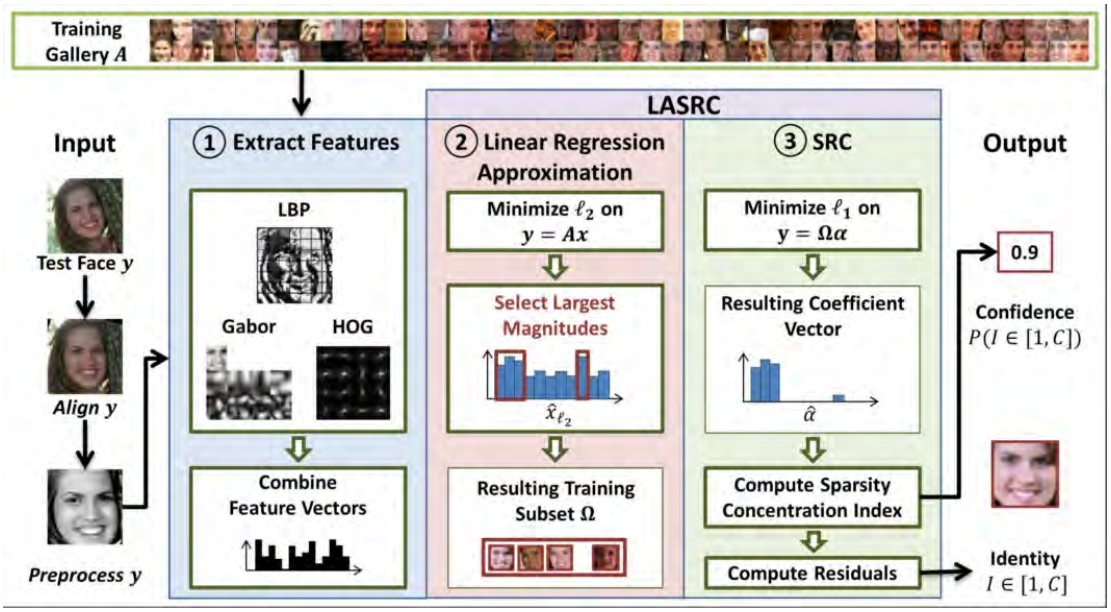


Figure 2.1: Depiciton of the workflow of the LASRC algorithm (image source: [64])

Following initial alignment and preprocessing as well as normalization of the test image, they extract and use in their approach three local features Local Binary Pattern (LBP), Histogram of Oriented Gradients (HOG) and Gabor to address the problems of pose, occlusion or misalignment sensitivity. The feature vectors are combined and fed into the linear regression approximation (least square solution), which is used to discover a subset of the initial face dictionary using the following steps:

1. Normalization of the columns of the training gallery A to result in unit ℓ^2-norm form
2. Calculation of coefficient vectors by performing linear regression using pre-calculated pseudo-inverse
3. Selection of K samples with the largest coefficients from A in $|\hat{\boldsymbol{\chi}}_{\ell_2}|$ as representative training samples Ω.

This again serves as input to the SRC ℓ^1-minimization, which finally classifies the identity and confidence of a given test set: Ω is inputted to the ℓ^1-solver, which performs ℓ^1 minimization in order to calculate the most probably face identity and classification confidence

The resulting face identity is $I(\mathbf{y}) = \arg\min_j r_j(\mathbf{y})$ and the confidence is calculated as $P(I \in [1, C]|\mathbf{y}) = SCI$. The residual error is calculated for each class j as $r_j(\mathbf{y}) = ||\mathbf{y} - \boldsymbol{\Omega}_j \boldsymbol{\alpha}_j||_2$ and the sparsity concentration index SCI is

$$SCI = \frac{C \cdot max_j ||\boldsymbol{\alpha}||_1 / ||\hat{\boldsymbol{\alpha}}|| - 1}{C - 1} \tag{2.1}$$

According to Ortiz and Becker, in contrast to SRC LASRC speeds up classification by 100 times by adding a new tunable parameter K to select a small pool of training samples for ell^1 minimization with a linear regression approximation at the price of a drop of 2.1%. Evaluating different algorithms under real-world scenarios the authors further show that LASRC with local features are applicable to real-world face identification.

2.4.2 DeepFace

A novel approach for SNS-based face recognition with a large scale training dataset of four million facial images of more than 4.000 identities has been proposed by Taigman et al. in [87]. It is based on an effective Deep Neural Network (DNN) architecture and learning method. With that a face representation can be obtained, which generalizes well to other datasets. They introduce a facial alignment system based on explicit 3D face modeling. The workflow of their proposed method is shown in Figure 2.2. With their method they advance the face recognition state of the art significantly in the Labeled Faces in the Wild Labelled Faces in the Wild (LFW) benchmark reaching near human performance and the YouTube Faces dataset decreasing the error rate there by more than 50%.

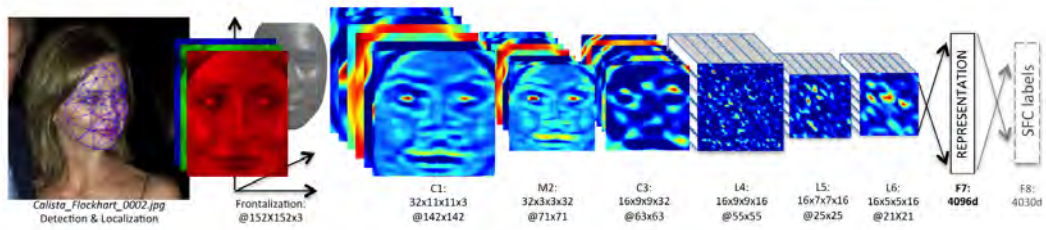


Figure 2.2: DeepFace algorithm architecture outline (image source: [87])

The key novelties of their approach is in the alignment and representation steps: Their methods implements an alignment step based on explicit 3D face modeling and iteratively applying fiducial-point detectors using Support Vector Regressors and LBP histogram image descriptors: First step is a 2D alignment based on fiducial points and the application of affine transformations into six anchor locations. The resulting 2D-aligned crop subsequently undergoes a 3D alignment step to compensate for out-of-plane rotations. This is done using a generic 3D shape model and registration of a 3D affine camera, followed by warping the 2D-aligned image to the image plane of the 3D shape and concluded with a face frontalization. In the representation step they derive a representation of the face using a nine-layer deep neural network. Therefore, the approach relies on deep-learning rather than feature-based methods, following the finding in [40] that engineered features have started to be outperformed by learning-based approaches. Taigman et al. assume that once the alignment has been completed, the location of each facial region is fixed at the pixel level. Therefore, it can be learned from the raw pixel color information and rather than having to apply several convolution layers. The work of Taigman et al. can be seen as an aim for this work in terms of the possibilities of accuracy that can be achieved within the context of unconstrained face recognition. Though, the pitfall is as described in [40] the necessity to have large amounts of training data and hardware resources for computation (in a dimension of thousands of CPU's and GPU's) available. Hence, the deep face approach opposes to the context of this work as minors are the main user group and making the software tool available through the web. Starting point for the literature research are methods for age detection, such as [107] , gender classification [55] and for emotion classification [20, 47, 89]. In the context of the analysis of personal attributes a related project is SHORE^{TM}[32] by Fraunhofer. It is a proprietary software product performing age, gender and emotion (happy, surprised, angry, sad) classification in live videos in real time.

2.5 Face Databases

For the training and evaluation of image analysis algorithms labeled reference datasets are used, which comprise ground truths holding *correct* results. Face databases have been developed aiming on different application scenarios and consisting of face images taken from different groups of individuals under various settings referring to lighting conditions, face pose or colors. Following, relevant face databases for the training and evaluation of the face analytics algorithms for the Profiler software are listed.

2.5.1 Labelled Faces in the Wild (LFW) Database

LFW[33] [36] is a de facto standard face database with pictures taken in uncontrolled settings and environments from online magazines and news. The LFW database aims supporting studies for face recognition using previously existing images, i.e. images that were not taken for the special purpose of automatic face recognition. The LFW images contain arbitrary expressions

[32] `http://www.iis.fraunhofer.de/de/ff/bsy/tech/bildanalyse/shore-gesichtsdetektion.html` accessed 05/2016

[33] `http://vis-www.cs.umass.edu/lfw/` accessed 05/2016

and variation in clothing, pose and background and strive to capture a set of realistic images. From the same individuals pictures are taken in different settings and at different times. LFW is targeted at face recognition or identification and has a broad distribution of people belonging to different ethnicities. It is used by researchers to evaluate and compare the performances of image analysis algorithms especially with respect to real-world and unconstrained input faces as well as for pair matching scenarios [6, 32, 102]. The dataset is composed of images directly outputted by the Viola Jones face detector and does not provide eye position markings, though faces are centered and of similar scale. LFW consists of an average of 2.30 images per person and 5.749 different individuals in total. Furthermore, it constitutes a basis for other face database extending the LFW dataset, such as PubFig83+LFW database [6].

2.5.2 LFW+Pubfig83 Dataset

The dataset available for non-commercial use combines the LFW and Pubfig83 databases [41], whereas the latter is intended for application in face verification scenarios. LFW+Pubfig83[34] is realized by Becker and Ortiz [6] and simulates a more realistic context for face recognition as compared to either of the datasets alone. The authors developed it with the aim of identifying celebrities in crowded environments while rejecting background faces. The PubFig83 datasets contains images from 83 individuals and is used as test images and training gallery. All remaining individuals from the LFW database represent the distractor gallery or background faces. The database contains 8.720 trainings and 4.282 test face images of altogether 83 individuals as well as more than 5.000 individuals with 12.066 faces from LFW for background and distractor faces.

2.5.3 MMI Database

The MMI Database[35] [65] is focused on its use for facial expression related applications. It includes more than 2.900 videos and images of 75 individuals and is fully annotated with respect to Action Units (AUs) within every frame. It does not only contain the six basic emotions but also expressions where only one single Facial Action Coding System (FACS) AU is activated. The MMI Facial Database is an ongoing project whereas at this point from 2894 sessions in the database, 1395 are AU encoded and 197 contain basic emotion labels[36].

2.5.4 CASIA Database

The CASIA database[37] is released for research use by the center National Laboratory of Pattern Recognition at the Center for Biometrics and Security Research Bejing. It contains a total of 2.500 face images from 500 different individuals taken under laboratory settings with intra-class variations resulting from illumination, pose, expression, imaging distance or accessories. It is available as the whole dataset or as subsamples of each 200 pictures as well as in a cropped version.

[34] `http://pubfig83lfw.briancbecker.com` accessed 05/2016
[35] `http://mmifacedb.eu/` accessed 05/2016
[36] `http://mmifacedb.eu/pages/about/` accessed 05/2016
[37] `http://biometrics.idealtest.org/dbDetailForUser.do?id=9` accessed 05/2016

2.5.5 COLOR FERET Database

The COLOR FERET database[38] released by the Defense Advanced Research Project Agency (DARPA) is a 24bit color version and successor of the FERET database[39]. It contains 2.413 face images of altogether 856 individuals of 512 x 768 pixels in dimension, which are taken in controlled laboratory settings.

2.5.6 Extended Cohn Kanade (CK+) Database

The CK+ [53] Database is the successor of the initial Cohn Kanade (CK) AU-Coded Facial Expression Database aiming at facial image analysis and synthesis with focus on facial expressions and is made available by the Affect Analysis Group at the University of Pittsburgh[40]. CK contains 486 sequences from 97 individuals, each of them beginning with neutral expression and proceeding to a peak expression, which is labeled with the Emotion Facial Action Coding System (EMFACS) emotion label of the emotion requested. CK+ includes validated emotion labels and posed as well as spontaneous expressions as well as further meta data. Also number of individuals is increased by 27%. In addition the database holds data necessary for facial feature tracking and emotion recognition, such as baseline results or protocols.

2.5.7 AR Database

The AR face database was developed by Martinez and Robert Benavente at Computer Vision Center at the U.A.B. [56]. It consists of 4.000 frontal view faces of 70 male and 56 female individuals, i.e. of altogether 126 persons. The photos are taken under strictly controlled conditions and from every person in two sessions separated by an interval of two weeks. No restrictions are made with respect to wear, make-up or hair style. The 24bit depth color photos of 768x576 pixels contain different facial expressions – neutral, smile, anger and scream – and different illumination conditions as well as occlusions of facial parts due to sun glasses or scarfs. The AR face database is free for academic use.

2.5.8 Adience Dataset

The Adience dataset[41] consist of unfiltered face images from Flickr[42], which have been automatically uploaded from smart-phones and do not include any prior filtering. Therefore, the images are unconstrained with respect to factors such as head pose or lighting conditions and reflect real-world settings. The collection comprises 26.580 images from 2.284 individuals and includes subject, gender and age labels. Concerning age, there exist eight age group labels from infant age to 60+ (0-2, 4-6, 8-13, 15-20, 25-32, 38-43, 48-53, 60-). The Adience database is used for gender and age classification in real-world scenarios [21].

[38] `http://www.nist.gov/itl/iad/ig/colorferet.cfm` accessed 05/2016
[39] `http://www.nist.gov/itl/iad/ig/feret.cfm` accessed 05/2016
[40] `http://www.pitt.edu/~emotion/ck-spread.htm` accessed 05/2016
[41] `http://www.openu.ac.il/home/hassner/Adience/data.html#agegender` accessed 05/2016
[42] `https://www.flickr.com/` accessed 05/2016

2.5.9 Japanese Female Facial Expressions (JAFFE) Database

The JAFFE database[43] comprises 213 frontal face images taken of ten female Japanese persons. From every person three to four photos included for each of the following seven facial expressions – neutral, happy, sad, surprised, angry, disgusted and fear. The rating for the degree of each component basic expression is done by altogether 92 Japanese female undergraduates using a five point scale [54]. All photos are available as grey-scale images with a resolution of 256x256 pixels. The database is available free of charge for academic, non-commercial research use.

2.5.10 Craniofacial Longitudinal Morphological (MORPH) Database

The non-commercial MORPH database is available for a charge of $99 and contains images of the same subjects taken over a span of five years from 2003 to 2007 in uncontrolled settings. It comprises in total 55.000 images of more than 13.000 persons with an average of 4 images per individual. The database includes labels for ethnicity, gender, date of birth facial hair and glasses flags and meta-information referring to the age difference as number of days since the previous picture was taken[44].

2.5.11 10k Adult Faces Database

The 10k Adult Faces database[45] comprises 10.168 face images taken from natural photographs. In addition, for 2.222 faces measures are included, such as computer vision attributes or landmark point annotations as well as psychology attributes. All pictures are of 256px height. The development of the database was funded by the National Science Foundation and by Google and Xerox Research Awards and is available for academic use [4].

[43] `http://www.kasrl.org/jaffe.html` accessed 05/2016
[44] `http://people.uncw.edu/vetterr/MORPH-NonCommercial-Stats.pdf` accessed 05/2016
[45] `http://wilmabainbridge.com/facememorability2.html` accessed 05/2016

CHAPTER 3

Methods & Implementation

In this chapter the holistic concept approach is described in detail, which is developed based on the research questions. Characterized by its interdisciplinary structure, the following sections include both the applied methods as well as their implementation. This is done using the perspectives of sociology, technical aspects and education concept, integrated into the overall approach work-flow.

The core of the concept is constituted by image processing and computer vision focusing on application fields such as the Internet and SNSs. This field contributes to the project with the development of the *Profiler* software tool and with research, extension and integration of state of the art image analysis algorithms. Furthermore, the contributions include the development of an age-appropriate and intuitive user interface design based on state of the art frameworks and tools.

