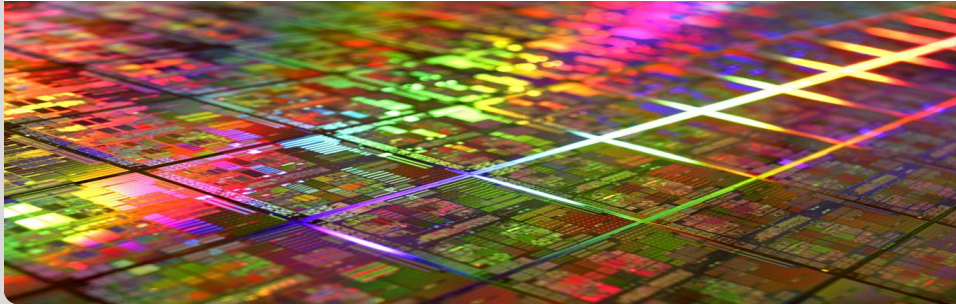# Towards Bringing Together Numerical Methods for Partial Differential Equation and Deep Neural Networks

Progress Update, Supervisor - Markus Hoffmann

Stanislav Arnaudov | September 26, 2019

Project description

Basic idea: Perform numerical simulation with ML-models

Description
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Data
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Models
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Results
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Project description

Basic idea: Perform numerical simulation with ML-models

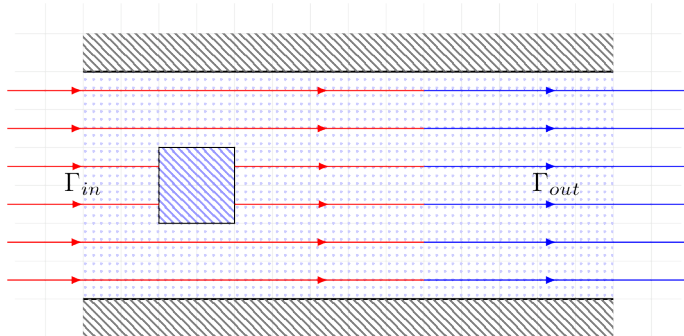- Concrete problem: Flow around an object according to the Navier–Stokes equations.

Figure: Simulation Setup

Description

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Project description

Basic idea: Perform numerical simulation with ML-models

- Solutions of the simulation can be represented as images.

Figure: Simulation Image

Description
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Project description
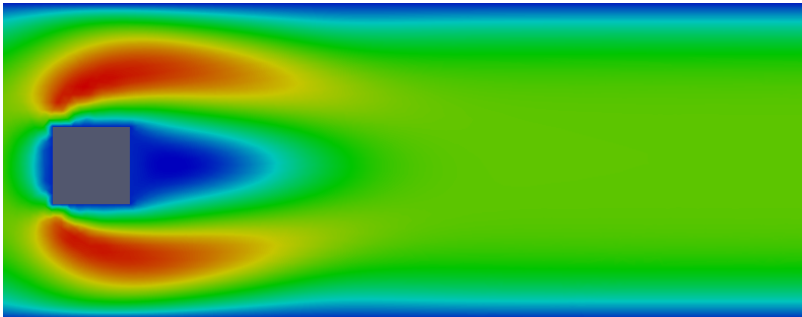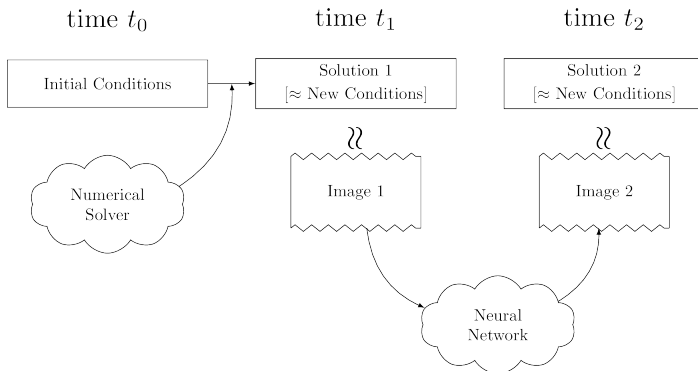
Basic idea: Perform numerical simulation with ML-models

