King Abdullah University of Science and Technology

KAUST

AMCS / CS 247 – Scientific Visualization
Lecture 3: Introduction, Pt. 3

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Reading Assignment #2 (until Sep. 16)

Read (required):

- Data Visualization book, finish Chapter 2
- Data Visualization book, Chapter 3 until 3.2 (inclusive)
- Continue familiarizing yourself with OpenGL if you do not know it !

Visualization – Three Major Areas

Four major areas

- Volume Visualization
- Flow Visualization

Scientific Visualization

Inherent spatial reference

3D

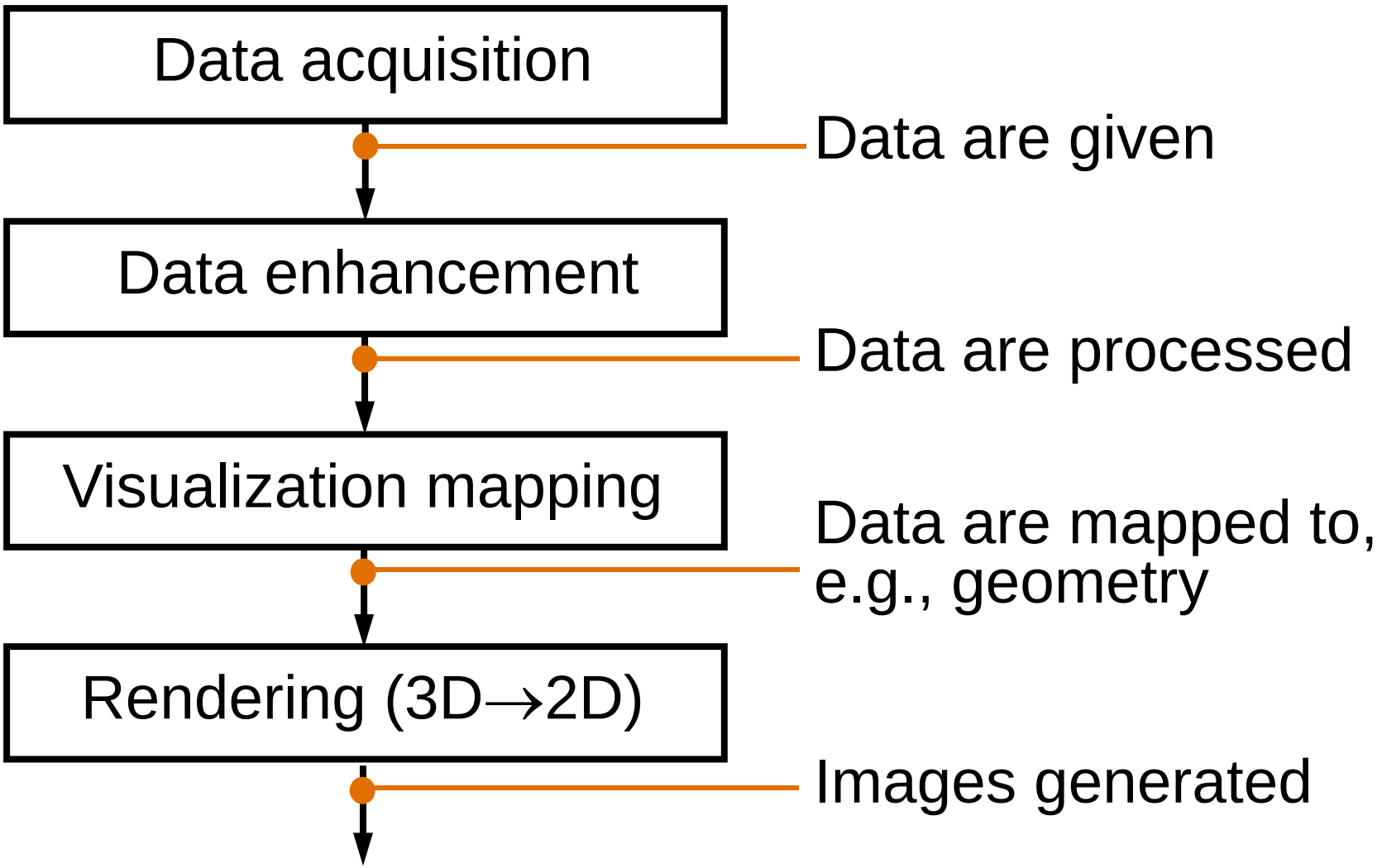
nD

- Information Visualization
- Visual Analytics

Usually no spatial reference

But these lines are becoming more and more blurred!