Other than in Germany, e.g. with the KIM and JIM studies, there do not exist comparable large studies within the context to date in Austria. Therefore, the research field of sociology, more precisely, youth research, aims at generating comparable results. For this studies are developed and conducted in in a limited application environment, which can be extended to large scale later on, e.g. at a national level. Sociology complements the computer science part in the user requirement analysis: It conducts research about the media and Internet use of children and teenager, with special focus on images in the online world. The outcome of this is also used for the scenario design with respect to the software tool design and development. The starting point is a qualitative sociological research, which follows a mixed methods participatory approach: It combines qualitative research using focus groups and interviews as well as quantitative research using an online questionnaire. Both these sociologically dominated tasks also take into account research on the language and terminology students use as well as the status quo of their context-relevant awareness.

Concerning the software tool, first a requirement analysis is carried out. It takes into account technical aspects, the state of the art in the relevant fields as well as user aspects and requirements gained a.o. from the sociological research activities. Based on this and a feasibility study, the technical specification of the *Profiler* software tool is defined, which is the basis for its

subsequently following implementation (see subsection 'Implementation'). In the next step, technical as well as user-oriented tests, evaluations and optimizations of the *Profiler* tool are conducted (see subsection 'Evaluation and Optimization') and finally, the software is applied in school workshops (see Section 3.4). This hands-on-experience workshops are combined with an evaluation of the sociological aspects and aims, such as the impact of the concept on the pupils' awareness for possibilities, risks and their responsibilities online.

3.1 User Requirement Analysis - Sociological Research

The sociological research part comprises qualitative and quantitative research methods [96]: They aim at gaining insights into the life worlds of children and teenagers within the context of their Internet and media use behavior. Special focus is put on digital images. The sociological research constitutes also the user requirement analysis for the software tool development. Its implementation is coordinated by and carried out by sociologists from University of Graz in close collaboration.

3.1.1 Qualitative Research Methodology

The qualitative research part of the mixed methods approach using exploratory studies [81] is divided into two steps – one before a quantitative survey and one following it. Its aim is to gain detailed insights into the life world of 10-15 year-old pupils in the given context. With respect to the quantitative survey this phase also researches the language and terminology used by the children and adolescents, as it is seen as a crucial criteria for a successful implementation of the online questionnaire.

The introduction for the pupils at the beginning of the project work is concise: It consists only of a brief overview of the project scope and an introduction of the involved interdisciplinary team. Then it is directly proceeded with the first qualitative research workshop. Getting started directly prevents the students from preparing and dealing with the topics in advance to the sociological research. Therefore, it allows to gain an unbiased status quo of their media use and awareness of the topic.

The first qualitative research work is conducted with pupils from both first and fifth grade (i.e. ten to eleven as well as fourteen to fifteen years old children and adolescents). In a group discussion of the pupils the topic of media use and SNS use as well as their motivations for and activities when using it is elaborated on. The discussion is moderated by one member of the sociological and technical scientific team each in order to balance both aspects within the discussion and retrieve insights within both research fields. In the subsequent session short questionnaires are distributed to the pupils to be filled out as individual work. This exercise can reveal requirements and constraints concerning the contents, terminology, methodology and an estimate for the duration to accomplish it referring to the development and methodology of the questionnaire, e.g by questions or difficulties of the pupils while filling out the form. The individual work is followed by a group discussion on both the contents of the questions, the structure and language of the short questionnaire as well as their experience during the exercise. Therefore, this task is both about the experience and skill level of the students as well as their

feedback on the structure (including terminology, type of questions) and about the results. It is used as a starting point for the development of the final online questionnaire.

In addition to the group discussions and first small example questionnaire on paper the pupils work together in groups of three or four and draft questions they would be interested in finding out about their peers within the context. The results of this group work on the one hand represent the pupils' interests and values as well as they describe their life worlds within the context. The insights into their perspectives might reveal topics and research questions and fields which would have not been covered without the pupils' participation. Thus, it serves as a valuable input for the online questionnaire as well. All discussions and workshops are documented and evaluated by the researchers.

Finally, consecutive to the quantitative study, group interviews are held with two gender-separated groups of five pupils of each of the involved grades. It is based on the questionnaire, but extends it in order to gain a more comprehensive yet detailed evaluation of the media use and behavior dealing with pictures online as well as about their awareness and experience with risks and problems in the Internet. Furthermore age- and gender aspects are assessed in depth using this method. The group interviews are video-documented with prior consent and the transcript is evaluated to provide a qualitative Status Quo for the youth research part as well as to contribute to the technical development phases later on.

In addition, interviews with eight pupils from fourth grade and eight pupils from sixth grade (four girls and four boys respectively of each age group), are held. Individual motivations, topics and perspectives not covered by the questionnaires, especially in the context of risks and consequences of handling images online, can be assessed. For each of the interviews a duration of one lesson is planned and it is done by one scientist. It is audio-recorded for documentation with the consent of the interviewee. For the evaluation of migration backgrounds, in addition to the forename and the age of the student, also the origin of their parents is noted.

3.1.2 Quantitative Research Methodology

To gain insights about which SNSs 10-18 years old children and adolescents use, a pre-survey is carried out in one class of the first grade and one class of the fifth grade at GRG23 Draschestraße in Vienna, Austria, in September 2014. The survey is done open and orally. The outcome of this pre-survey supports by providing a preliminary estimate which online image sources to be further researched for the image acquisition. To research the use of media and the Internet among pupils in Austria, specifically Vienna, a quantitative approach using an online questionnaire is chosen [97]. The goal of the survey is to gather quantified data about the following aspects:

- As a basis for their Internet and media use: Which devices with Internet access do they own? Which devices do they use to go online, how often and how long?
- Relevant Social Media Services and means for communication
- Use of Social Media: Which services do they use and for which activities? Which SNSs and communication Apps are used most often? What is the size of their personal contact network in each of them and where do they know their contacts from? Furthermore the

correlation between contacts from the virtual world and those they know personally as well is researched. Which information do they share in SNSs?

- Pictures in SNSs: Do they publish and share pictures and media? Where? What is their experience with it (see negative experience below)
- Social Media, their online identity: Assessment of their motivation for their online activities related to their online representation and image status
- Awareness for risks, potential problems and for legal aspects, such as privacy settings, deriving from their online behavior
- Negative experience, cyberbullying, or sharing/tagging pictures without prior consent
- Gender aspects
- Anonymous information about their person, such as gender, age, citizenship, migration background (parents), their school type and grade as well as their parents' highest degree of education

Concerning a successful implementation of the questionnaire, in addition to the scientific requirements on sociological surveys also constraints evolving from the age and skills of the survey audience are considered. These include the use of an age-appropriate language and a terminology they understand. Furthermore, the structure and user interface have to be appropriate to their computer skills and age. A logistic-specific requirement is, that under the supervision of a teacher, all students in each school class have to be able to accomplish their questionnaires within one lesson (i.e. 50min) including the time for an introduction done by the teacher, the login to the system and browsing to the questionnaire website as well as logout after accomplishing.

The questions developed by the students and the lessons learned from the conducted workshops are inputs for the development of the online questionnaire. It complies with scientific standards and extends the results of the discussions during the school workshop.

3.1.3 Quantitative Research Implementation

Preceding the implementation of the survey a demo-run is conducted with a test user group of five pupils in order to detect possible pitfalls and difficulties for them in the process and review and optimize the questionnaire respectively.

The quantitative survey is implemented as an online questionnaire created with surveymonkey.com[46]. Based on pre-survey and and a workshop with 25 pupils of age ten and fifteen a questionnaire draft is developed. It is tested in March 2015 with five pupils of the same age per each and improved concerning language, navigation and time required to complete the form. Two different questionnaires are subsequently enrolled class-wise at the whole school during school lessons in summer term 2015: The complete version for pupils of seventh to twelfth grade

[46] `https://de.surveymonkey.com/` accessed 04/2016

and a subset excluding detailed questions about specific SNSs and online self-representation for fifth to sixth grade pupils. The shorter questionnaire e.g. does not include detailed questions about different SNSs and self-representation online as considering social media they use mostly smart-phone-based messenger for communication rather than SNSs. A further reason for the short questionnaire is due to the maximum time for accomplishment of the survey is one lesson per class and considering that the younger pupils are not yet as experienced with computers and thus more time is needed compared to the older pupils for logging in and out to/of the network, accessing and navigating through the questionnaire. Pupils are supervised by one teacher, who assists them in case of questions or difficulties in navigating through the form. The evaluation of the questionnaire results is done by sociologists from the University of Graz based on the interview analysis method of Mayring [59].

3.1.4 Qualitative Research Implementation

Qualitative research is carried out to create a base for and to complement the quantitative research results and gain deeper insights comprising a user workshop in December 2014 (prior to the quantitative research) and semi-guided focus groups and individual interviews in October 2015 (following the quantitative research). The latter are audio-recorded, transcribed and evaluated following [59]. The guideline is developed by the sociologists involved in the project and are based on the outcome of the quantitative survey.

In total four gender homogeneous group discussions with five pupils per group are implemented with a maximum duration of each 100 minutes: one with girls and one with boys of each eighth and tenth school year. Individual interviews of maximum 50 minutes are conducted with each four girls and four boys from eight school year as well as from tenth school year.

3.2 The *Profiler* Tool

3.2.1 Technical Requirements Analysis and Technical Specification

The core part of the developed concept is the development and application of a software tool, which creates person descriptions based on online acquired pictures, a content-based analysis and synthesis of the analytics results. Basis for the requirement analysis and technical specification of the *Profiler* tool is a comprehensive state of the art research covering the involved research fields: Computer-science-related aspects of unconstrained image analysis for facial attributes in web-scale datasets, affective information processing and web crawling and SNS analysis.

Computational and network requirements are extracted by evaluating the estimated number of users using the tool as well as the proposed implementation of the tool as a browser-based application. Concerning the facial image analysis the requirements are evaluated based on research of current in-the-wild face databases as well as of user profiles in SNSs.

Furthermore, technical aspects with respect to the target audience are included from the user requirement analysis. They include an assessment of relevant online image sources with respect to the target user group, constraints concerning their computer skills and requirements with respect to the user interface design and usability. This task is carried out in an interdisciplinary

way with all different parties involved contributing with their expertises, expectations and wishes as well as constraints.

Legal aspects are assessed and defined: Privacy and data protection aspects, legal terms and regulations and provided interfaces and options for image acquisition of the respective SNS and data sources are taken into account. This task is carried out in an interdisciplinary way with all different parties involved contributing with their expertises, expectations and wishes as well as constraints. In cooperation with the pupils use cases scenarios of the *Profiler* tool with relevance to their everyday lives are developed, which serve as input for the technical specification and implementation of the software and as a basis for its evaluation later on. Based on this interdisciplinary requirement analysis the assessed technical and non-technical requirements are correlated and balanced. First algorithmic prototypes are developed to evaluate the technical feasibility.

Finally, the technical specification of the *Profiler* software tool is inferred, which constitutes the basis for the software design and implementation. It includes the software architecture, workflow and interfaces as well as the selection of the online image sources to be implemented. Computational, network and facial analysis requirements are balanced with available open-source state of the art algorithms for face analysis. Respective algorithms for face similarity estimation, age, gender and emotion classification are selected for integration.

3.2.2 Software Design and Implementation Methodology

Based on the technical specification the *Profiler* software is implemented. The implementation task is divided into the following steps: framework development, image acquisition, image analysis, data synthesis (profiling) and visualization as well as user interface design. Therefore, section describes the applied methods and the implementation of the *Profiler* Software Tool.

Figure 3.1: Profiler software tool concept

Following the methodological approach of opening children and adolescents' eyes through confrontation with their own "bare" online self the basic workflow of the *Profiler* software tool comprises three stages – image acquisition, image analysis & profiling and visualization of the resulting profile as shown in Figure 3.1.

In the *Image Acquisition* step the picture pool related to a target person is established. From specified online sources, such as SNSs and search engines images are retrieved utilizing the respective Application Programming Interfaces (API) and written temporarily to a database.

These pictures are then forwarded to the second step – the *Image Analysis & Profiling* phase. It comprises the core image analytics and synthesis tasks of the *Profiler* tool including different algorithms for the analysis of face-based personal attributes from images as well as means to aggregate the results in order to describe a person. Finally, the *Profile Visualization* takes care of making the results of the previous step visible and printable to the users in form of a suspect profile.

From a technical point of view the main goals are:

- Development of a software tool for children and teenagers of age ten to fifteen to evaluate and explore their own (often unknown) online-mirror image based on a retrieval, analysis and synthesis of online personal images.
- Research, implementation and evaluation of algorithms for face detection and recognition, age, gender and emotion analysis in unconstrained datasets
- Image Acquisition: digital images are retrieved from SNSs and using Google Custom Search Engine (GCSE) as well as Bing
- Image Analysis & Profiling: The retrieved images are analyzed with state-of-the-art image processing algorithms for face detection and recognition, age and gender classification and emotion detection. This is followed by a synthesis of the analytics results and composed into a person profile.

3.2.3 Profiler Architecture

The *Profiler* tool comprises a three layer architecture consisting of the *Presentation Layer*, the *Service Layer* and the *Persistence Layer* from top to bottom as visualized in Figure 3.2. The *Persistence Layer* at the bottom temporarily caches the downloaded and processed images using the HDD and a PostgreSQL database[47]. Further, after 30 minutes of inactivity or in case the browser tab is closed a dedicated routine clears the related data from the cache.

The *Service Layer* holds a web server, which serves the web application and the image analytics and logic. They are implemented using Python and C++ programming languages. The top layer is the *Presentation Layer*, which constitutes the user interface. It is realized as a browser-based application with HTML5 and JavaScript using the AngularJS web application framework. For security and data protection reasons the information transfer is secured with a Secure Sockets Layer (SSL) certificate issued by Vienna University of Technology.

The database is implemented using the open source object-relational database system PostGreSQL. The Extended Entity Relationship (EER)model visualizing its structure is visualized in Figure 3.3.

