TECHNISCHE UNIVERSITÄT WIEN

Bundesministerium Arbeit und Wirtschaft

Christian Doppler Forschungsgesellschaft

Comparison of AI-based Signal-Strength Prediction Models on the Vienna Drive-Test Dataset

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CD-Lab for Digital Twin Assisted AI for Sustainable Radio Access Networks

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institute of telecommunications

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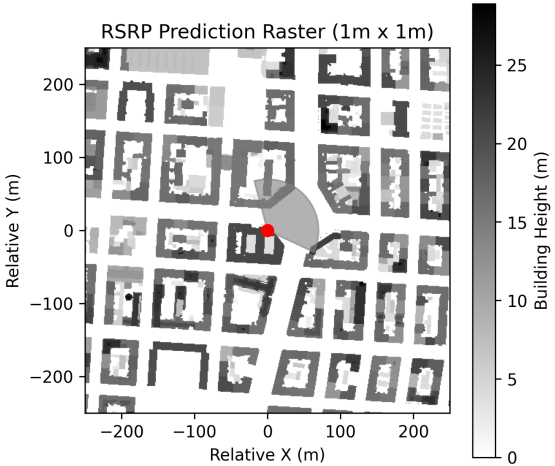
Signal-Strength Prediction

- Network planning
- Complex propagation environments
- Traditional methods not sufficient



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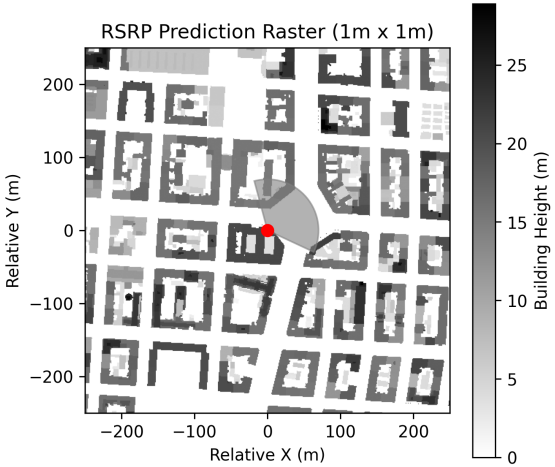
$\Rightarrow$ AI-based methods



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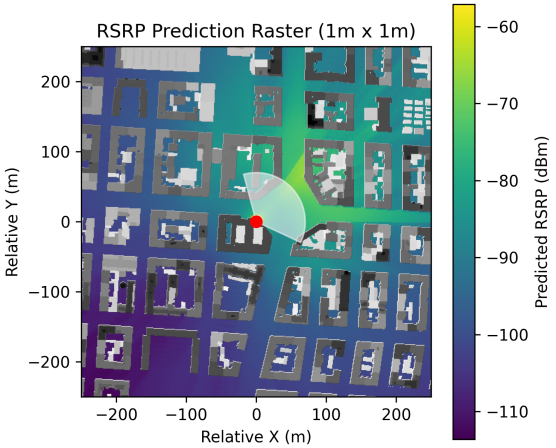

The Challenge when Comparing Models

- Models usually compared based on evaluation performance, e.g., RMSE
- Hard to compare with different underlying datasets

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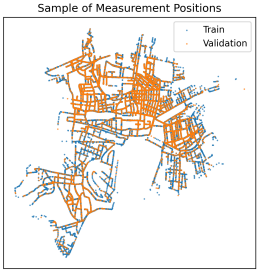
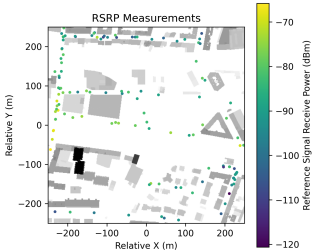
- Hard to compare with different underlying datasets
- Interpolation vs prediction [1]

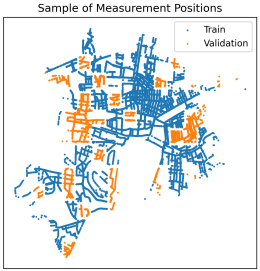
[1] [Eller et al., A Deep Learning Network Planner, 2022, DOI: 10.1109/ACCESS.2022.322]

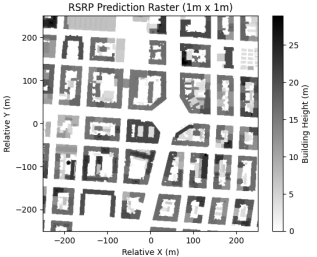
Interpolation vs Prediction





Coverage Map Generation



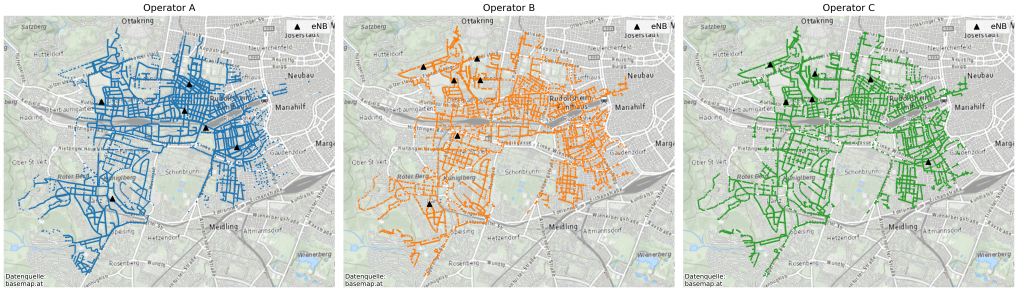


Network Planning

The Need for Common Datasets

- Benchmarking
- Enabling other research groups
- Best practice: MNIST handwritten digits, ...

