



Franz Pernkopf

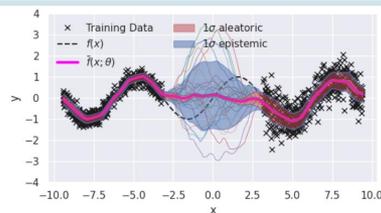
Intelligent Systems Group
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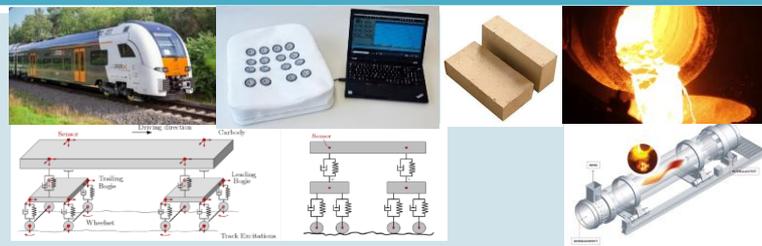
Machine Learning for Radar Processing



Uncertainty Modelling, Graphical Models, Edge AI and Causality



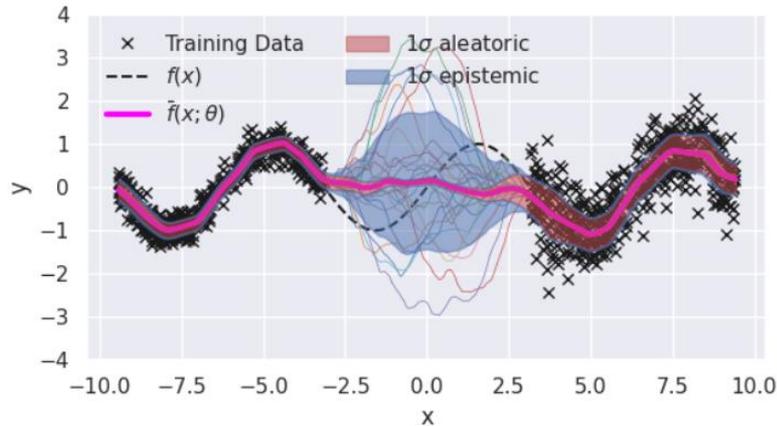
Robust AI for Industrial and Medical Applications



Christian Doppler
Forschungsgesellschaft



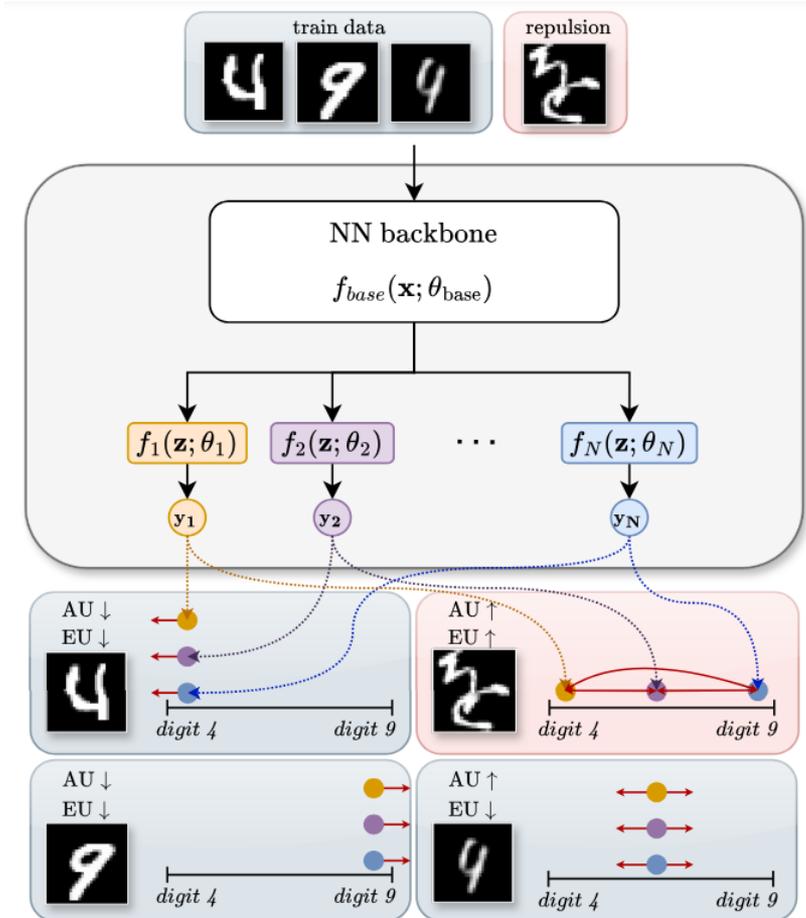
Uncertainty Modeling



- **Aleatoric uncertainty:** Captures noise inherent in the data (not reduceable)
- **Epistemic uncertainty:** Uncertainty in the model due to lack of knowledge and data