3.2.4 Image Source Integration

Based on the results of a workshop and oral survey with pupils of age eleven and fifteen years as well as a feasibility research focusing on supported integration interfaces and access to online

[47] `ttp://www.postgresql.org/` accessed 04/2016

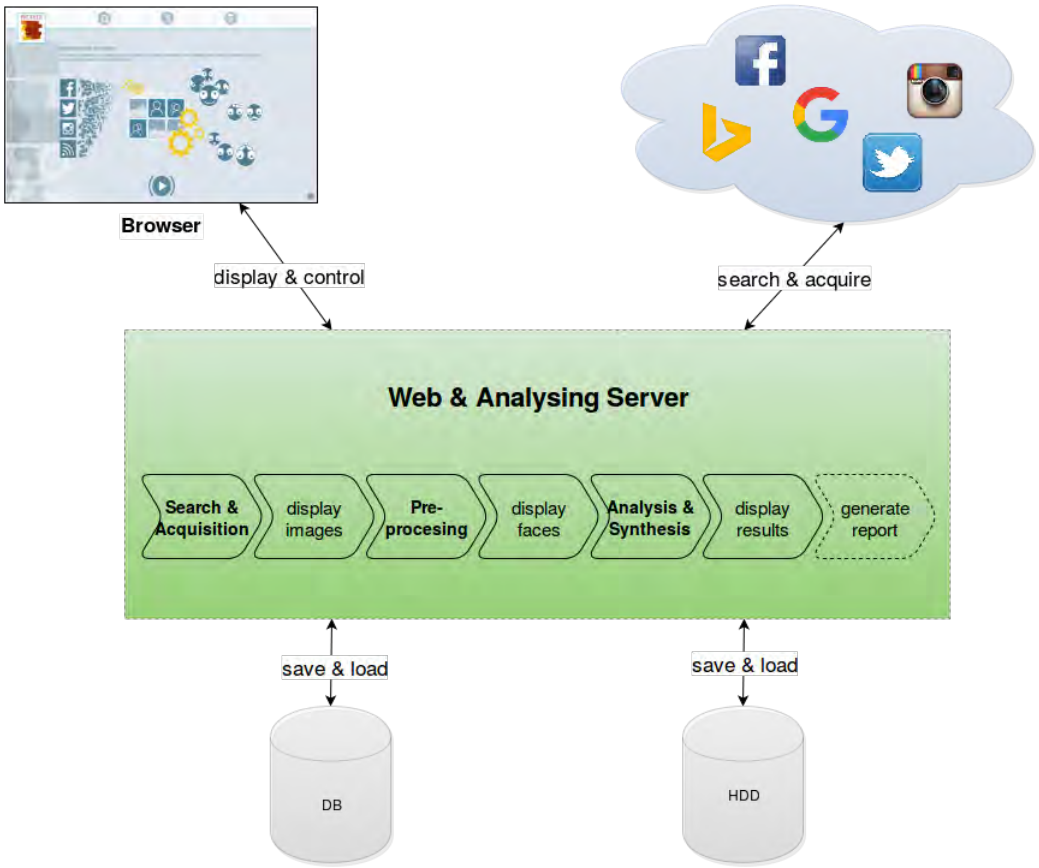


Figure 3.2: Profiler architecture

image data on respective platforms the following resources are selected to be integrated in the *Profiler* tool:

Google Custom Search Engine

As a basic image source GCSE[48] is integrated. It is an interface for the Google search using a JavaScript Object Notation (JSON) Restful State Transfer (REST) API enabling developers to use Google Search for various applications, such as to perform image searches and use the output for further processing. Within the context of this work it is used to search only for images based on a text-based query containing the name of the profiling target specified by the user (see Listing 3.1) and filtering for the image type *face*. Furthermore, duplicates are filtered and the web search is disabled as only images are relevant. The following Listing 3.1 depicts the configuration parameters set for the integration of GCSE.

[48] `https://cse.google.com/cse/` accessed 05/2016

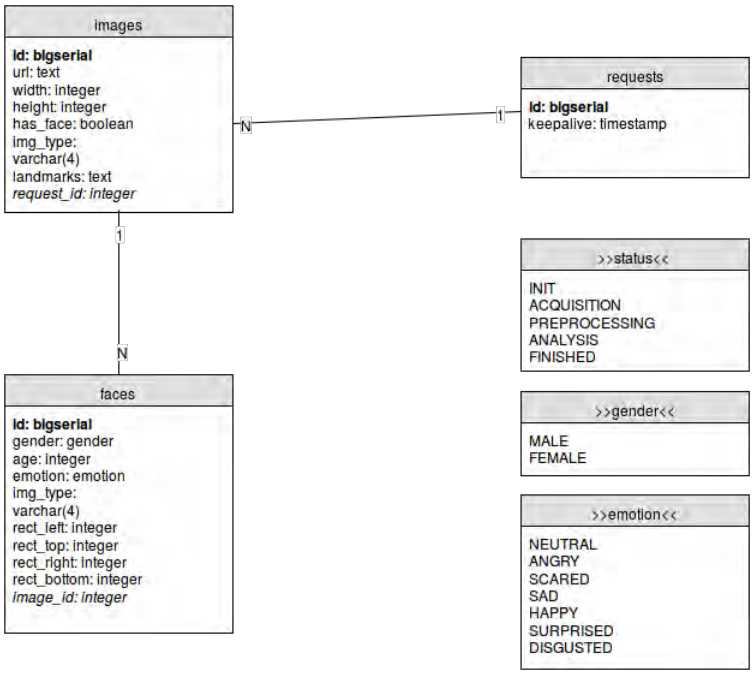


Figure 3.3: Profiler database EER model [2]

```
google_cse_api_url = 'https://www.googleapis.com/customsearch/v1'
google_cse_searchtype = 'image'
google_cse_safety = 'medium'
google_cse_imgtype = 'face'
google_cse_duplicate_filter = '1'  # 1=on, 0=off
google_cse_disable_web_search = True
```

Listing 3.1: GCSE configuration parameter

The GCSE returns the Uniform Resource Locators (URLs) of the found images, which are subsequently downloaded and cached in the database for the further *Profiler* processes. Google CSE is available for free including 100 search queries with each 100 result image URLs per day. As for the school workshops more than 100 search queries are needed, additional requests are purchased via the Developers Console allowing for a maximum of 10.000 queries per day for a price of $5 per 1000 queries.

Furthermore, the following SNSs are integrated to be used as optional additional data sources to be considered for the image acquisition:

Facebook

Facebook provides with the Facebook Graph API[49] an interface for developers to access, process or push user-related information from or to the platform or to perform actions therein[50]. Examples are to retrieve user profile information, to analyze user relations within Facebook or to upload status messages, media content or comments to the user timeline, albums or other posts. As communication is Hypertext Transfer Protocol (HTTP)-based any language is supported incorporating an HTTP library. Every user account in Facebook has a unique user ID (user_id) and a user-name. Access to user data is based on the user_id, a unique identifier for every Facebook account. /me therefore refers to the user_id of the person whose access token is currently being used for the API calls. All photos of one's own profile can be retrieved with **GET graph.facebook.com /me/photos**.

To access photos of a user without logging in and without knowing the user ID the scenario would be to query the name of the target person and to try to retrieve the user ID. This is called scraping and would be a violation of the Facebook Automated Data Collection[51] terms. Therefore, to access the images of the *Profiler* subject an App is developed and in the first step the user has to explicitly grant the *Profiler* the permission to access to his or her photos. The authentication process is implemented using OAuth[52] , an open standard for authorization, enabling it users to log into third-party websites (in this case the Profiler, when using Facebook as an optional image resource) using the Facebook account (see also 3.2).

```
# facebook config
fb_api_url = "https://graph.facebook.com/v2.2/"
# OAuth endpoints given in the Facebook API documentation
fb_authorization_base_url = 'https://www.facebook.com/dialog/oauth'
fb_token_url = 'https://graph.facebook.com/oauth/access_token'
fb_redirect_uri = base_url+'/api/facebook/callback'
fb_redirect_uri_dev = base_url_dev+'/api/facebook/callback'

fb_permissions = ['email', 'user_photos']
```

Listing 3.2: Facebook configuration parameter

Rate Limiting Facebook imposes rate limits[53] to each App: Every App can make max. 200 calls per hour per user in aggregate. Due to this fact and network load and analyzing performance reasons the number of photos the *Profiler* downloads from Facebook is limited to 25. Furthermore, only photos with a length multiplied with height value of 150.000-450.000 are

[49] https://developers.facebook.com/docs/graph-api accessed 05/2016

[50] https://developers.facebook.com/docs/graph-api/common-scenarios accessed 04/2016

[51] https://www.facebook.com/apps/site_scraping_tos_terms.php?hc_location=ufi accessed 05/2016

[52] http://oauth.net/2/ accessed 4/2016

[53] https://developers.facebook.com/docs/graph-api/advanced/rate-limiting accessed 04/2016

downloaded in order to filter out high-resolution photos and thumbnails. Primarily, photos from the profile photo album are taken, as it is assumed that it has the highest possibility to contain photos showing the target person's face. If the album contains less than 25 photos, the remaining photos are taken from random albums. All photos are selected randomly from either the profile pictures album or all other albums.

Instagram

Instagram is integrated using the Instagram API Platform[54] Python library[55]. Using a registered App holding a client ID and client secret the user-specified Instagram username of the profiling subject is looked up using the Instagram_search_url and Instagram_lookup_url parameters are given in Listing 3.3.

```
# Instagram
instagram_search_url='https://api.instagram.com/v1/users/search'
instagram_lookup_url='https://api.instagram.com/v1/users/{}'
instagram_photo_url='https://api.instagram.com/v1/users/{}/media/recent'
instagram_client_id = '...'
instagram_client_secret = '...'
max_instagram_photos = 25
```

Listing 3.3: Instagram configuration parameter

Public available photos published on the respective username's account are then acquired using the Instagram_photo_url, whereas the maximum number of acquired photos is limited to a maximum of 25 photos.

In contrast to Facebook and Twitter Instagram does not require yet an OAuth 2.0 token for authorization, though as per November 17th 2015 Instagram has changed their Platform Policy and by end June 2016 also Apps created before November 17th 2015 will be affected by the new API behavior, such as that an OAuth 2.0 token will be required for all API endpoints or a specific permission scope[56] granted by the user. Otherwise, they will be switched to Sandbox mode automatically.

Twitter

Similarly to Facebook, Twitter requires OAuth (1.0.A) authentication and provides OAuth endpoints to send secure and authorized requests to the Twitter API as well as to connect users to Twitter. The integration is realized using the Twitter API[57]. Presuming a successful OAuth authentication the username inputed by the user it is looked up and using API calls a maximum number of 25 photos randomly selected from the user and acquired in JSON format.

[54] `https://instagram.com/developer/` accessed 05/2016
[55] `https://github.com/Instagram/python-instagram` accessed 05/2016
[56] `https://www.instagram.com/developer/authorization/` accessed 05/2016
[57] `https://dev.twitter.com/rest/public` accessed 05/2016

Not Included SNS or Instant Messengers

Even though Whatsapp and Snapchat are among the most commonly used by children and teenagers of age ten to eighteen they are not integrated to the Profiler. Reasons are that they are smart-phone-based Apps and data is sent between users or user groups rather then being published to a timeline or user profile. For Snapchat there is no official public API available since it had been closed in 2014 after a hack took place using a security loophole to exploit user data in third-party application based on their API[58] .

3.2.5 The *Profiler* Pipeline

The Web & Analyzing server performs the workflow as depicted in Figure 3.4: In the first step, Search & Acquisition, based on the query string inputed by the user holding the profiling subject's name, and with the SNS-related information (Facebook ID, Instagram or Twitter username) the search for online pictures is started using the respective services as described in the previous subsection. Found images are downloaded using their respective acquired URLs and resized to match a resolution of max. 600 pixels height/width. Finally, the scaled image is saved to the PostGreSQL database in the Persistence Layer.

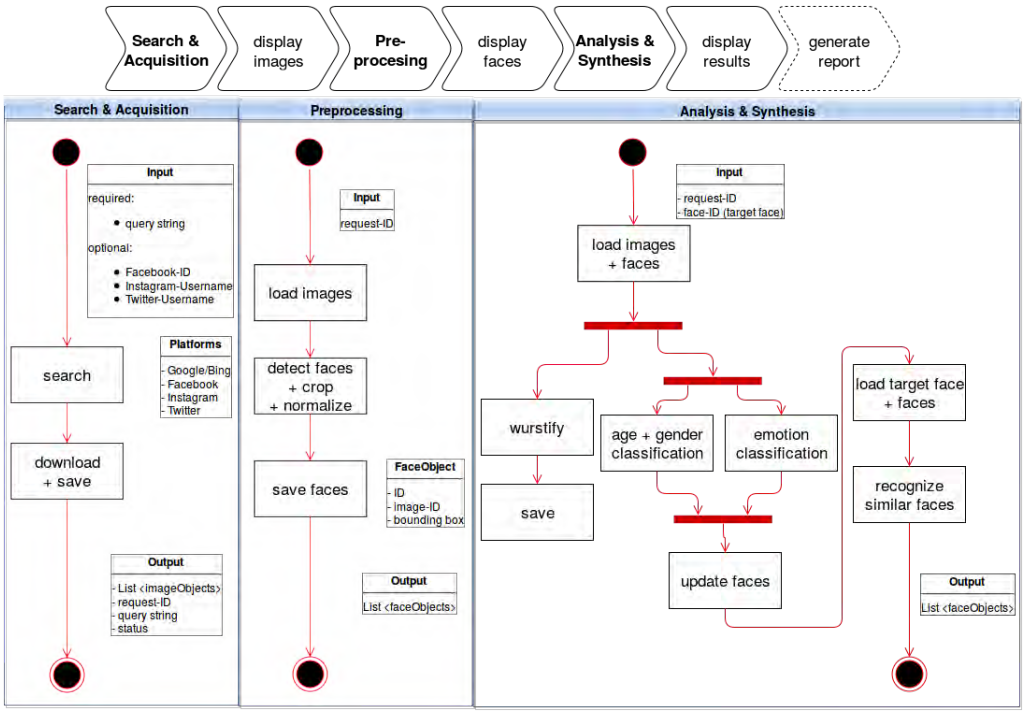


Figure 3.4: The *Profiler* workflow including the Analysis pipeline

[58] `http://snapchat-blog.com/post/99998266095/third-party-applications-and-the-snapchat-api` accessed 05/2016

Subsequently, the preprocessing step is started. Every picture is is loaded and runs through face detection and face pose algorithms based on the dlib frontal Face Detector[59] and the dlib face pose estimation using 68 facial landmark points[60]. Detected faces are cropped, normalized and saved to the database. In the next step, every picture saved to the database as is pushed through the *Profiler* analysis&synthesis part of the pipeline shown at the right in Figure 3.4.

In parallel the following analysis and processing tasks are carried out on the loaded images and faces objects:

Wurstify

Wurstify[61] is a web-based application and Chrome extension developed by Benjamin Grössing and David Fankhauser, which adds – in honor of the Eurovision song contest 2014 winner Conchita Wurst – a beard to every detected face in an image. It is based on a face detection and followed by extraction of facial landmark points to locate characteristic features in the face, such as nose tip, lip corners, jaw corners, etc. Based on the detected facial landmark points the pose of a face can be estimated using the dlib pose estimation [62] to apply the beard texture (see Figure 3.5, center) onto the face with the correct scale, rotation and perspective. For performance reasons and with the consent of the developers the application is integrated to the *Profiler* and the face detection and landmark extraction of the preprocessing step are utilized. The *wurstified* picture of each face (see Figure 3.5, right) is cached separately in order to be displayed within the results visualization step when the Wurstify feature is activated.

Figure 3.5: Wurstify - “wurstification” of a face

[59] `http://dlib.net/face_detection_ex.cpp.html` accessed 04/2016

[60] `http://blog.dlib.net/2014/08/real-time-face-pose-estimation.html` accessed 04/2016

[61] `http://wurstify.me` accessed 05/2016

[62] `http://blog.dlib.net/2014/08/real-time-face-pose-estimation.html` accessed 05/2016

Age Estimation and Gender Classification

Age and gender analysis are both implemented using the OpenBR library[63] and with the respective algorithms provided as part of it. They are based on the 4SF algorithm [38] and perform a face detection based on the OpenCV Viola-Jones frontal face detector [95] wrapped in OpenBR and face classification registration containing affine transformations and the ASEF eye detector. The OpenBR library supports respective trained models for gender and age prediction and classification is done in parallel using different classifiers as provided by OpenBR. Both age and gender analytics are controlled using C++ and a python3 wrapper, since OpenBR itself only supports python2. The implementation is described in detail in [2] and the analysis results per face are stored to the <age> and <gender> attributes of faces in the database.

Emotion Classification

For the emotion classification the face detection result from the preprocessing step is utilized and the faces are aligned using affine transformations. Subsequently the face pose is estimated following [78] and AUs [22] reflecting facial muscles and their visible movements or intensities within the face are calculated as described in the EMFACS by Ekman and Friesen [30]. For that, landmark points are localized and transformed into the EMFACS AU coding system, whereas the implementation is described in detail in [2].