The Vienna Drive-Test Dataset

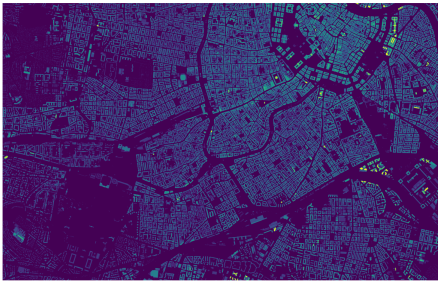


- Subset of a larger drive-test dataset
- $\sim 50\,\mathrm{km}^2$
- 119 000 measurements
- Urban and suburban, Vienna

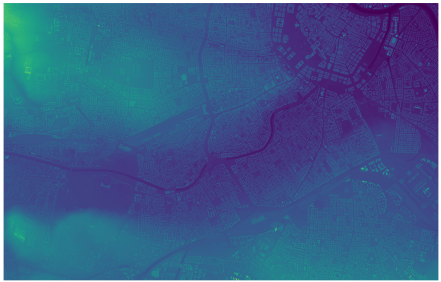
- 4G live network, 3 MNOs
- 800 MHz, 1800 MHz, 2600 MHz
- RSRP, RSSI, RSRQ, CINR, timing advance
- Estimated base station positions and antenna orientations

RSRP . . . Reference Signal Receive Power, RSSI . . . Reference Signal Strength Indicator, RSRQ . . . Reference Signal Received Quality
CINR . . . Carrier to Interference plus Noise Ratio, MNO . . . Mobile Network Operator

The Vienna Drive-Test Dataset

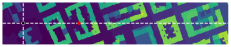


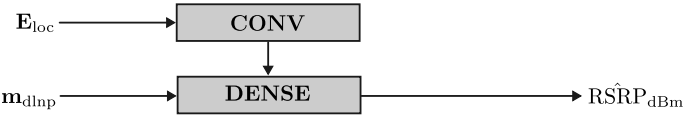
City Model



City and Terrain Model

Chosen Models for AI-Based Signal-Strength Prediction





DLNP model.[1]

[1] [Eller et al., A Deep Learning Network Planner, 2022, DOI: 10.1109/ACCESS.2022.322]
[2] [Sliwa et al., DRaGon: Mining Latent Radio Channel Information Leveraging Deep Learning]

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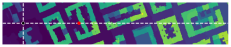

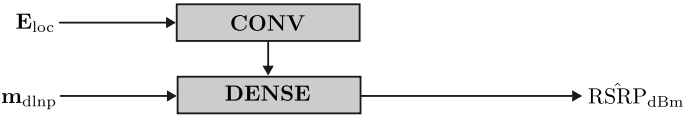

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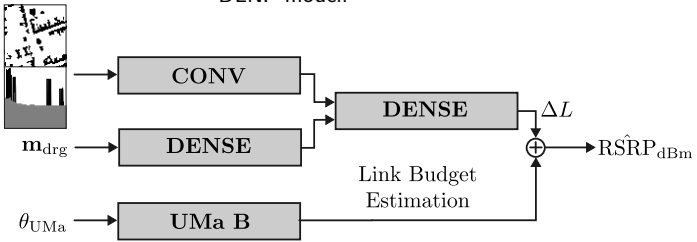

DRaGon model.[2]

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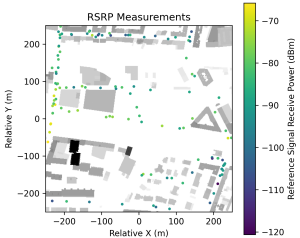
Results



RMSE results in the original works [1,2].

Scenario	DLNP	DRaGon	UMa
Interpolation			
Prediction			

RMSE results in our comparison.

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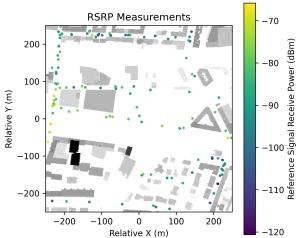

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Scenario	DLNP	DRaGon	UMa
Interpolation	4.6 dB	2.7 dB	12.5 dB
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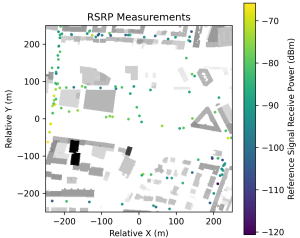

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Scenario	DLNP	DRaGon	UMa
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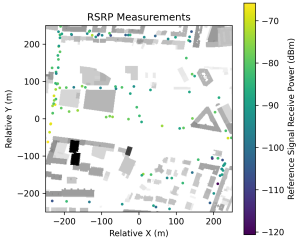