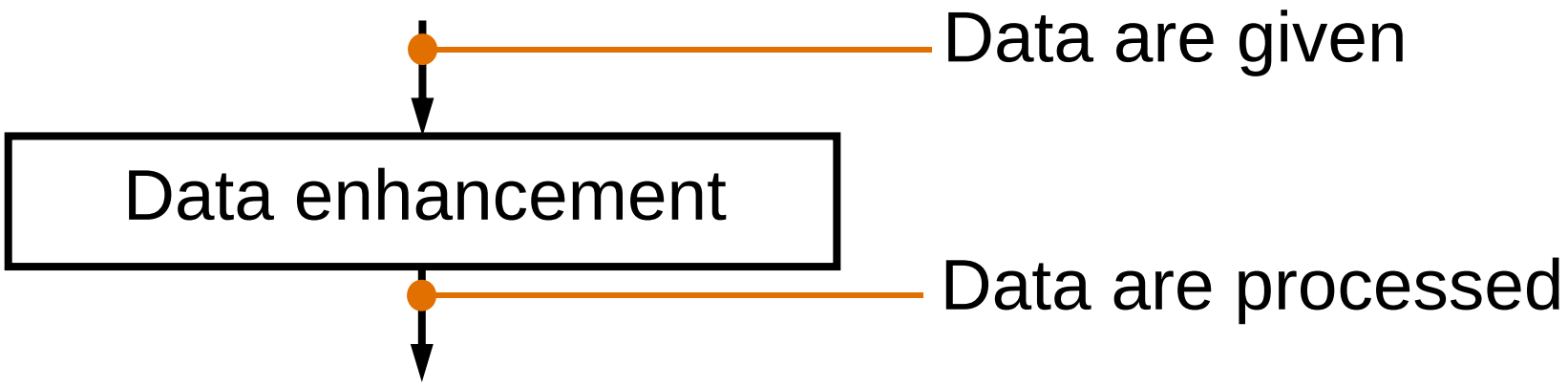
The Visualization Pipeline – Overview



The Visualization Pipeline – Stage 1

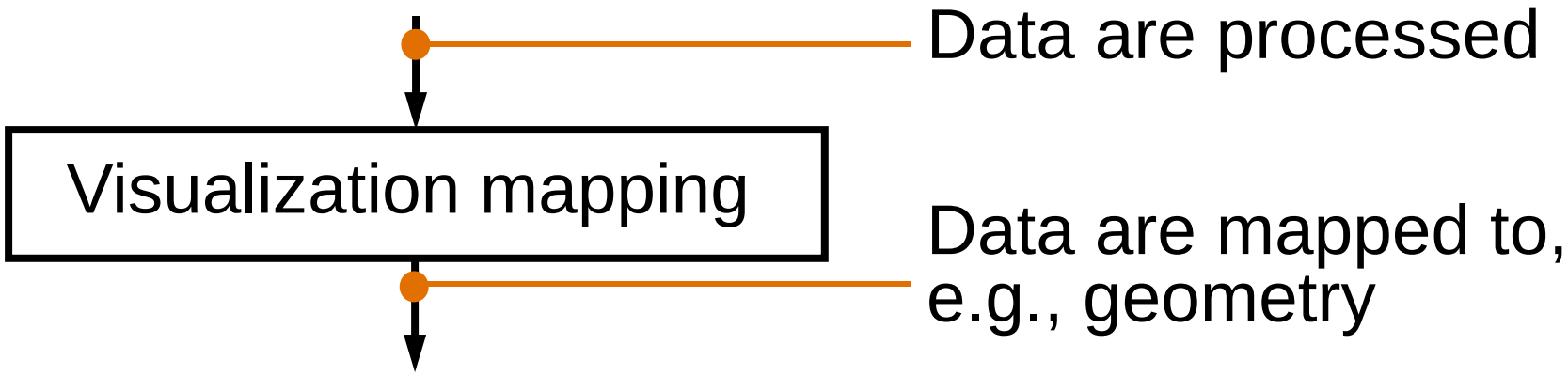
- Measurements, e.g., CT/MRI
- Simulation, e.g., flow simulation
- Modeling, e.g., game theory