According to EMFACS specific combinations of activated AUs indicate emotions. Examples for four major emotions and their respective active AUs are depicted in Table 3.1.

Table 3.1: Examples for EMFACS emotions built from combination ofAUs

Happy	6 (cheek raiser) + 12 (lip corner puller)
Sad	1 (inner brow raiser) + 4 (brow lowerer) + 15 (lip corner depressor)
Disgusted	9 (nose wrinkle) + 15 (lip corner depressor) + 16 (lower lip depressor)
Contempt	12 (lip corner puller) + 14 (dimpler)

The result of the emotion classification is saved as one of the following values: *neutral, angry, scared, sad, happy, surprised, disgusted,* to the <emotion> attribute of faces in the database.

Target Person Recognition and Profiling

In contrast to common face recognition scenarios, where a database of known faces is available and a query face is either to be identified or verified as one of the persons stored in the database in the scenario of the *Profiler* no such database is available. Therefore, a reference face has to be selected by the user during the process, which serves as example of a face confirmed to show the target person. Using this reference face, the found faces undergo a feature detection using Local Binary Pattern histograms [33] and are clustered using affinity propagation [29]. Using a distance threshold faces showing the target person are considered to be those within the same cluster as the reference face.

[63] `http://openbiometrics.org/` accessed 05/2016

All found faces associated with the target person are taken into account for the profiling process. The relevant information is aggregated and retrieved using database queries, as all analytics results are stored in the database. This has the benefit that response is possible in real time.

The gender of the target person is decided using a majority voting of the gender classification results of all images of the person. For the age the minimum and maximum age estimates are retrieved from the database and the average age is calculated as a**ge['avg'] = round(age['sum'] / age['count'])** and considered as the final age estimate used in the *Profiler* report.

```
emotion_mapping = [{ 'bound': 0.0, 'text': 'selten' },
                   { 'bound': 0.4, 'text': '"uberwiegend' },
                   { 'bound': 0.6, 'text': 'meistens' },
                   { 'bound': 1.0, 'text': 'total' } ]
```

Listing 3.4: Emotion frequency mapping

Finally, for the emotions a ranking is calculated and the top three ranked emotions with their hit numbers are used for the report. For the first-rated emotion the relative frequency is calculated and depending on the resulting value the significance is encoded in the text (see Listing 3.4). For example, if the top-ranked emotion is 'happy' and the corresponding frequency value is 80% (i.e. in 80% of the images the person's emotion is classified as happy), it is encoded as "meistens glücklich" (engl. mostly happy).

3.2.6 User Interface and Visualizations

One approach to address the objective of the idea "There is no privacy, deal with it" (Roger Chesley) is to make the target users aware of the underlying processes of the *Profiler* tool. With that an understanding and basic knowledge is imparted about the steps and processes necessary to obtain a profile report through acquisition of online photos and their analysis and synthesis – as an example for how personal information available online can be processed with image processing technologies and exploited. Therefore, one goal is to design a user interface revealing and visualizing the underlying processes to the users in an age-appropriate way.

The user interface is designed to reflect the *Profiler* workflow, whereas the respective inputs for and results of the tasks are reflected in views. The underlying performed processes are visualized using modal windows with animations, which link the views together and serve as visual feedback instead of progress indicators. The workflow structure of the user interface views is depicted in Figure 3.6 whereas the large circles reflect the views and the small ones show the underlying processes and the optional report generation option. The red labels specify the user input and interactions.

The implementation is realized by the project team using Python, Hypertext Markup Language (HTML) with Cascading Style Sheets (CSS) and AngularJS[64]. The latter is an open source

[64] https://www.angularjs.org/ accessed 05/2016

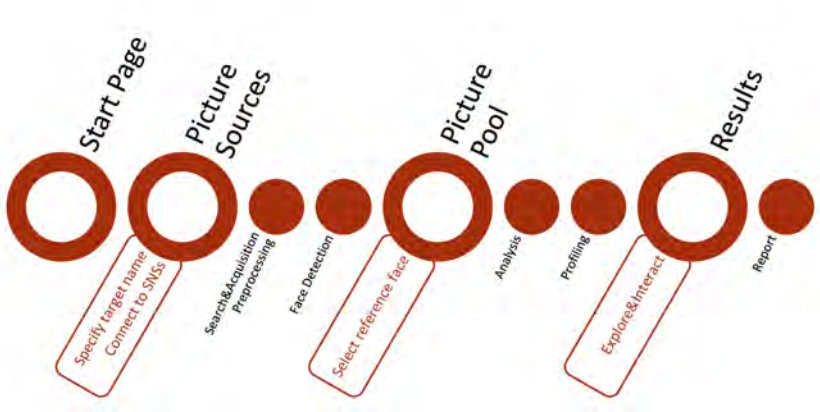


Figure 3.6: The *Profiler* user interface structure

client-side JavaScript framework developed by Google Inc. with which single-page web applications can be developed using a model-view-viewmodel pattern.

Page Layout

The *Profiler* page is structured in three parts:

Header The header contains the *Profiler* logo, which comprises a link to the start page, and the progress indicators. The progress indication is located at the top and implemented using symbols. In addition, tooltips inform the users via mousehover about the the content and tasks of each step. As the start page is linked to the *Profiler* logo at the top left it is ignored from the progress symbols. Therefore, three symbols are implemented to reflect the main steps as depicted in Figure 3.7:

Figure 3.7: Profiler *where am I* symbols (from left to right: Search, Analysis, Report)

Footer The footer contains the forward and restart buttons to navigate through the *Profiler* steps and restart the whole process. Furthermore, at the bottom right information symbol is displayed which minimizes and maximizes a footer banner holding the institution and funder logos and access to the imprint. Within the results page also at the left corner a button is displayed which initiates the download of the PDF report.

Body Finally, the center part of the page contains the contents of each view and step, such as the text fields and buttons to specify the image sources, the found images and the *Profiler* results

arranged as tiles in a grid. The process animations are realized as modal windows overlaying the views disappearing automatically at completion of the underlying process. In parallel, in the background the next view is built.

Start Page

The start view is displayed when browsing to the *Profiler* website. It contains a brief introduction using a welcome text and graphical information about the *Profiler* processes.

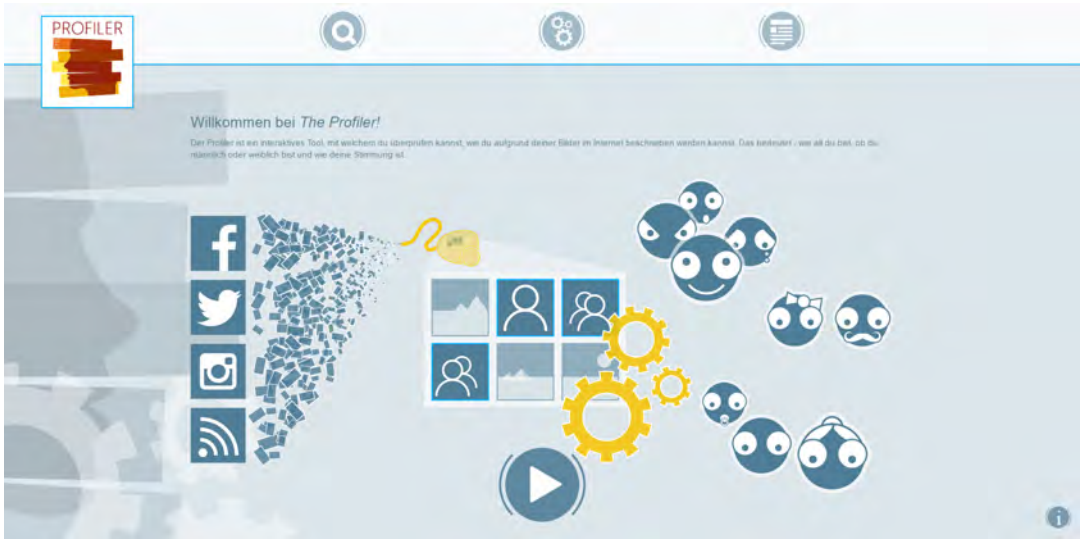


Figure 3.8: Profiler Start Page

Figure 3.8 shows the welcome page. At the left in the graphic the available image sources are displayed. The acquisition process is visualized using a vacuum cleaner metaphor: the flood of images are "leeched" by the vacuum cleaner. This works because the in German the slang word for *to download from the Internet* is the same as the short form of *vacuum cleaning - saugen*. The center part shows the face detection process with the image tile view showing either individual-symbols or non-individual symbols. Finally, the connection using cogwheels symbolizes the analytics performed on the images leading to the right part, visualizing the facial aspects of the image analysis: emotion, gender and age (from top to bottom).

With the forward button at the footer center the *Profiler* is started – leading the user to the Picture Sources view.

Picture Source View

In the Picture Source View the image sources to be considered for the profiling can be selected (see Figure 3.9).

Using the buttons with the Facebook, Instagram and twitter logos, the user can connect the respective SNSs. Using the text field the name of the profiling target person is inserted, which serves as input to the Google Image Search. The Figure shows the original "empty"

Figure 3.9: Profiler image source page

fields in the red box at the bottom left and the use case of a search for the author of this work "Elisabeth Wetzinger" and taking into account all three SNSs. This is visualized with display of the respective profile picture and username of the SNS account after it is connected successfully.

Download and Face Detection Modal Windows

Once the image sources are selected by the user hitting the forward button starts the first processes of the Profiler: Image search and acquisition, download and preprocessing as well as face detection. Within the user interface they are summarized using two modal subsequently displayed modal windows: Download, as shown in Figure 3.10 for the first three tasks and a separate one for the face detection, as depicted in Figure 3.11.

Figure 3.10: Image download modal window

Figure 3.11: Face detection modal window

Picture Pool View

After the face detection is completed the picture pool view is displayed. All found images are displayed as thumbnails in a tile view. For every image information is shown from the image source from where it has been acquired as well as the number of faces that have been detected (see Figure 3.12).

Figure 3.12: Face detection modal window

Clicking the image maximizes it and detected faces are indicated using rectangles. In this

view the user has to select a reference face showing the target person which is used by the analytics to find images showing the same person. This is achieved by clicking onto one face rectangle within the maximized image view.

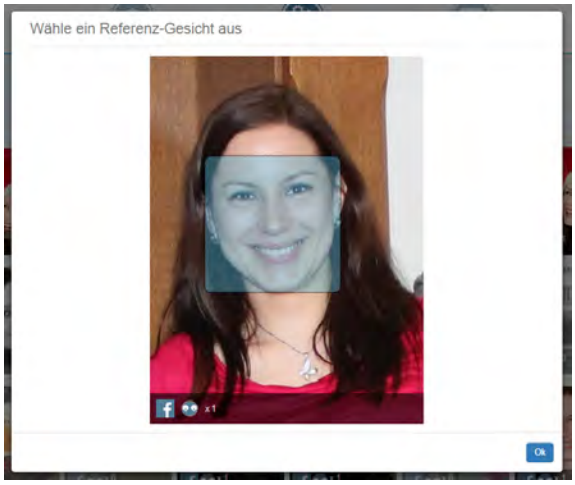


Figure 3.13: Reference face selection

Image Analysis and Profiling Window

After the user has selected and confirmed a reference face showing the target person the image analytics and profiling tasks are performed. During the process the modal window as depicted in Figure 3.14 is shown.

Figure 3.14: Image analysis and profiling modal window

It contains an animation with three smiley groups being outputted from the moving gear-wheels and being arranged one after the other at the top (emotion-related smilies), the center

right (gender smilies) and the bottom right (age smilies). The modal window is completed with an informative text describing that the best images of the target person are searched for and the person profile is composed by classifying for gender and emotion as well as estimating the age in the relevant pictures. In addition to the analysis algorithms, the profiling is performed. This constitutes a results synthesis to calculate profile information necessary for the report, such as the average age of the target person, her main emotional status and a decision about her gender.

Results View

After the analysis and profiling processes are accomplished the results are displayed in the results view, see Figure 3.15. It contains all images found showing the profiling target person with the respective image source as well as the analytics results displayed as symbols and alphanumeric values within a semitransparent overlay over the lower part of the thumbnail. In addition, the gender and emotion result is also shown as a tooltip when hovering the image.

Figure 3.15: Profiling results visualization

Furthermore, the results view also includes a slider for toggling the Wurstify feature online or offline. Clicking an image expands it to a full resolution view of the picture including the bounding rectangle surrounding the detected face, the image source and analytics results. An example is depicted in Figure 3.16).

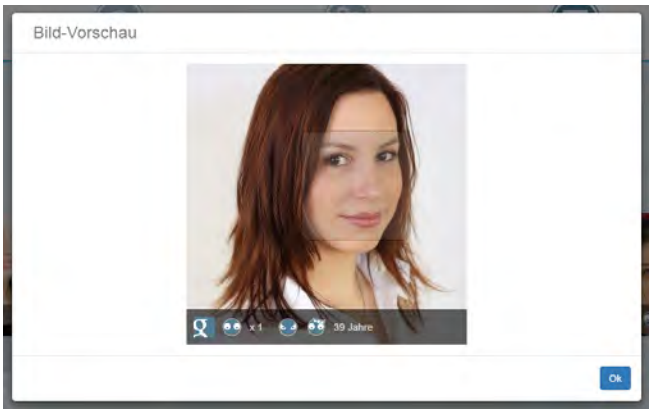


Figure 3.16: Profiling results detail view

Profiler Report

The idea for the *Profiler* report structure is outlined in Figure 3.17. The intention is to design it similarly of a police-record or set-card including one profile picture (constituted by the reference picture selected by the user), the profiled information and a number of found images of the person with their analytics details. It is implemented as a one page PDF using weasyprint[65] by the project team. The Berkeley Software Distribution (BSD)[66] licensed visual rendering engine supports web standards for printing and renders HTML and CSS that can export to PDF.

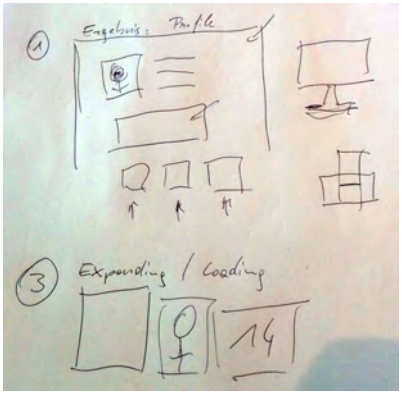


Figure 3.17: Profiler report sketch

[65] `http://weasyprint.org/` accessed 05/216
[66] `https://opensource.org/licenses/BSD-3-Clause` accessed

Figure 3.18: Profiler report example

The *Profiler* report is shown in Figure 3.18. It shows a banner with the reference picture of the person and its wurstified copy. Furthermore, the name (as queried in the text field at the image sources view by the user), the average estimated age and emotion as well as the overall classified gender are shown therein. Below the banner the detailed analytics results are visualized:

Based on the user test results it is described how many images from each image sources are found and how many from them show the target person respectively. In addition, the three most

often analyzed emotions are listed. For gender, it is described how many hits female and male gained and what the overall gender result following a majority voting is. Finally, for the age estimation the average age as well as the minimum and maximum age estimates are shown. All information is wrapped in sentences or sentence groups, enriched with symbols and arranged at the report with information of the same attribute grouped together.

Finally, three more pictures of the target person are including their emotion classification results visualized using the emoticons.

