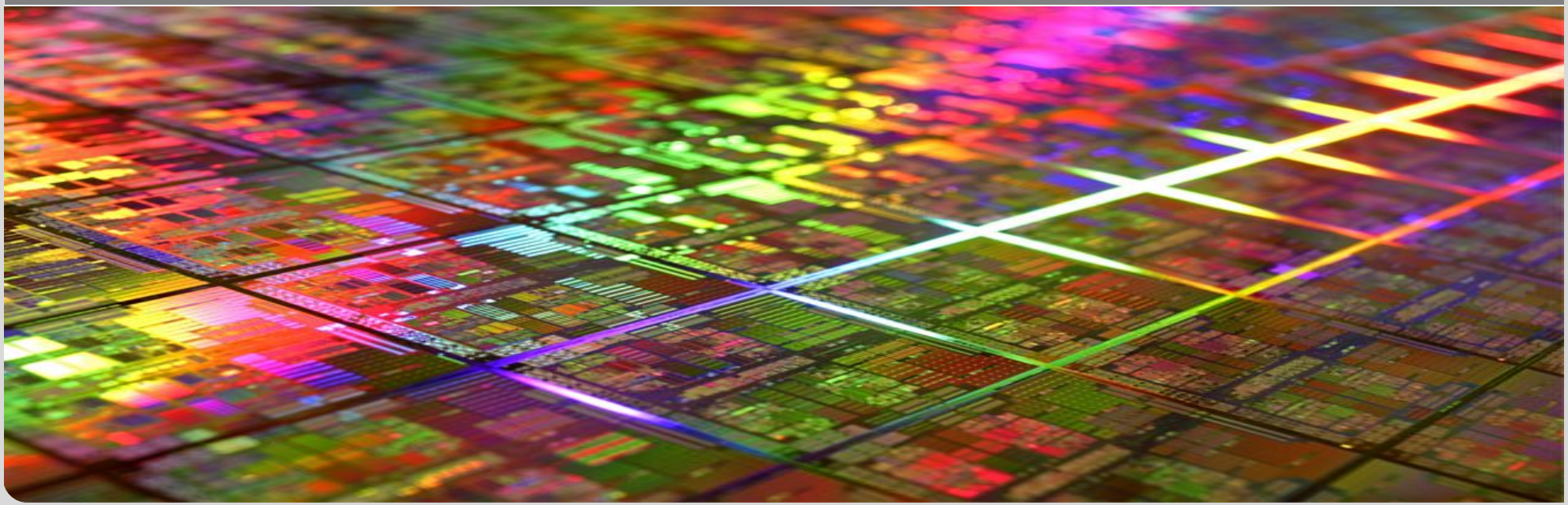
Towards Bringing Together Numerical Methods for Partial Differential Equation and Deep Neural Networks

Progress Update, Supervisor - Markus Hoffmann

Stanislav Arnaudov | September 26, 2019

CHAIR FOR COMPUTER ARCHITECTURE AND PARALLEL PROCESSING



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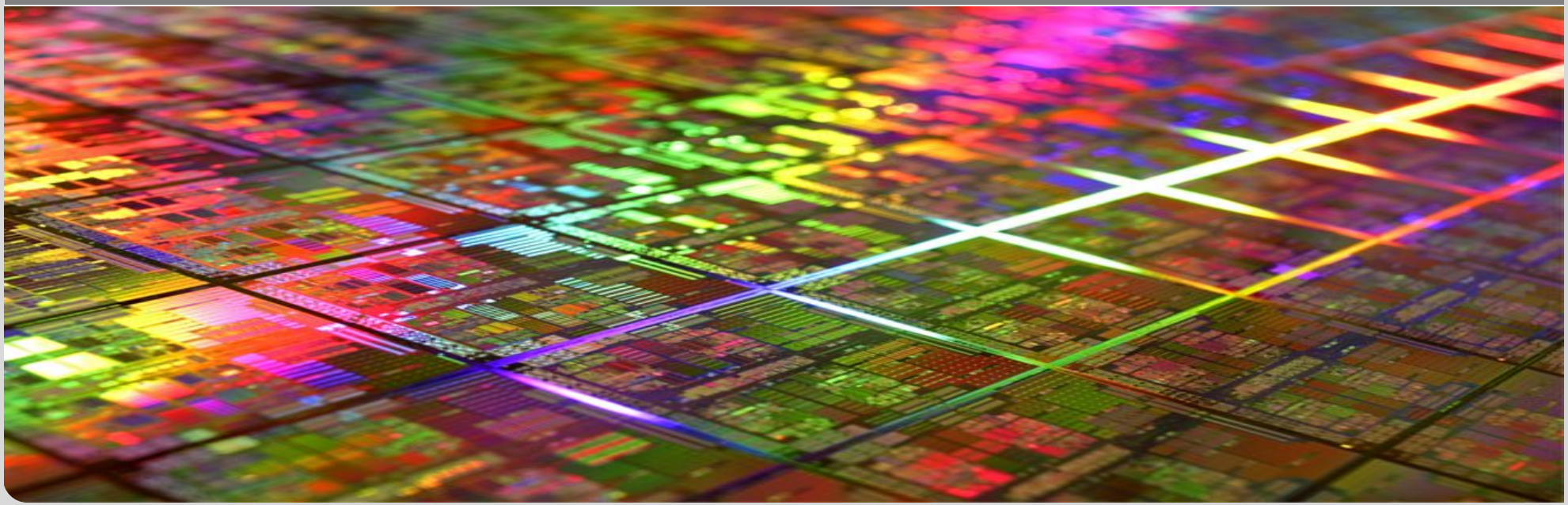

Project description

Basic idea: Perform numerical simulation with ML-models

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- Concrete problem: Flow around an object according to the NavierStokes equations.

Project description

Basic idea: Perform numerical simulation with ML-models

- Solutions of the simulation can be represented as images.

Project description

Basic idea: Perform numerical simulation with ML-models

- Or ML-model primarily use images as input and output.

Project description

Several cases to investigate

- Constant model
- Fluid speed model
- Fluid viscosity and density model
- Object in space model

Data Generation

- Use of numerical solver for real simulation data generation.
- The simulation has several adjustable parameters
  - inflow speed
  - fluid viscosity
  - fluid density
- Reynolds Number in the range of [90, 350]

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Data Generation

- Use of numerical solver for real simulation data generation.
- The simulation has several adjustable parameters
- Reynolds Number in the range of [90, 350]
- Choosing appropriate color space
  - RGB
  - Grayscale

Models

- Two types of architectures based on our preliminary research:

Models

- Two types of architectures based on our preliminary research:
  - ResNet

Models

- Two types of architectures based on our preliminary research:
  - UNet

Models

- Two types of architectures based on our preliminary research:
  - UNet turned out to perform better.

Models

- Two types of architectures based on our preliminary research:
- Data being used by the network.

Models

- Two types of architectures based on our preliminary research:
- Data being used by the network.
  - Usage of pressure field

Models

- Two types of architectures based on our preliminary research:
- Data being used by the network.
  - Processing of real values

Models

- Two types of architectures based on our preliminary research:
- Data being used by the network.
  - Usage of pressure field $\rightarrow$ the pressure field turned out to be useful
  - Processing of real values $\rightarrow$ extra image channel filled with the value

Evaluating the results

Evaluation cases

Thank you for your attention.

Questions?