Last-Layer Ensemble:

Repulsive particle-optimization variational inference in function space



Robust AI for Industry: Refractory

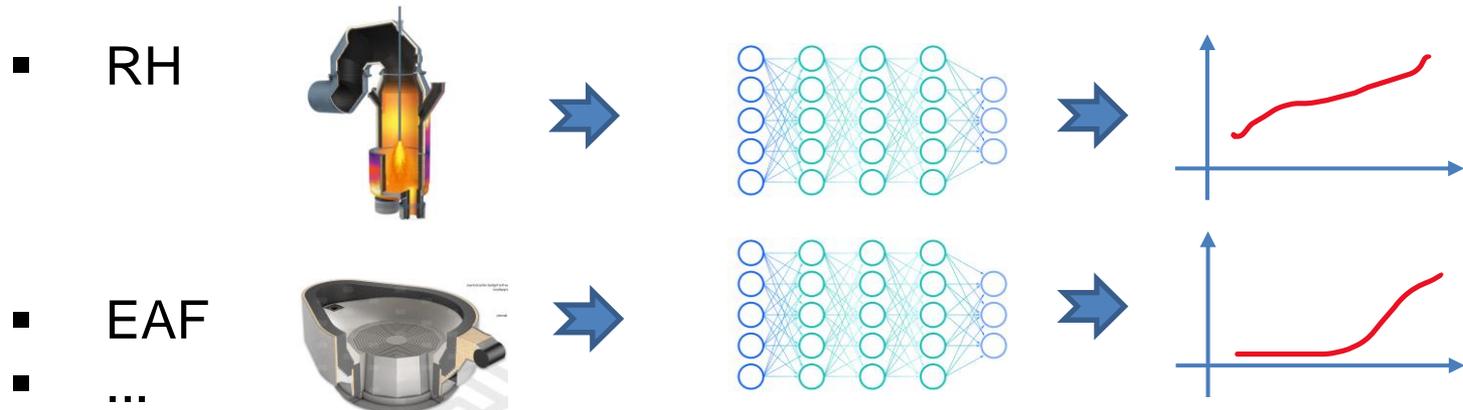
Condition Monitoring:

- Model the wear of refractory
- Optimal usage of refractory
- Safety!



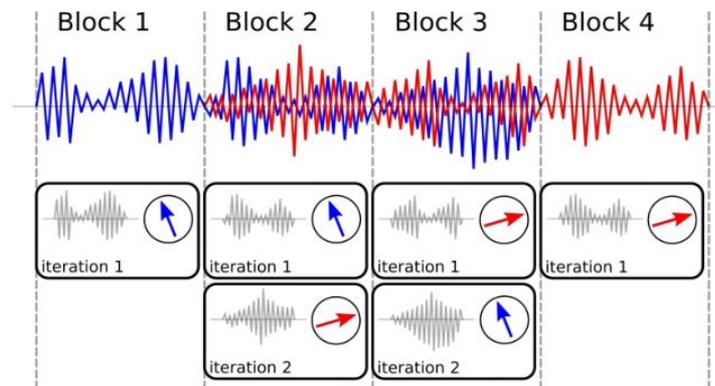
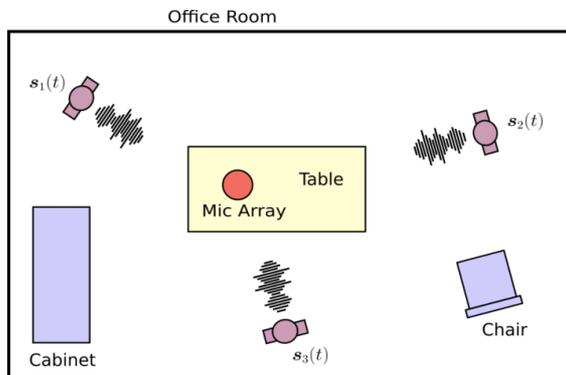
Meta Learning:

- Transfer learning of many *inhomogenous* source tasks
- Leverage performance by transferring knowledge among tasks
- Fine-tuning of pre-trained model for particular application:

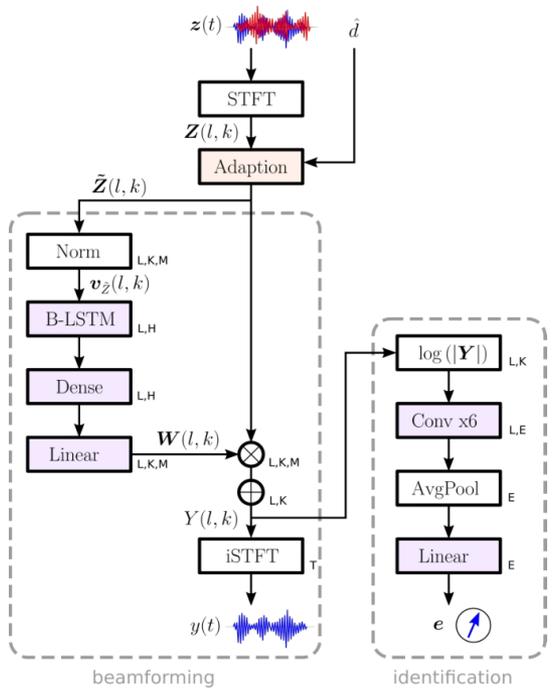


Blind Speech Separation and Dereverberation

- Setup



- Model



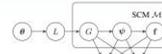
- Results:

TABLE III: Speech separation and dereverberation performance for the *real RIRs* in *block-online* mode.

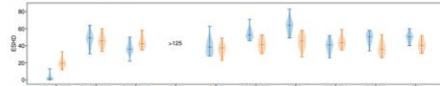
model	C	T_B	SI-SDR	WER	BER
BSSD-FD-SA	2	1.0s	3.80 dB	66.94 %	37.40 %
		2.5s	7.05 dB	44.22 %	15.88 %
		5.0s	8.64 dB	34.79 %	10.00 %
	3	1.0s	3.00 dB	75.68 %	48.90 %
		2.5s	5.19 dB	59.94 %	27.13 %
		5.0s	6.73 dB	52.98 %	14.75 %
	4	1.0s	2.49 dB	78.21 %	64.40 %
		2.5s	3.71 dB	71.96 %	43.75 %
		5.0s	4.76 dB	68.07 %	35.00 %



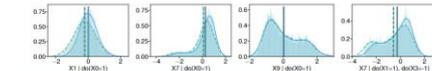
Bayesian Causal Inference



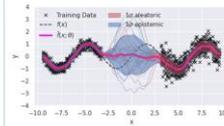
- Structural Causal Model (SCM) inference:
 - Infer a causal order L using a neural autoregressive distribution $p(L|\theta)$
 - Marginalise over causal graphs by limiting the cardinality of parent sets
- Causal discovery: Expected Structural Hamming Distance (ESHD)



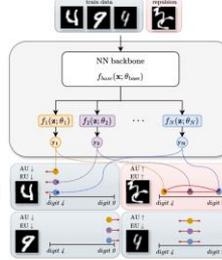
- Blue: Scale free graph; Orange: Erdős-Renyi graph; 20 nodes, 200 data samples
- Posterior interventional distribution: Consensus protein interaction graph [Sachs et al. (2005)]



Uncertainty Modeling

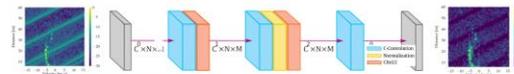
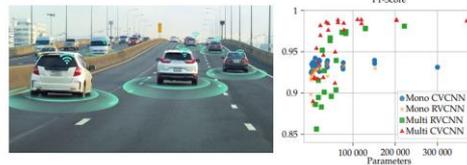


Last-Layer Ensemble:
Repulsive particle-optimization variational inference in function



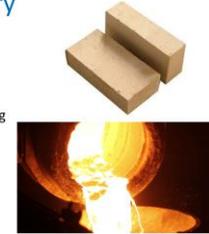
- Aleatoric uncertainty: Captures noise inherent in the data (not reducible)
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Radar Interference Mitigation

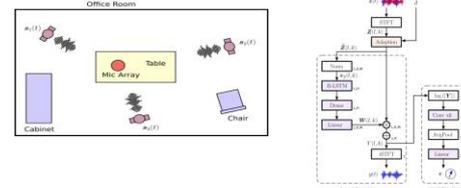


Robust AI for Industry

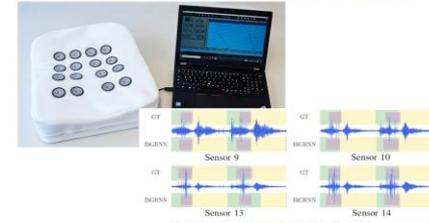
- Meta Learning:
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Speech Separation & Dereverberation



Computational Lung Sound Analysis



- Recording of data in Vietnam
- Multiple Instance Learning

Analysis of Belief Propagation and Bethe Free Energy Approximations

- Fixed point analysis of Belief Propagation
- Graph pruning based on Bethe free energy
- Reliability of Bethe free energy approximation