3.2.7 Technical Evaluation and Optimization

For the training, testing and evaluation of the specific image analysis algorithms face databases are required. Face databases contain annotated pictures displaying persons. Annotated means, that – depending on their use case - they hold verified information about the identity of a person shown or their emotional state, age or gender, respectively. Therefore, they serve as reference datasets for the development and optimization of the image processing algorithms and face representations. Appropriate face databases with respect to the specific image analysis algorithms and acquired for scientific use within the project. For the evaluation of the software, test cases are developed with which the developed profiling software performance with respect to analysis accuracy and temporal measures is evaluated. In addition, in course of practical *Profiler* workshops with the pupils, a user test workshop (see Section3.4) is conducted to evaluate and optimize the usability and to evaluate minors-related analytics results. Based on the results optimizations of the software tool are carried out iteratively in order to develop a final *Profiler* tool version, which can be applied in school workshops.

3.3 Education Concept

The aim of the concept is not about prevention through restriction, but rather about increasing media literacy and raising awareness in order to empower the young generation. This is achieved by imparting knowledge and hands-on experience in a way to encourage them to deal responsibly with their images in the online world.

3.3.1 Methodology

For the students the concept is implemented as a school project: This gives the opportunity to conduct several events of multiple school lessons to elaborate on subtopics rather than having to squeeze tasks into 50 minutes. The project work is enriched with workshops for the junior researchers covering a variety of topics related to the project: Examples are digital images, legal aspects, SNSs, image processing technology and applications, impact assessment and user interface evaluation. On the one hand, they introduce the students to their project tasks and contain basic knowledge about the task at hand. On the other hand, they work practically in the workshops on various research, development and evaluation tasks. The events also provide them with first-hand knowledge and insights into state of the art research and serve as open space for interaction and discussions with scientists.

During the course of the project the pupils are invited for an excursion to the university to experience scientists' work lives and tasks. Suggestions for and mentoring of pre-scientific theses are provided for pupils' of the final grade. Interested teenagers are proposed the possibility to participate in a university seminary lecture. Optionally, they are encouarged to present their project work and discuss it with undergraduate university students.

The key aspect of the project with respect to the implementation methodology is the active participation of the pupils in every project phase. Students work in close cooperation with the researchers. They are involved in every phase of the project to gain insights on how research projects are realized and to comprehensively be educated in media literacy and critical media use2.

Examples for their active participation as junior scientists are, that pupils:

- develop questions for the quantitative survey, test the online questionnaire and give feedback for optimization
- partizipate in the requirement analysis and scenario design, the user interface design and evaluation of *The Profiler* software
- assist in generating a ground truth for the evaluation of the image analysis algorithms
- present their work online and at events to their peers and to the public

Through the holistic project approach including side-events, workshops on related topics, practical development, testing and exercising with the profiling software, they learn and improve their media literacy skills using an experience-based and learning-by-doing driven approach. Furthermore, they have the opportunity to collaborate with scientists and reserach topic of high relevance for their everyday lives and their futures.

3.3.2 Implementation

There is no privacy – deal with it.

ROGER CHESLEY

The implementation of the education concept is realized in close collaboration of all participating research and education groups. The main elements are workshops and teaching units within the context, the offering of topics for pre-scientific theses within the research fields and excursions to the university department:

Three workshop events have been implemented by the interdisciplinary team covering the workshop topics and implementation methods as described below:

3.3.3 Workshop I

The first workshop is held with 19 pupils of 9th grade and five pupils of 5th grade and comprised three parts:

Project introduction In an interactive presentation supported with projector slides a brief introduction to the project is given. Prior to the workshop the pupils have not been confronted with any details in order to enable the researchers to experience an as uninfluenced behavior and opinion of the pupils as possible. The presentation is structured openly with open questions to the pupils in order to motivate them to actively participate and to engage discussions. The discussion focus on research in general, research projects and their structure, as well as project-centered topics such as SNSs or their Internet use behavior.

Scientific work This section dives into the focus of integrating the pupils as young scientists into the project. In active discussions one researcher of the sociologists team and the author (representing the computer science team) give an overview about scientific work using the examples of qualitative and quantitative research methods. Concerning quantitative research methods the example of surveys are used and it is elaborated with the pupils using a guideline created by the sociological team on how to build a scientific questionnaire for quantitative research, what the challenges and pitfalls are and what has to be considered.

Creating questionnaires Following the scientific work discussion, the pupils work in groups on the assignment of creating questions themselves for an online questionnaire. The questions should focus gaining insights of their own age group about Internet and SNSs use behavior and they should consider the techniques and aspects how to create scientifically correct and 'good' questions as learned in the preceding session. For that, they work in teams of two to three (9th grade) or five (5th grade). The researchers and two teachers supervise the pupils and answer their questions in case of problems in understanding the assignment. Furthermore, the practical session also constitutes an open space for the pupils to ask project- or topic-relevant questions of their interest, which are either answered directly or in a concluding discussion following the practical workshop. The concluding discussion also includes a brief feedback round on their experience with the assignment. All questions have been written down by the pupils and are collected by the researchers and taken into account into the development of the online questionnaire.

Workshop II

My picture online In a practical workshop the pupils work together in groups of two or three and basically perform manually what the *Profiler* software does automatically: Using the example of a job interview, they take on the role of the interviewer at a company, who wants to find out more about the person applying for the open position and undertakes online research about him or her. Using the name and image search engines as well as popular SNSs the task for the pupils' is to find out as much as possible about the job applicant, which is in the concrete cases each one member of the team. Focusing on image-based results they should take notes and discuss questions about how the person can be described solely based on the found results, such as:

- Where was the picture taken?
- How old is the person in the image

- How is the main emotion or mood of the person?
- Are other persons also in the picture - if so, who could it be? How do the individuals look?
- Which pictures are part of the results, which do not show the person searched for? What could be reasons for the images to be still included?
- What impression would the Human Resources Manager or boss of a company have about the applying person? How would it influence their decision?
- What could be reasons to not hire the person based on the online research?
- Are ther images, information or other search results we have not been aware they are published online?
- How could we prevent that content we consider as confidential, private or not meant for the public from being published online?

In addition, pupils are encouraged to also perform their manual research using the names of friends or family members, relatives or teachers in order to compare the range of findings to each other and discuss why, e.g. more images are found from an adult than from a child or how the different persons having the same names affects their manual profiling ability. Finally, pupils are also motivated to find out possibilities how to consciously manipulate their online self-representation and what impact it could have.

Following the group work every team presents their findings and lessons learned and are discussed with the other teams. Questions are answered by either the supervising researcher or peers and impact assessment discussions conclude the workshop session.

The Profiler This session comprises the user test as described in Section 3.4 and is supervised by one researcher of the scientific team. It is implemented as a practical questionnaire-based workshop and provides also an open space for feedback from the pupils concerning the *Profiler* tool as well as discussions with the researchers.

Digital Images and Their Analysis In an interactive presentation with discussions and Q&A researchers introduce the research field of Image Processing as well as examples for image processing applications in their everyday's lives. Starting out with a brief overview on what digital images are basics on how images can be analyzed and processed are explained using practical and multimedia examples with relevance to society and especially to the pupils', e.g. automatic face or smile detection in cameras or smart-phones or detecting persons or behavior in videos.

Workshop III

The topics for the third workshop have been selected based on feedback previously gathered from the pupils during school lessons by the teachers. The workshop is based on their open topic-relevant questions and wishes the workshop comprises the following parts and focuses on active participation and integration of the pupils into the sessions.

Project Results After a brief overview over the project aim and the conducted research, in interactive presentations the project results are presented. The focus is put on the outcome of the online questionnaire, the focus groups and the interviews with the pupils as well as the optimizations of the *Profiler* tool, which have been implemented based on the user test results.

Face detection and recognition As an introduction visual examples on human perception and human face detection and recognition are presented and discussed. Furthermore, the pupils are made aware of examples where it is challenging or difficult even for humans to recognize faces. Subsequently, they are introduced to how faces can be detected and recognized automatically with computers by working through the basic approach step by step using example images and videos visualizing each of them.

Legal Aspects Based on questions asked by the pupils during the previous workshop as well as stated in their feedback practical facts about legal aspects concerning their use of SNSs and publication of images therein are presented and discussed. Briefly, relevant aspects of the Austrian copyright and dataprotection laws are presented and visualized using example scenarios and pictures. Furthermore, pupils are encouraged to ask their questions and are motivated to participate in the discussions and to set the knowhow in context to their experiences by asking them activating questions.

Impact assessment and reflexion After the presentations the practical part of this workshop is conducted as a a *world café* [12], see Figure 3.19:

Figure 3.19: World café method (Image source: AgileTools[67])

The pupils form groups of five members each. For every group a desk has been prepared and equipped with flip-chart and paper sheets as well as pens and permanent markers. One member of every team is selected to be the host, who moderates and leads the assignment. There are four types of desks referring to the three different topics to be worked at. In the first rotation the teams

[67] http://www.agile-tools.de/die-agilen-formate-mit-how-to-s/world-caf%C3%A9/ accessed 05/2016

work on their topic, which is prepared as an assignment at the desk as well. For the second and third rotation the teams move on to the next desks of different types and work on the other topics, respectively. Due to the limited time available for the world café every team only visits three out of four desk types. The host, though, remains seated at the same desk for all three rotations and will introduce the new teams to the assignments and summarize the outcome produced by the previous teams, which serves as a starting point for the assignment in the respective second or third rotation.

The method is visualized in Figure 3.19 and the topics for the world café are:

- *Sheer luck or simply a nightmare?* For the team of the first rotation, create a diary entry, which will be continued by the team in of the second rotation. Imagine, you wake up one morning and not any possibility of mobile data, Internet, SNS use is available anymore. Think of situations, where the use of mobile data has been especially useful, exciting, entertaining, boring or annoying for you. Describe how this situation would proceed without any electronic deice and what actions you would take or have to take. Of course, you can also write down your thoughts, wishes or curses down.

- *What might the future hold for us?* For the team of the first rotation, create a diary entry, which will be continued by the team in of the second rotation. Imagine, you wake up and it is 2026: Which SNSs or which features will you use, which are not existing as to date? Describe scenarios, where these innovations prove themselves and consider, what you will to be especially careful about.

- *Bullying - Cyberbullying* Using an excerpt for discussion about a girl which has become a victim of sexting and - as a result - of cyberbullying at school. For the teams of the first two rotations: Conduct a role play where one team member is the victim, one is the offender and two are confidants. Think about how you would act and behave and write down your actions and thoughts. Consider for your role the following motifs or potential behaviors:

  - Victim: Has the victim done something wrong? Is there risk of becoming an offender in the future?
  - Offender: What could be reasons for anyone to do this? What are probable motives for cyberbullying?
  - Confidants: How could or should confidants behave in such cases?

  Finally, the team of the third rotation summarizes and completes the notes written down by the first two teams with their own thoughts and opinions.

- *Using Social Networks - a guide for beginners* For the teams of the first two rotations: Write a guide for beginners on ow to use SNSs taking into account the following three aspects: Legal constraints and recommendations, No Go's and Secret Rules (what is actually forbidden but done by everyone). Take notes to the flip-chart sheet using a table form. For the team of the third rotation, complete the tables created by the previous teams and write it neatly to a new flip-chart sheet for presentation.

After the third rotation all content created by the teams is collected at flipchart walls and presented by the respective hosts.

3.3.4 Excursion

In addition, an excursion to the Computer Vision Lab of the Vienna UT[68] is conducted with 25 pupils two classes of 5th grade (i.e. eleven years of age). One professor introduces the pupils to the department and gives an overview over the research carried out and over a typical workday of a scientist. After that a rotation station learning workshop is implemented where the pupils gather hands-on experience and practical introductions as well as knowledge provided by researchers. For that, three different stations are implemented and respectively, three pupils-groups are formed. In rotation, every group visits one station after the other. The excursion is concluded with a Q&A as well as discussion with all pupils, the two supervising teachers as well as the researcher team from the Computer Vision Lab providing space for knowledge and experience exchange and for the young people getting their individual context-related questions answered first hand by the scientists.

Station I: 3D analysis In this station research centered around the analysis of 3D sensor data is introduced. The pupils learn how games using 3D sensor, such as the *Microsoft Kinect*[69], work. They gain hands-on experience through hands-on exploration about the technology that works in the background enabling them to control games with one's own body movement. In addition, they get in touch with ongoing projects aiming at utilizing this technology and applying it to other contexts or application fields, such as Active and Assisted Living (e.g. *fearless life comfort system*[70], a solution for fall detection for elderly people) or smart cities (e.g. *infos@ourhouse*[71], a gesture-based information display).

Station II: Object recognition for smart eWaste sorting Using the project example of automatic sorting of eWaste researched in the EU-FP7[72] project RECLAIM[73] the pupils learn which sensors and cameras produce what kind of pictures and videos. Subsequently, using the pilot prototype developed in the project, a setup consisting of a conveyor belt and a multi-camera setup within a blackbox - they experience, how these live-videos can be analyzed in order to recognize and distinguish specific electronic components on printed circuit boards. They learn about characteristics, advantages and disadvantages of different sensors with respect to image analysis and in addition, they are also provided with an overview on how their electronic waste, such as mobile phones or computers, can be recycled.

Station III: Introduction to image processing and image analysis research and applications Similarly, as in Workshop I an interactive presentation with discussions and Q&A researchers

[68] `http://www.caa.tuwien.ac.at/cvl/` accessed 05/2016
[69] `https://developer.microsoft.com/en-us/windows/kinect` accessed 05/2016
[70] `http://www.fearless-system.com/` accessed 05/2015
[71] `https://www.caa.tuwien.ac.at/cvl/project/infosourhouse/` accessed 05/2016
[72] `https://ec.europa.eu/research/fp7/index_en.cfm` accessed 05/2016
[73] `https://www.caa.tuwien.ac.at/cvl/project/reclaim/` accessed 05/2016

introduce the pupils to the research field of Image Processing as well as examples for image processing applications in their everyday lives. Furthermore, one professor explains to them how researchers work, what research projects are and why they are conducted as well as how results find their application in economy and how pupils might use, experience or be confronted with them in their own everyday lives.

Further Elements

Close collaboration between researchers, teachers and pupils is implemented during the whole project phase and includes regular meetings between researchers and teachers and also the possibility for pupils to contact the researchers directly e.g. via email.

Furthermore, pupils are tightly integrated in sociological empirical research on media use of their own age group. In addition to the scientific work and quantitative surveys workshop sessions as part of Workshop I a group of pupils also take part in testing the questionnaire draft and discuss their feedback with the researchers. Based on that, the questionnaire is developed further to a final version released for implementation at the whole school and a poster summarizing the questionnaire results is presented and put up at the entrance hall of the school as a feedback for all pupils, teachers and parents.

For the parents of all pupils of the whole school a special informative event is hosted at school. Its aim is to inform and raise awareness also among them about the project and research results as well as knowhow relevant for their and their children's everyday lives within the context. The content comprises the content of Workshop II as well as a practical demonstration of the *Profiler* software tool. In addition, the event focuses on interactive discussions and on providing parents a platform to get their individual questions about the topics answered first-hand by researchers. Finally, the information material as well as the URL is made available at the school website for download.

3.4 User Test Workshop

The *Profiler* software tool is applied in practical workshops at school. The pupils use the tool to explore which image data is available online about themselves and what propositions about their own person can be made using image analysis. In interactive sessions the pupils their findings, lessons learned and experiences made through the utilization of the software with the scientists. From the software development perspective this includes user tests and user feedback, user acceptance and scenario-based feedback.

The user test is realized as a qualitative questionnaire-based exploratory workshop. For the experiment a usability questionnaire is developed based on [43]. It aims at evaluating specific usability aspects such as the overall user experience, qualitative feedback on visual appearance, easy and intuitive navigation, subjective impressions about the temporal performance as well as at receiving feedback concerning accuracy of the analytics results and satisfaction with the created profiling report. The questionnaire contains open questions to motivate users to write down their impressions and answers in their own words and individual level of detail.