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

Description
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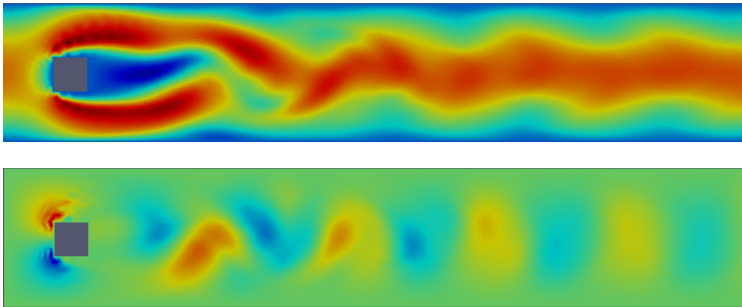○○○○○○○○

Results
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Project description

Several cases to investigate

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

Description
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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]

Description

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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]

Description
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Data
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Models
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Results
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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]

Karman vortex street

Description
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Data
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Data Generation

- Use of numerical solver for real simulation data generation.

- The simulation has several adjustable parameters

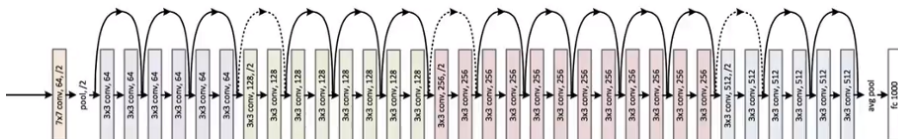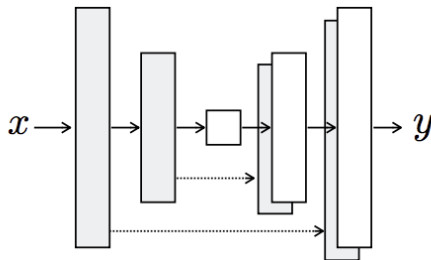- Reynolds Number in the range of [90, 350]

- Choosing appropriate color space
  - RGB
  - Grayscale

Description

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Models

- Two types of architectures based on our preliminary research:

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Models

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

Models

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

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Models

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

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Models

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

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Models

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

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Models
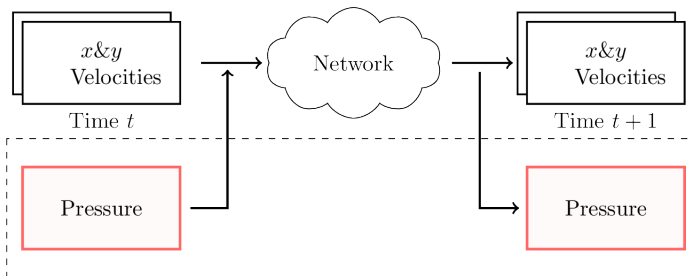
- Two types of architectures based on our preliminary research:
- Data being used by the network.
  - Processing of real values
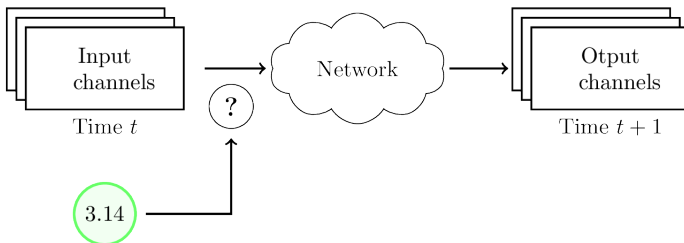
Description
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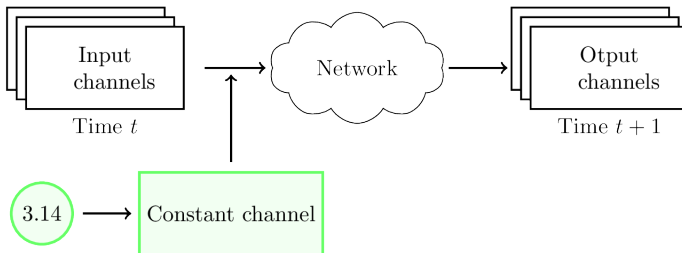Stanislav Arnaudov – Progress Update

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Models

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

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Evaluating the results

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Evaluation cases

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Thank you for your attention.

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Results
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Questions?

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Models
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