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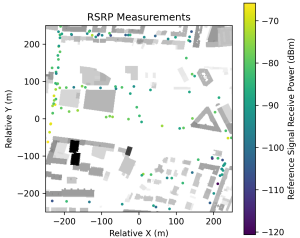

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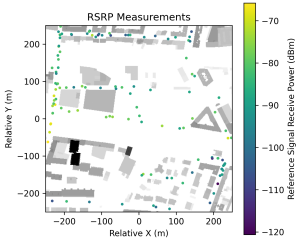

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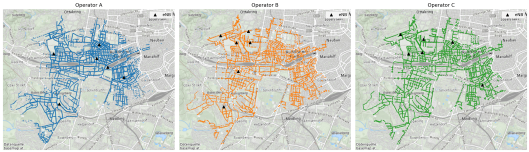
Conclusion and Outlook

Conclusion:

- Training data determines model capabilities
- Benchmarking requires common dataset
- Possible Solution: Vienna drive-test dataset



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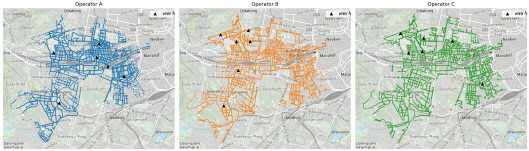
Outlook:

- Publish complete Vienna drive-test dataset



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Thank you for your attention!
Questions?

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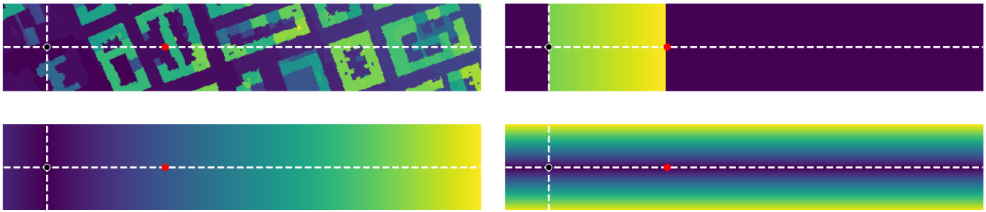
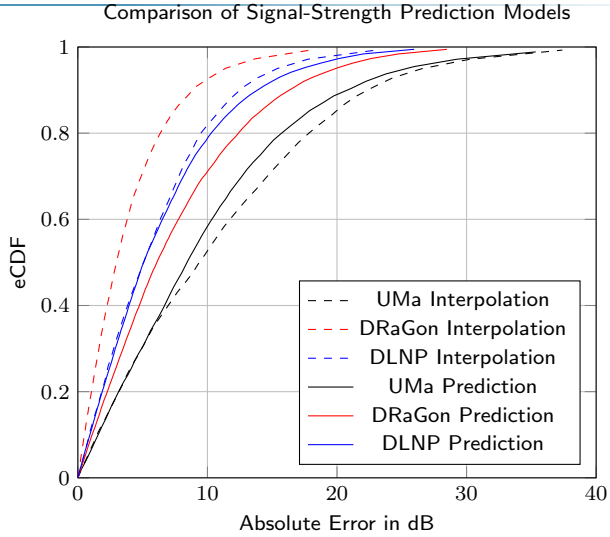
For Further Reading

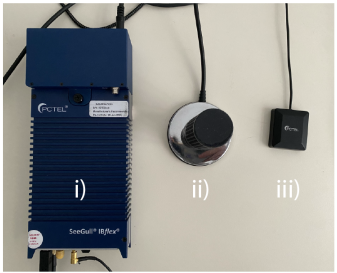
Lukas Eller, Philipp Svoboda, Markus Rupp
A Deep Learning Network Planner: Propagation Modeling Using Real-World Measurements and a 3D City Model
IEEE Access, 2022.
10.1109/ACCESS.2022.322

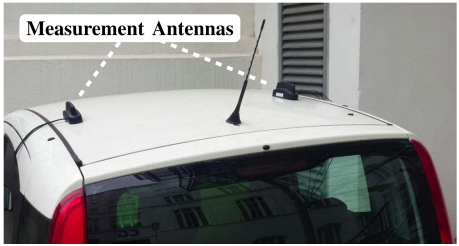
Benjamin Sliwa, Melina Geis, Caner Bektras, Melisa Lopéz, Preben Mogensen, Christina Wietfeld
DRaGon: Mining Latent Radio Channel Information from Geographical Data Leveraging Deep Learning
IEEE Wireless Communications and Networking Conference (WCNC), 2022.
10.1109/WCNC51071.2022.9771981




Comparison of Signal-Strength Prediction Models
eCDF
Absolute Error in dB
0
0.2
0.4
0.6
0.8
1
0
10
20
30
40
UMa Interpolation
DRaGon Interpolation
DLNP Interpolation
UMa Prediction
DRaGon Prediction
DLNP Prediction

Measurement Equipment





i) IBflex scanning receiver from PCTEL
ii) 2x OmniLOG PRO antennas
iii) GPS antenna from PCTEL