Table 3.2: User test questions with grading.

Welche Schulnote würdest du vergeben für: • Das Aussehen des Profilers? • Die Symbole? • Die Farben?	Which school mark would you assign for: • The *Profiler* visual appearance? • The symbols? • The colors?
Wie beurteilst du die Richtigkeit der Ergebnisse?	How do you evaluate the accuracy of the results?
Wie gefällt dir die Anzeige der *Profiler* Ergebnisse?	How do you like the *Profiler* results visualization?
Wie gefällt dir der *Profiler* Report vom Aussehen?	How do you like the *Profiler* report (design)?

For the questions listed in Table 3.2 also an option to grade the respective aspect of the *Profiler* tool is given. The quantitative evaluation supports the textual answers as it quantifies their subjective feedback. It allows for further evaluation, such as the calculation of averages and a relative assessment, whereas the latter may only focus on one or two specific details considered the most important by each team. For the grading the Austrian school marks system is used ranging from *1 = Very Good* to *5 = Failed*. The detailed questionnaire is attached in the Appendix (see Chapter 7).

CHAPTER 4

Results

The results are presented focusing three aspects: First, a brief summary of the sociological results relevant to the context of this work is presented. These constitute a basis for the following results. Second, regarding the *Profiler* tool, the main focus is put on the outcome of the conducted user test experiment and a brief overview on the technological aspects is given. Finally, lessons learned of the education concept and workshop results are given in the third section following the holistic interdisciplinary concept approach.

4.1 Internet Use Behavior and Awareness Among Children and Adolescents

Altogether 953 pupils of the age between 10 to 19 years at the Viennese Secondary Academic School GRG23 Draschestraße completed the online questionnaire. Almost all (98.7%, n=953) of the pupils own a mobile or smart-phone and nearly three out of four have their own computer or laptop and 40% (n=953) own a tablet. They access the Internet via mobile or smart-phones, or via computer or laptop at home. More than half of the pupils are longer than for two hours online per day. Online communication as well as publishing and sharing pictures are substantial activities in their everyday lives. Focusing on SNSs and online communication applications, Whatsapp[74] (smartphone-based messenger application), Youtube[75] (online video portal) and Instagram [76] (a service to publish and share images) followed by Snapchat[77] (smartphone-based messenger for photos which adds an expiry date to every so-called "snap") and Facebook[78] ("classical" online social network service) are the most used ones, whereas Whatsapp seems to be the alternative for SMS and SNS-integrated chats, such as the Facebook Messenger[79].

[74] `http://www.whatsapp.com` accessed 05/2016
[75] `https://www.youtube.com/` accessed 05/2016
[76] `https://instagram.com/` accessed 05/2016
[77] `https://www.snapchat.com/` accessed 05/2016
[78] `https://www.facebook.com` accessed 05/2016
[79] `https://www.messenger.com/?_rdr` accessed 05/2016

The SNSs are mainly used to interact with peers rather than adults: Questions about their virtual friends-network compared to their social network in the real world revealed, that more than seven out of eight (n=901) pupils know their Internet contacts also from real life (friends or peers), but more than a quarter are known only from the Internet. Almost two out of three (63.9%) only add someone to their network if they at least know him or her in real life. Less than one out of ten (8.1%) accepts any friendship/follower-request. More than half of the pupils (55.9%) presume other persons to be their friends in real life in order to be added to their online network.

> Auf Instagram kann man gut andere kommentieren und liken, Leute suchen und kennenlernen oder Fotos/Videos posten. Das mach ich oft, wenn mir langweilig ist oder wenn ich verfolgen will, was jemand macht (female student, 15 years)

Concerning publishing and sharing pictures online, 73% (n=886) have uploaded photos of themselves in SNSs and two out of five published videos or photos of friends. Half of the pupils share details about their hobbies, other activities and their age, whereas from the latter the majority (82%) states their correct age. One third of the pupils answered that they either often or sometimes have been tagged in photos without prior consent. Referring to cyberbullying, almost one fifth knows someone who was been bullied. The results concerning Internet use, online activities and risks are similar as in [27]. Pupils are careful when it comes to adding new contacts to their network or sharing personal images, but less aware about information shared with platform providers. Though having knowledge about security settings, data protection and copyright, they lack in implementing it consequently, e.g. by regularly updating the security settings of their SNS accounts. For example, less than half of the pupils (42,8%, n=624, this question was part of the questionnaire for all classes except for the fifth to eighth grade pupils) regularly use security or privacy settings in SNS. Approximately one third has used it at least once. Concerning negative or disturbing experiences 16% of the pupils (n=892) state that at least sometimes videos or photos have been published to SNSs without prior consent and vice versa 11,6% have published media content showing other persons without consent to SNSs. One third states, that they have been tagged at least sometimes without consent. 7% have been experience with being a victim of cyberbullying and almost one out of five knows someone who was or has been a cyber-harassment victim. More detailed results of the sociological research are accepted for publication at NYRIS 2016 and to be published as a report by the sociology partners of the project consortium.

4.2 The *Profiler* Software Tool

The *Profiler* Software Tool is realized as a web-based application available at the URL `http://try.theprofiler.at` platform- and browser-independently.

4.2.1 User Test Experiment

In total, 95 pupils of the 10th grade (age 15-16) took part in the user test and worked in groups of two to four to evaluate the user interface design of the *Profiler* prototype.

Table 4.1: User test ratings by team

Team	Visual Appearance	Symbols	Colors	Results Accuracy	Results Visualization	Report
1A	1	2	2	4	3	2
2A	-	-	-	-	-	-
3A	2	2	3	10	2	2
1B	2	2	3	5	2	-
2B	1	1	1	4,5	3	2
3B	1	1	1	5	3	1,5
1C	2	-	1	3	2	1
2C	2	1	1	4	1	2
3C	1	2	2	4	2	3
1D	2	1	2	-	-	-
2D	2	3	3	4	3	2,5
3D	2	1	2	4	3	1
1E	1,7	2,5	2	4	2	3
2E	2	3	2	4	3	2
3E	2	1	1,5	2	2	1
1F	2	2,3	1	4	2	1
2F	1	1	2	4	1	1
3F	1	2,5	1	3	2	1
Average	1,6	1,8	1,8	4,3	2,3	1,7

The results are summarized using the same structure as in the questionnaire and were taken into account for the development of the final *Profiler* tool version. The ratings of the respective questions are given for all teams in Table 4.1.

Visual Appearance

The visual appearance of the *Profiler* software tool gains overall Very Good to Good feedback with an average rating of 1,6. Comments concerning colors are ambiguous reaching from “could be selected better” or “could be chosen more differently” to “very nice graphics” or “logo does not fit to the rest of the website”. One group assesses the visual appearance too childish, another team does not like the vacuum cleaner as animation for the image acquisition visualization. One group finds the design “somewhat unprofessional” and another team suggested to put the *Play* button somewhere else rather than at the bottom center. The buttons are commented ambiguously: For one group the purpose of the symbols is unclear concluding from their design. The *Forward* button leading to the next step is seen as *Play* button because of the arrow-design. Other groups though find the symbols big and simple, intuitive but not always working or not clearly enough arranged. Two groups suggest to add more color to the symbols. In the respective section for the colors the rating is similarly controversially discussed as above – from “does not fit” or “could be better” or “a bit boring” to “very nice”, “soothing”, “pleasant colors” to “good

contrast, nice combination of orange and blue".

Likes

Following the visual appearance and prior to more detailed questions the questionnaire contains a field asking for what users like most about the overall *Profiler* Software. 15 out of 17 teams answered the question about what they like most about the *Profiler* tool, which are summed up in the following: Among the answers, three groups specially like the *wurstify* feature. The visual appearance is also evaluated positively with four teams mentioning the design to be very clear, further three find the colors or relaxing nice, one group especially likes the symbols and three groups finding it easy or not too complicated to use the tool. The emoticons gains positive response by two groups and also the visualization of the results was found "sweet" by one group. Three teams also remark they especially like about the *Profiler* the face analytics, gender and emotion classification.

Dislikes

Subsequently, what users dislike the most or find worst about the *Profiler* is asked for. In contrast, what the users criticized about the *Profiler* can be divided in the aspects "analytics", "design" and "navigation and handling". The users are unsatisfied with the *Profiler* analytics results as they lack accuracy. Three groups report that the age is estimated 15 to 40 years older than the real age of the displayed person in the picture. Also gender results are reported to be incorrect "sometimes" and emotion is not classified correctly. As a consequence, one group stated that the totally wrong analytics results make the system a bit pointless. Referring to navigation and handling three groups complained that the loading times are long. Furthermore, there are issues with the navigation through the *Profiler* process resulting in error messages (stated by one group) and app freezes which requires the browser to be restarted. Furthermore two groups found the navigation as confusing as the features cannot be selected well and it is not clear that the symbols showing the SNS logos are buttons to connect with the respective network in order to include it as an image source the Profiling. Concerning the design there are comments complaining that the website is not clearly structured and that the colors of the logo do not fit the *Profiler* theme. Furthermore, information about the buttons are wished and the descriptions to be aligned center. One team found the *wurstify* feature superfluous. Finally, one group stated that they dislike the "somewhat discomforting feeling that you might be stalked by others".

Navigation and Handling

All 17 groups answered the question about navigation and handling of the *Profiler* tool. The question aims at revealing difficulties, errors and software issues concerning navigation through and controlling the *Profiler* process. Therefore, answers focusing on other aspects but navigation and handling (such as referring to analytics quality) are discarded. Three groups complain about long loading times, whereas one comments it only happened when they use the Internet Explorer as browsers. Two teams stated that they experienced application hangs and had to restart it. Five groups experienced issues connecting to the SNSs' ranging from confusions with the connec-

tion process (2x), authorization errors to failures when trying to connect with Instagram (2x). Concerning face detection three groups experienced the problem, that when using the *Profiler* for the first time, no images are found (1x) or no faces are detected (2x). There were issues detected concerning the navigation buttons, such as that some design elements were mistakenly understood to be buttons or that the *Profiler* does not automatically jump to the next step after accomplishing the current step, but rather requires user interaction. Furthermore, a *Back* button is missed, which also resulted in problems when trying to go back one or more steps or to the starting page or to restart the search. In addition, for one group it was not clear that there were next steps at all after the acquire images are displayed. The cause for this has been identified as problems in recognizing the *Forward* button, which has been experienced to look like a *Play* button and was visually not prominent due to color and placement at the bottom center. Finally, three groups assessed the *Profiler* as (rather) easy to use ("Einfach zu bedienen [...]"; "[...] Die Bedienung ist eigentlich ziemlich einfach").

Results Accuracy

Overall the users are not satisfied with the accuracy of profiling results concerning age, gender and emotion rating it with an average of 4.3. They state that the estimated age differed more than ten years, in cases also 20 to 30 years from their real age. Furthermore they realized that the age for similar pictures (same content, but different sources and therefore possibly different resolutions or compressions) differs. Emotion classification shows a tendency to overclassify faces as angry or disgusted, whereas in real they smile and look happy. According to the users gender classification works ambiguously ("Nur Geschlecht war richtig" vs. "Geschlecht bei dreiviertel der Bilder falsch"), with a bias of the system to over-classify men to be female. Examples (if available, rating given in the brackets) are that

- For male users the gender is often stated as female, as well as faces are classified to be angry although the person in the picture seems to be happy
- The age is estimated incorrect in 99% of the cases and only once it is completely correct. Further, two identical pictures result in an age difference of five years and a man is entitled as a woman. Emotion is 100% incorrect (4)
- Age often does not correspond at all ($\pm$ 20 years). In one example, a man is only classified a man in four of ten cases and within two same images the estimated age is different (4)
- Gender is in three quarter of the cases wrong, the age is decades too high / emotion is totally incorrect and wrong persons are found (5-)
- Age: hardly correct / gender: almost always correct / emotion: almost always correct (3)

Results Visualization

The visualization of the profiling results is rated to be Good (2,3) by the users. Altogether, 14 teams out of 17 rated and commented the question. Focusing on the analysis results similarly as in the previous question the answers reflect that the accuracy of the analytics results is not

satisfying, e.g. stating that the“face recognition is bad” or the “results are not correct”. Furthermore, one group states that “not always the photos of the profiling subject” or “the pictures that one ‘wants to see’ are shown” or that even for popular persons not many results are found. Concerning the result visualization design the overall feedback is that it looks good but complicated or organized and clear. One group finds the page nicely and in detail designed and another requested more animations such as progress indicator during the profiling step. One group misunderstood the magnifier in the background as a button and stated that it is not necessary, that anyway only the “play button” (forward or next step button) works. One team answered that the selection is limited. When maximizing a picture of the results, further, the analysis results should also be displayed within the maximized picture, not only in the tile-view. Also, two teams mention*wurstify* to be funny or amusing, though one team finds it not necessary.

Report

The one-page PDF report gained Good to Very Good user feedback with an average rating of 1,7. Eleven out of seventeen teams graded the report with a school mark, from which five graded it as 1 (Very Good), one as 1-2 (Very Good – Good) and three found it is worth a 2 (Good). One rating is 3 (Satisfactory) and finally, one is 2-3. Eleven out of seventeen groups added comments to the report: Six groups describe the report as looking good, simple and convenient, clearly and well-structured or summarizing the results well. Twice it is mentioned that the report is simple and not overloaded. One team finds the design “a bit childish, though beautiful”. One team comments that the colors fit well to the topic of SNSs. Another group finds the emoticons sweet. Finally, one group found it not comprehensive.

Additional Information for the Report

The questionnaire motivated users also to write down information they miss in the *Profiler* report and want to have included. Three out of 17 groups did not answer the question. The remaining users are satisfied with the range of information contained in the report, as the rating for the report (1.7) and comments show: “everything is there, but it could be more precise”, “none [information to be added], everything is available”, “I find all information is appropriate as it is”. Additional information requested by the remaining eleven groups include more details concerning information about the time and location the picture was taken, as well as an indicator from which online resource the photo had been acquired. Furthermore they found ethnology, nationality and profession relevant for a comprehensive person profile.

Remarks

The questionnaire is concluded by providing space for additional remarks. Except for one group, all used the space to add comments.

Nine teams made remarks concerning the image analytics results accuracy, i.e. the need for improvement concerning age estimation and emotion classification accuracy. One group suggests to take into account text- and meta-data based profile information from respective SNSs to support a more precise age or gender classification of the target person. Another two groups

state that the App *YouCam Perfect* detected their faces but not the *Profiler* using the same picture and that the resulting emotions were only *disgusted* or *angry* disregarding of the *real, correct* emotion of the person.

As mentioned in the navigation question, again here two groups mentioned long loading times or too slow face detection. In order to prevent confusions, one team also stated that buttons should not change their colors as it could be misinterpreted as them being either activated or deactivated. There is a demand for more photos, a home button, an option to go back one or more steps, a possibility to logout from the connected SNSs' as well as for a button to restart the search. Furthermore, Twitter search should be integrated. Room for improvement is also detected concerning the *Profiler* performance: The login-window should be replaced by an additional window in the same tab. There was also one issue detected that it was not possible for one group to select one face as a reference face. Two groups remarked the *Profiler* could be more clearly structured or even though the simple layout it could be more intuitive than it is. One group suggested to use a *Forward* ("*Weiter*") button instead of the 'play' button and another wished the vacuum cleaner to be replaced by another animation. Finally the question mark raised expectation of providing a brief user guide or assistance, but displayed the funding partners.

