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## Ringvorlesung Medizinische Informatik

### Known Operator Learning - Towards Fusion of Machine Learning, Physics, and Signal Processing

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We describe an approach for incorporating prior knowledge into machine learning algorithms. We aim at applications in physics and signal processing in which we know that certain operations must be embedded into the algorithm. Any operation that allows computation of a gradient or sub-gradient towards its inputs is suited for our framework. We derive a maximal error bound for deep nets that demonstrates that inclusion of prior knowledge results in its reduction. Furthermore, we also show experimentally that known operators reduce the number of free parameters. We apply this approach to various tasks ranging from CT image reconstruction over vessel segmentation to the derivation of previously unknown imaging algorithms. As such the concept is widely applicable for many researchers in physics, imaging, and signal processing. We assume that our analysis will support further investigation of known operators in other fields of physics, imaging, and signal processing.

Prof. Dr. Andreas Maier was born on 26th of November 1980 in Erlangen. He studied Computer Science, graduated in 2005, and received his PhD in 2009. From 2005 to 2009 he was working at the Pattern Recognition Lab at the Computer Science Department of the University of Erlangen-Nuremberg. His major research subject was medical signal processing in speech data. In this period, he developed the first online speech intelligibility assessment tool - PEAKS - that has been used to analyze over 4.000 patient and control subjects so far. From 2009 to 2010, he started working on flat-panel C-arm CT as post-doctoral fellow at the Radiological Sciences Laboratory in the Department of Radiology at the Stanford University. From 2011 to 2012 he joined Siemens Healthcare as innovation project manager and was responsible for reconstruction topics in the Angiography and X-ray business unit. In 2012, he returned the University of Erlangen-Nuremberg as head of the Medical Reconstruction Group at the Pattern Recognition lab. In 2015 he became professor and head of the Pattern Recognition Lab. Since 2016, he is member of the steering committee of the European Time Machine Consortium. In 2018, he was awarded an ERC Synergy Grant "4D nanoscope". Current research interests focuses on medical imaging, image and audio processing, digital humanities, and interpretable machine learning and the use of known operators.



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