4.2.2 The *Profiler* Architecture and Pipeline

The *Profiler* architecture and pipeline as well as the browser-based interface approach allow for easy demonstration in course of workshops independently from the venue or location. However, the user test was performed with the prototype at school, which included basic functionality, but lacked performance optimization User test results showed that response times of more than two minutes lead users to be bored and unsatisfied as waiting times are too long. Based on the user test results optimization was carried out, such as parallelization of analysis tasks, limiting the number of images acquired from each source and scaling down all images in the preprocessing step. This results in a decrease of factor 10 in processing times in final *Profiler* tool compared to the prototype. If all image resources are considered it takes the final *Profiler* approximately 95 seconds from the *Profiler* start to the results display (excluding the times needed by the user to select the reference face) and only 37 seconds if only Google as image source is used with one user accessing the server at the time of the test. The user tests further showed that the hardware specification of the server states the bottleneck for the number of parallel access which can be processed. More than five parallel accesses during the prototype test led to instabilities and response times of more than two minutes per step. Finally, the modular architecture and pipeline structure proved successful for the application, evaluation, testing and optimization of the *Profiler* as it allowed the team for easy and independent work in parallel on different modules as well as integration of additional analysis algorithms or training using other training sets.

4.2.3 The *Profiler* Image Analysis

The image classification algorithms integrated in the *Profiler* are evaluated **separately and isolated** from the remainder of the *Profiler* pipeline to get valid results for each method. The

Table 4.2: Gender

	Bekios-Calfa et al. [7]	The Profiler
Test set	FERET Database	FERET Database
Algorithm	Fisherfaces	4SF
# test images	199	352
Accuracy	93.33±2.33%	88.92%

Table 4.3: Age Estimation test result

	Fu et al. [107]	The Profiler
Test set	MORPH	Adience
Algorithm	ageing pattern subspace	4SF
# test images	8000	1808
Accuracy	8.83 years	12.81 years

Table 4.4: Emotion Classification test result

	Walecki et al. [99]	The Profiler
Test set	CK+	CK+
Algorithm	geometric	geometric
# test images	327	309
Accuracy	93.9 %	57.28%

Color FERET database [68] and Adience collection of unfiltered faces [21] as well as CK+ database [53] are used for the evaluation.

Table 4.2 summarizes the gender classification results and shows an accuracy of 88.92% for the 4SF algorithm implemented in the *Profiler* software tool, tested on the FERET database. The results of the age and emotion classification are depicted in Table 4.3 and Table 4.4, respectively. Age estimation accuracy using the 4SF algorithm and the Adience dataset is 12.81 years and the emotion classification, tested with CK+ database is 57.28%. They contain the respective used test set and algorithm as well as the number of test images for each of the classification types. A detailed evaluation of the classification algorithms is performed by Michael Atanasov [2] and published also in [101].

4.3 Education Concept

Altogether the following common activities have been conducted as part of the school project: Three half-day workshops covering topics such as scientific work and development of online questionnaires, manual and automated image-based person profiling including a user test experiment and an introduction to technological basics, as well as impact assessment and project results.

4.3.1 Workshop I

In course of the first workshop 24 pupils, 19 of 9th grade and 5 of 5th grade, worked in teams and developed in total 19 questions following. Taking into account their experience with and use of SNSs and Instant Messenger Apps, which is concentrated only on Whatsapp, the participating pupils of 5th grade developed questions for the respective Messenger App. The students of 9th grade worked in groups on the following topics: Whatsapp, Snapchat, Instagram, Youtube, ASK.fm.

The corresponding English translations of the questions are listed below:

Whatsapp

- Have you ever sent your address to someone via Whatsapp?
- Have you ever sent a picture to someone?
- Have you ever experienced an unknown number in a Whatsapp group?
- Do you have Whatsapp?
- How many groups are you a member of?
- Do you use it regularly?
- How manyhours per day do you use it?
- Do you know all your contacts?
- What do you use it for? Answer possibilities: school (pictures of homeworks, etc.); private; communication
- How do you get your special contacts in Whatsapp? Answer possibilities: personal reference persons (family, personal friends, acquaintances,...); friends of friends; Internet friends (chatrooms); others

Snapchat

- Have you at least once received upsetting pictures/videos from a stranger? (nude pictures, etc.)
- Has this happened [to you] in Snapchat? Answer possibilities: upsetting pictures/videos received; someone posted something even if you asked to not do it; blocked someone; having been blocked

Instagram

- What topics are your posted photos about?
- What kind of pictures are on your newsfeed?
- How do you find persons you follow?

Youtube

- How many persons of your circle of friends (+family) post videos regularly?
- Which categories do you watch most often? Answer possibilities Lets Plays; Make up (tutorials); music videos; vlogs; pranks

ASK.fm

- How oftendo you use ASK.fm? Answer possibilities: never; rarely; sometimes; often; regularly
- What do you do at ASK.fm? Answer possibilities: I answer questions; I ask questions non-anonymously; I ask questions anonymously; I bully others anonymously/non-anonymously
- Have you every been "hated"at ASK.fm? Answer possibilities: yes/no

Referring to the assignment to take into account the guidelines for creating scientifically "good" questions, the results are diverse in scientific quality: The language and structure is simple, the questions are short. They are appropriate to the age of the persons to be surveyed (i.e. their peers), which are able to answer them. For some questions vague expressions for frequencies, such as "immer (always), oft/häufig (often), selten (rarely), nie (never)" or "regelmäßig (regularly)" are used and for some questions the answer possibilities are not exhaustive. With respect to the content of the questions, the main overall focus is put on usage and SNS or Whatsapp network as well as about sharing one's own pictures and negative experiences. The content of the questions serve as input for the sociological research as well as for the requirement analysis of the *Profiler* software tool as they constitute topics and information which are of special interest and relevance to the pupils and give insights on what they use themselves.

4.3.2 Workshop II

The results of this workshop are divided into two parts: The outcome of the session where pupils work in groups and assess their own image-based online profile from the perspective of a potential employer, and the results of the user test experiments. Following, the results of the first session is presented.

61 teams of size one to three members submitted the completed assignment on conducting manual research on their own or other persons' image-based content available online. Concerning images they found showing themselves, the number of results is limited: For the majority of the pupils the results of pictures showing themselves is below five. These are e.g. pictures from school events which have been published at the school website or profile pictures of their accounts in SNSs. However, the image search results show also pictures of other persons, such as athletes, who's name might be similar. Also checking their own public SNSs profiles most of the pupils found none or up to two pictures as their accounts are private and therefore, the content is not visible to the public. Concluding from the found content, more than 90% of the pupils decided that no negative impression of themselves can be concluded, as there are either no pictures are available online or the found images can be considered neutral or positive. Two teams stated that the human resources manager might think they are sporty and active, one male pupil wrote that the manager might think that he prefers to do something outdoors rather than to work.

Approximately 20% of the teams stated that they have found content online they have not been aware of. Examples are images showing them as actors in musical, which had been performed at school, pictures available from which they have forgotten that they had uploaded them or large amounts of pictures among the results showing other persons. One girl was also shocked that among the results when searching for her father, images from a child abuser were

found. Following the websites where the images had been uploaded it can be concluded that both persons have the same names.

Concerning strategies how to best prevent unwanted images from being made available online, pupils think that it is most effective to not post nor upload any content they do not want to be published or others to see. Furthermore, they recommend to be careful when handling media and about what one publishes about oneself in the Internet. Also, they mention to not send nor let others force them send pictures to anyone whom they do not trust. In addition, the visibility of SNSs profiles should be set to private and they suggest to think twice before uploading any images. One team also stated that using a false name might assist in manipulating or obscuring image search results.

4.3.3 Workshop III

Four classes of 10th grade, in total 93 pupils, participated in workshop III, which was implemented in twice one after the other due with two classes of tenth grade each. Concerning the results presentations the the content covered the topics and questions remained open until then and. The pupils showed high interest in all presentations by discussing with the researchers and asking questions about the contents and outcome as well as potential future work. Concerning the optimization tasks performed to the *Profiler* software tool based on the outcome of user test results there were discussions which led to a delay in schedule. It is assumed that this was of special importance to them as they participated themselves in the user tests.

In the world café session very creative and diverse contents were produced by the pupils. They worked actively on each of the topics and discussions were enabled through the used method and did not have to be encouraged by teachers nor researchers. The implementation of the the world café starting from a brief introduction over forming the groups, host selection, desk rotations to the presentations went smoothly and without problems.

Following, the results of the respective topics are briefly summarized and visualized using one or two examples per each:

Sheer luck or simply a nightmare? The teams wrote eight essays about what would or could happen if they wake up and mobile data, Internet and SNSs were no longer available. The essays are written very creatively and cover a high range of different scenarios, such as: not being able anymore to check their school-related information platforms, SNSs accounts nor to contact friends, family or other persons using messenger apps, or science fiction essays including zombies. They further show that pupils would be shocked and surprised to find out that all these online services no longer work, but some essays also showed relief because it also means that they would not have to keep updated or in touch with others nor have to publish content to their timelines regularly anymore.

For example, the essay shown in Figure 4.1 describes it as a relief:

> something great has happened. Finally I am released from all the obligations. Now I do not have to post anything on Instagram nor Facebook anymore on a weekly basis. Finally I can concentrate only on myself and I will not be disturbed by thousands of Whatsapp messages. I should use the time and finally relax.

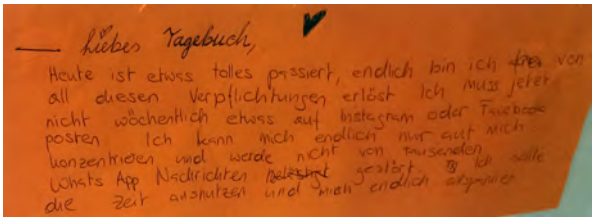


Figure 4.1: Example for an essay to the topic “Sheer luck or simply a nightmare?”

In addition, they would find more spare time for outdoor activities or planning trips, but also be bored and feel lonely:

> . . . I am so sad . . . I am devastated, but still cannot post. . . . I am feeling so alone

Some notes providing an overview over the outcome are visualized in Figure 4.2

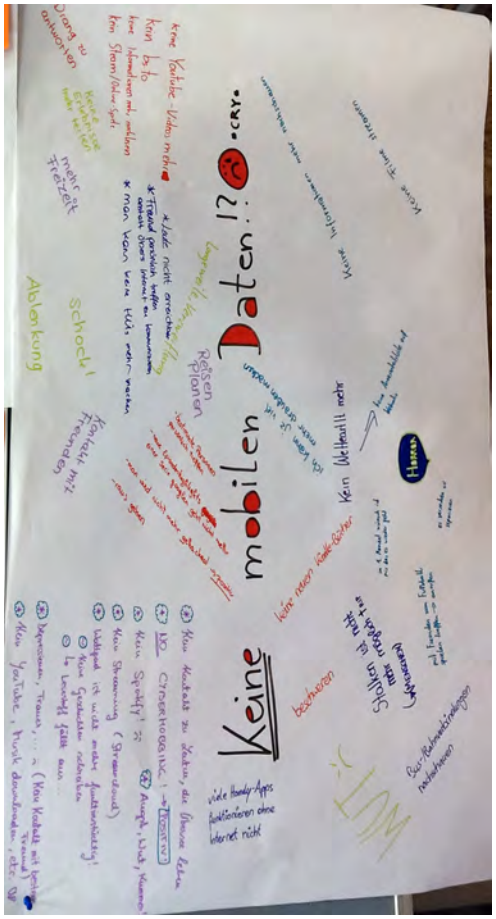
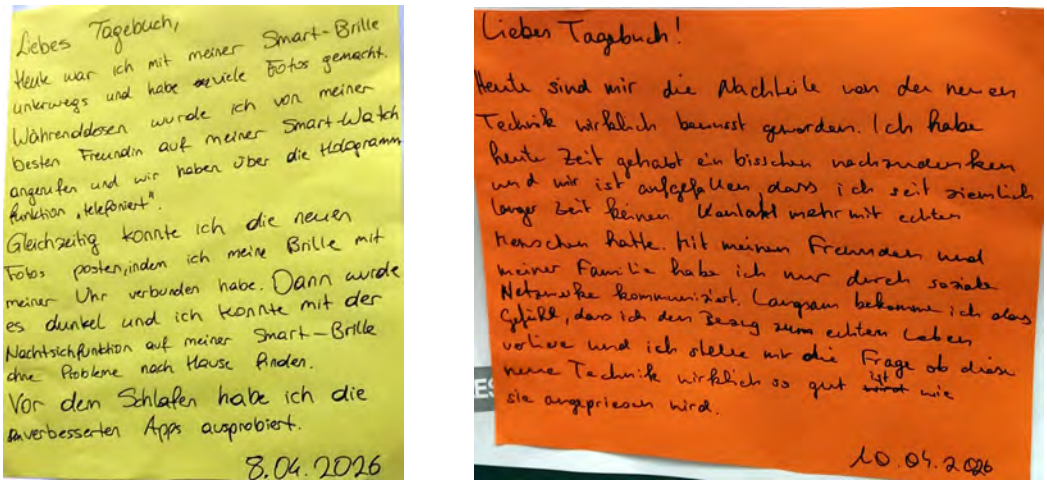


Figure 4.2: World café results of the topic “Sheer luck or simply a nightmare?”

What will the future hold for us? Altogether, fourteen essays were written about the future scenarios about potential technological innovations that would be part of everyday lives ten years ahead. Again, the resulting contents are very creative and diverse about the topics. Future scenarios include international WiFi connectivity or the use of special glasses making it possible for individuals to interact with SNSs and Messenger applications, such as to upload images, to control them with their own thoughts, to restore their vision and support night-vision functionality see Figure 4.3a). Another example presents the benefits of using a so-called *Siri-Hologram*, which makes it possible to share scents or cakes in real time with other person. A teleportation App would make it possible to select a destination and travel there instantly using one's own fingerprint. Parcels would be possible to be shipped through the Internet and opened using a 3D printer by the recipient. Also a critical essay was written about becoming aware of the drawbacks of technology, such as losing touch with real life and becoming socially isolated because communication would be only via digital means rather than face to face (see Figure 4.3b).



(a) (b)

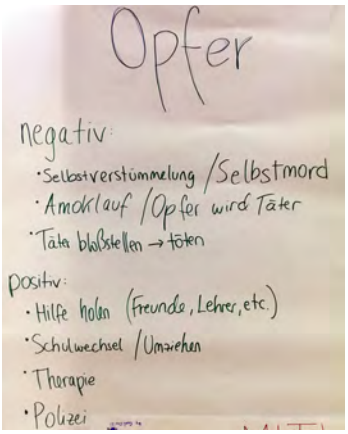
Figure 4.3: World café results examples of the topic "What might the future hold for us?"

Bullying - Cyberbullying In both workshop parts the teams created each one set of flip-charts with brainstormings, lists or essays containing a collection of possible or recommended motives and behaviors of each of the roles of the victim, the bullier and the confidants. One set is depicted in Figure 4.4. Figure 4.4a shows examples for negative actions the victim might take, such as suicide or maiming himself, committing assassins, becoming a bullier themselves or revenge through exposure or killing the bullier. Furthermore, pupils would recommend victims to contact the head of school, to inform the parents of the bullier or to search for help among their friends or a psychologist an if necessary, to change class at school.

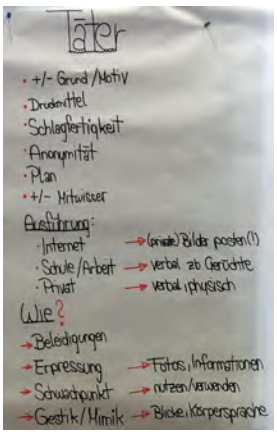
In Figure 4.4b the pupils characterize a bullier through having a reason or motive, a leverage, to be good at repartee, being anonymous, having a plan and possibly confidants. They further see the Internet, school or workplace and private as different places where the bullier might act

through posting images, spreading rumors about the victim or bullying physically. This can be done through insults, blackmailing with pictures or information, utilizing victims' weaknesses and using body language. Pupils state that wrong actions of the bullier are in their opinions to publish further images, to make the victim think he or she is not the bullier or threat other people to be blackmailed in order to prevent them from exposing their knowledge. They would find it correct if the bullier admits, apologizes and stops posting photos. Alternatively, they would find it positive if the bullier publishes positive images of the victim or posts compromising pictures of himself to move the center of attention away of the victim.

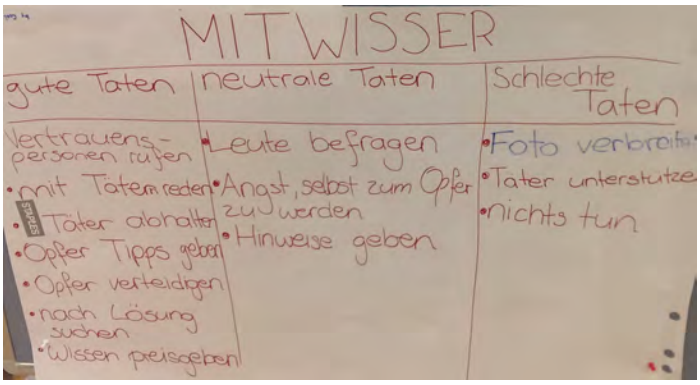
Finally, as confidants it is recommended to contact a trusted person or talk to the bullier. In addition, they encourage to defend the victim, pointing the victim in the right directions and search for solutions as well as expose their knowledge about the issue (see Figure 4.4c). They consider it as neutral to ask other persons or hint the victim or to be afraid to themselves become victim of the bullier. However, they consider it as mistakes to publish any pictures themselves, to support the bullier or to not do anything or even ignore the problem.



(a) The victim



(b) The bullier



(c) The confidants

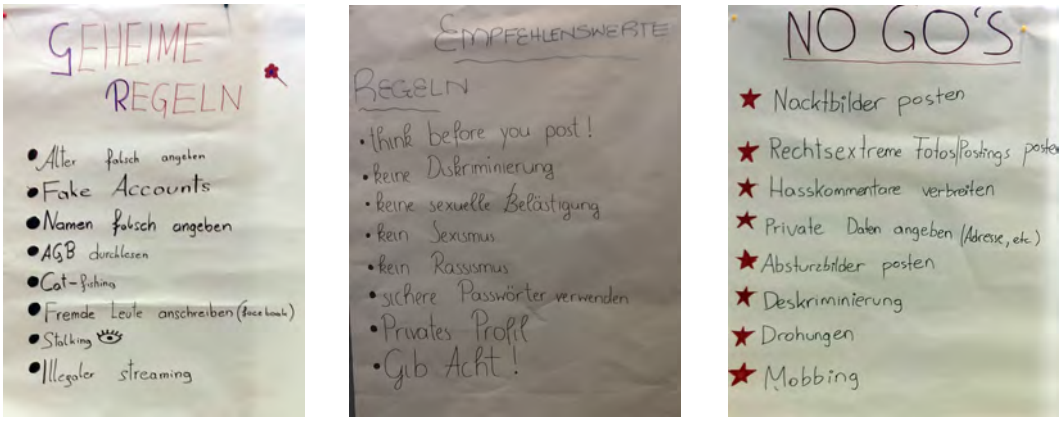
Figure 4.4: Cyberbullying role play results

Using Social Networks - a guide for beginners At the desks with this topic the teams discussed and elaborated on what they would recommend to beginners concerning the use of SNSs or Instant Messengers, what is a *No Go* and what are secret rules, everyone follows, but actually might not be allowed.

They recommend to "think before you post" and to avoid discrimination, sexual harassment, sexism and racism. Furthermore, they recommend to use safe passwords and set profile visibilities to *private*, to take into account copyright, not to post too much - and in general to "be careful!" (Gib Acht!) (see Figure 4.5b.

Absolutely not recommendable is to post nude contents, extreme right-wing postings or pictures, or hate-comments as well as to publish private data, such as one's own address or private data of others without their consent. Furthermore images showing oneself drunk should not be posted, discrimination, threats and bullying are a *No Go* as well. Examples are depicted in Figure 4.5c

Finally, as secret rules they consider the use of fake accounts or faking the age or name in SNSs. Terms of Use of online services should be read. Further, they mention cat-fishing, contacting strangers, stalking and illegal streaming, see e.g. Figure 4.5a.



(a) Secret Rules (b) Recommendations (c) No Go's

Figure 4.5: A Beginners' Guide for the Use of SNSs

CHAPTER 5

Discussion

This chapter comprises a discussion of the presented results of the holistic education concept, of the specific sociological research outcome and of the *Profiler* software tool evaluation. It also includes lessons learned and a brief impact assessment concerning the aim of the holistic media education approach.

5.1 The *Profiler* Software Tool

The *Profiler* architecture proved appropriate for both the software development processes as well as the application of the tool. Making the tool available as a browser-based web application enabled easy access for pupils during school workshops, for presentations and for other persons, such as friends, family or colleagues. The modular architecture supports working in parallel on different modules. This allows not only for a more rapid and efficient development in a team, but also for the parallelization of the tasks in order to optimize the performance of the analysis pipeline.

Concluding from the results of the user test combined with the image classification evaluation the image analysis accuracy of the *Profiler* shows potential for improvement in order to increase overall user experience. The age classification deviation of more than 12 years and its weak performance especially for minor profiling suspects are caused by the used test sets and unconstrained real-world images. The training dataset also contains age data labeled using discrete age classes rather than the specific ages in years. Finally, the weak performance especially with test faces showing minors is due to the fact, that publicly available datasets for training rarely contain faces of minors because of copyright or data protection reasons. Emotion classification results are not satisfying for the users either as they show a bias towards angry and disgusted. The overall accuracy of 57.28% is not accepted well. This is due to the unconstrained test data used in the Profiler and becuase a compromise had to be found between processing times and accuracy of the results. The reason for the tradeoff lies in providing the *Profiler* as a browser-based application operated on a server. Therefore multiple parallel accesses will lead

to a decrease in performance and available bandwidth for each user. Also classification times should take less than 90 seconds as otherwise users might be bored or annoyed having to wait too long for results as the workshops revealed. Optimization targets on using more appropriate training sets, on speeding up the overall performance by more efficient parallelization of the analysis tasks as well as on implementation of further classification algorithms, e.g. based on deep learning.

Concerning the user interface design the feedback of the users is good to very good, still potential improvements include:

- The "search" icon at the top banner a button is misunderstood to be a button. Hence, it is encouraged to make it clickable in order to start the *Profiler* also from there.
- The "Forwards" button to move from one step to the next is not prominent enough as it is placed at the bottom center of the page and it is light-blue in color and on top of the background, which are often images. This can be accomplished by making it larger and to animate it when actions are possible.
- The missing tooltips and text-based guiding information for the users to make the handling as well as the underlying steps of the *Profiler* tool better understandable have been already implemented in an optimization iteration.
- Due to the session handling implementation the users were advised to use anonymous-browsing tabs for the *Profiler*. Hence, they do not remain logged in automatically within the connected SNSs after having closed the browser until the session cleaning routine clears the data. This has been improved by optimizing the session handling: For every tab a separate session has been created. Cached data is only kept for as long as the tab remains open and will be cleared permanently after ten minutes otherways.
- The "?" button on the bottom right of the prototype used for the user test showed the logos of the Vienna UT as well as the funding program. Pupils assumed it constitutes a "Help" option. This was addressed already in course of the optimization: The button has been changed to an"i" (for information). Help has been provided by adding tooltips and more guiding information within the modal windows.

Future work include a stress test with one class (approximately 25 pupils) at school accessing and using the *Profiler* tool in parallel. Subsequently, extensive performance evaluations and optimizations will be conducted in order to make the tool available for the public and for other schools. Concerning image analysis focus will be put on researching the feasibility of integrating deep learning algorithms for emotion and age classification as they might enable significant increases in accuracy [87]. Furthermore, respective image databases for a better training with respect to the target users being minors need to be found or established.

5.2 Sociological Research

The findings, published in [97] and [96], show that Internet, online communication and image sharing are substantial parts of the pupils' everyday lives. They confirm there is awareness

for their responsibilities and potential impacts in context of their online behavior, but it is still deficient especially when it comes to its consequent implementation in actions.

However, studies cannot be considered to show representative results as for their limited sample size and considering that only pupils from one school in Vienna took part. However, they are comparable to the findings of the latest representative German KIM [27] and JIM [72] surveys. A more detailed discussion will be published by the sociologists of the project team, e.g. at NYRIS2016[80].

In the future, the survey might be extended to other schools or other parts of Austria in order to gain more representative insights and to evaluate how media and Internet use behavior of young people might change over time.

5.3 Project Concept and Lessons Learned

One major lesson learned throughout the implementation of the concept has been that the active participation of the pupils and teachers in all project phases is crucial for the project success: Most prominently, this is reflected in an *age gap* between the scientists (age 30+) and the pupils (age 10 to 15) concerning the used language and terminology referring to Internet and social media. For example, the term "forum" is rather unknown for the pupils. Furthermore, *chatting* and *writing back and forth* between peers or sending SMS is used similarly. Also the difference between synchronous (e.g. chatting) and asynchronous (e.g. email) communication has not been clear. The reason for this is seen in their media use and the ubiquitous Internet and smart-phone availability, which promotes and eases asynchronous communication anyway. Without actively having involved the target audience of the questionnaire, the questionnaire would have lacked an easy, age-appropriate and understandable language. This would have led to an increased need for support during the accomplishment and to a higher number of invalid submissions.

Another factor for the overall project success is the common project planning of scientists and teachers in the project pre-phase and during the project is crucial for the project success: the project work and time plan have to follow the pupils' and teachers' schedules at school as well as the didactic implementation and workshop planning has to be age- and skill-appropriate. Therefore, the teachers' competences and experiences as well as the fact that they know the pupils already directly influences a successful project realization.

The interdisciplinary cooperation also promotes creativity as different perspectives onto the topic can be combined. The structure of the consortium provides a fertile ground to learn from each other. In particular, the possibility to work with children and teenagers, scientists get the opportunity to retrieve information and details and see the topics from the young people's perspectives first-handed that would not have been considered nor detected without the active cooperation. On the other hand it opens the way for making science understandable for society.

In course of the workshops and excursions and through the discussions with the scientists about the topics as well as the presentation of project works at the Computer Vision Lab at the Vienna University of Technologies indications for a raise of awareness is observed. Pupils have started to consider topics such as privacy and potential "abuse" of technology (see e.g. Figure

[80] `http://www.hv.se/en/nyris13` accessed 05/2016

5.1) and engaged actively in discussions and asking the researchers during the excursion about what can be done to their data online, what can be analyzed and what could it be abused for or exploited. They also sought advice from experts and suggestions how to best protect themselves in the online world through sending emails to the researchers and through active engagement in the discussions.

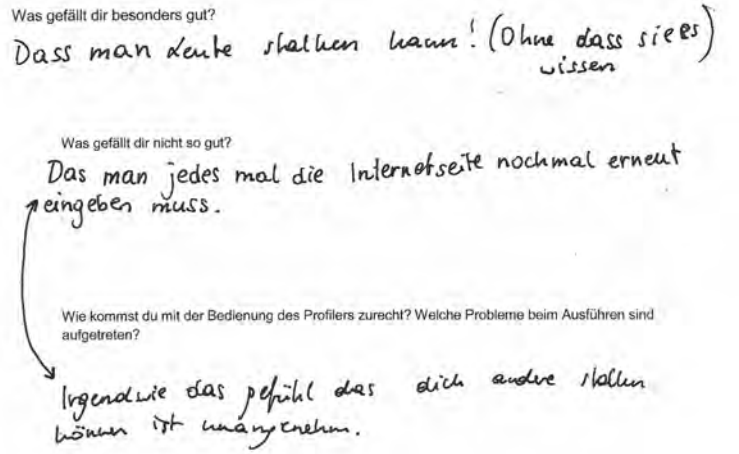


Figure 5.1: Stalking and being stalked

Furthermore, the outcome of the impact assessment workshop shows that there has been awareness for the topic among them and compared to the first workshops conducted an increase is shown as they have conducted online research on their own about themselves and started to use private profiles. They consider legal aspects, privacy and copyright in their discussions as well as they find strategies and recommendations for a critical use of media as well as when it comes to cyberbullying and questionable trends. The implementation as a world café proved successful as the pupils worked in small teams on different topics and as the method encouraged discussions and the production of creative content. It was appropriate to their age and except for the moderation they did not need special guidance and motivated themselves to deal with the topics at the desks rather than having to be motivated by external persons, such as teachers or scientists. Visualizing their content on flip-chart sheets clearly and presenting the produced content to everyone in the concluding discussion round they exercised presentation and discussion skills.

Also after the official project end the cooperation between the school and researchers will continue: Future work from this perspective includes annual workshops for pupils in course of their computer science lessons, such as applying the *Profiler* tool or the world café together with the researchers. Also, excursions for further classes to the Computer Vision Lab are offered as well as the possibility for pupils to contact the participating researchers in case of questions or for technical input for context-relevant pre-scientific theses.

CHAPTER 6

Conclusion

In this thesis an interdisciplinary concept for media literacy and critical media use education for children and teenagers for age 10+ using image analysis and integrating youth research has been presented. It supports interdisciplinary research and development of a software tool (*The Profiler*) on the one hand. On the other hand it brings together pupils and researchers together in order to create unique synergies from the collaboration and to transfer first-hand scientific knowledge to the young generation.

The concept implementation has proved successful and the interdisciplinary consortium structure and inclusion of pupils into the team enabled results, which would not have been possible for any discipline on its own. With their active participation the pupbils contributed also to research in order to support scientists to develop questionnaires and software tools appropriate to their age, skills, behavior and language.

The conducted user test of the *Profiler* tool shows that despite minor necessary optimizations, the user interface as well as the handling of the developed *Profiler* Web application proved successful. It enables students of age 10+ to access the tool from anywhere using their preferred browser. Access to the most commonly used SNSs (Facebook Instagram and Twitter) is integrated. The initial idea to add the also very popular messenger App Whatsapp was neglected since of its different API. Concerning image analysis a tradeoff between analytics accuracy and performance had to be drawn in order to keep the overall processing times acceptable low (<2 min.) for the users while still receiving a satisfyingly accurate result. The integrated image analysis methods, especially emotion classification and age estimation, are therefore not yet as accurate as to provide precise analytics result in the created profile reports, which could be addressed evaluating the feasibility of applying deep learning approaches. For a public release the performance would have to be optimized in order to make tenth of parallel accesses possible while keeping processing times within an acceptable range. Still, the application at school proved an entertaining, provocing, startling and educating tool in dealing with the thesis topic, not only for students, but also for parents, teachers and research colleagues.

The school project comprised several workshops, an excursion, tight collaboration between researchers and pupils and hands-on experience in scientific work. The awareness for possibilities and potential consequences concerning handling images online was successfully raised through these joint project activities. Risks and impacts deriving from uploading and publishing personal pictures to SNSs was impressively demonstrated to them using the *Profiler* tool. It is therefore recommended to host further events for them and also for other students in the future in order to increase the overall impact for the topic among them and among society.

CHAPTER 7

Appendix

List of Figures

List of Tables

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