The Visualization Pipeline – Stage 2



- Filtering, e.g, smoothing (de-noising, …)
- Resampling, e.g., on a different-resolution grid
- Data derivation, e.g., gradients, curvature
- Data interpolation, e.g., linear, cubic, …

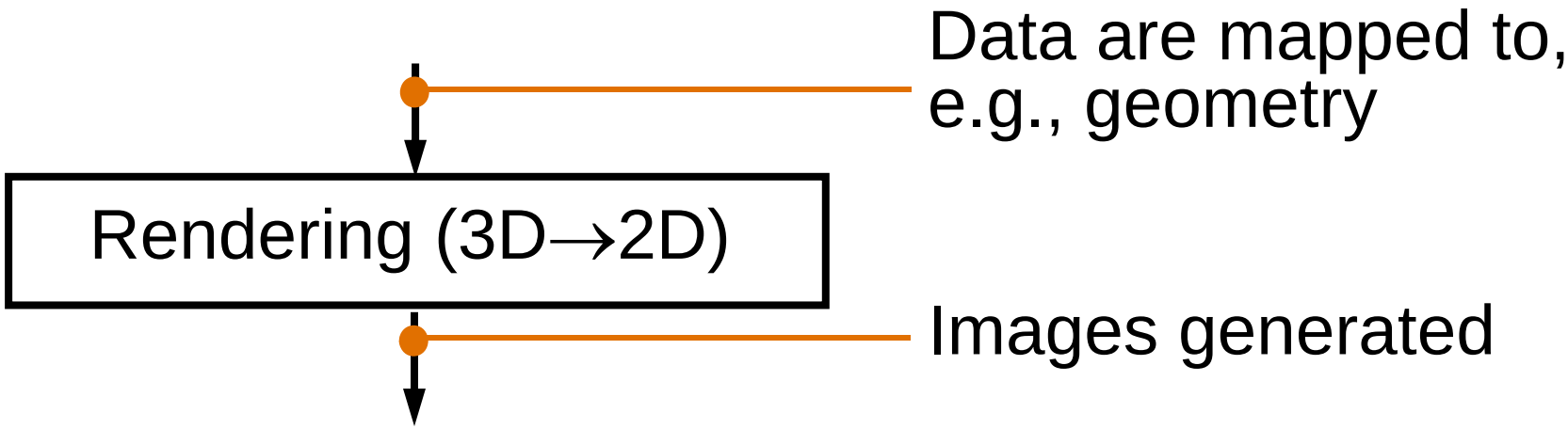
The Visualization Pipeline – Stage 3



Make data “renderable”

- Iso-surface calculation
- Glyphs, icons determination
- Graph-layout calculation
- Voxel attributes: color, transparency, …

The Visualization Pipeline – Stage 4



Rendering = image generation with computer graphics

- Visibility calculation
- Illumination
- Compositing (combine transparent objects, …)
- Animation

Data Generation, Visualization, Interaction

Coupling varies considerably:

- Data generation (data acquisition):
  - Measuring, simulation, modeling
  - Can take very long (measuring, simulation)
  - Can be very costly (simulation, modeling)
- Visualization (rest of visualization pipeline):
  - Data enhancement, visualization mapping, rendering
  - Depending on computer, implementation: fast or slow
- Interaction (user feedback):
  - How can the user intervene, vary parameters

Passive Visualization

All three steps separated:

- Off-line data generation
  - Measurements
  - Simulation
  - Modeling

- Off-line Visualization
  - Previously generated data are visualized
  - Result: video or images/animation

- Passive Visualization
  - Viewing of the visualization results

Interactive Visualization

Only data generation is separated:

- Off-line data generation
  - Measurements, Simulation, Modeling

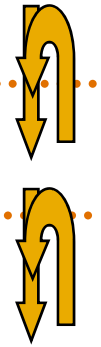
- Interactive visualization
  - Previously generated data are available
  - Visualization program allows interactive visualization of the data

  - Possibilities:
    choice, variation, parameterization of the visualization technique
  - Nowadays widespread
  - Focus of this course!

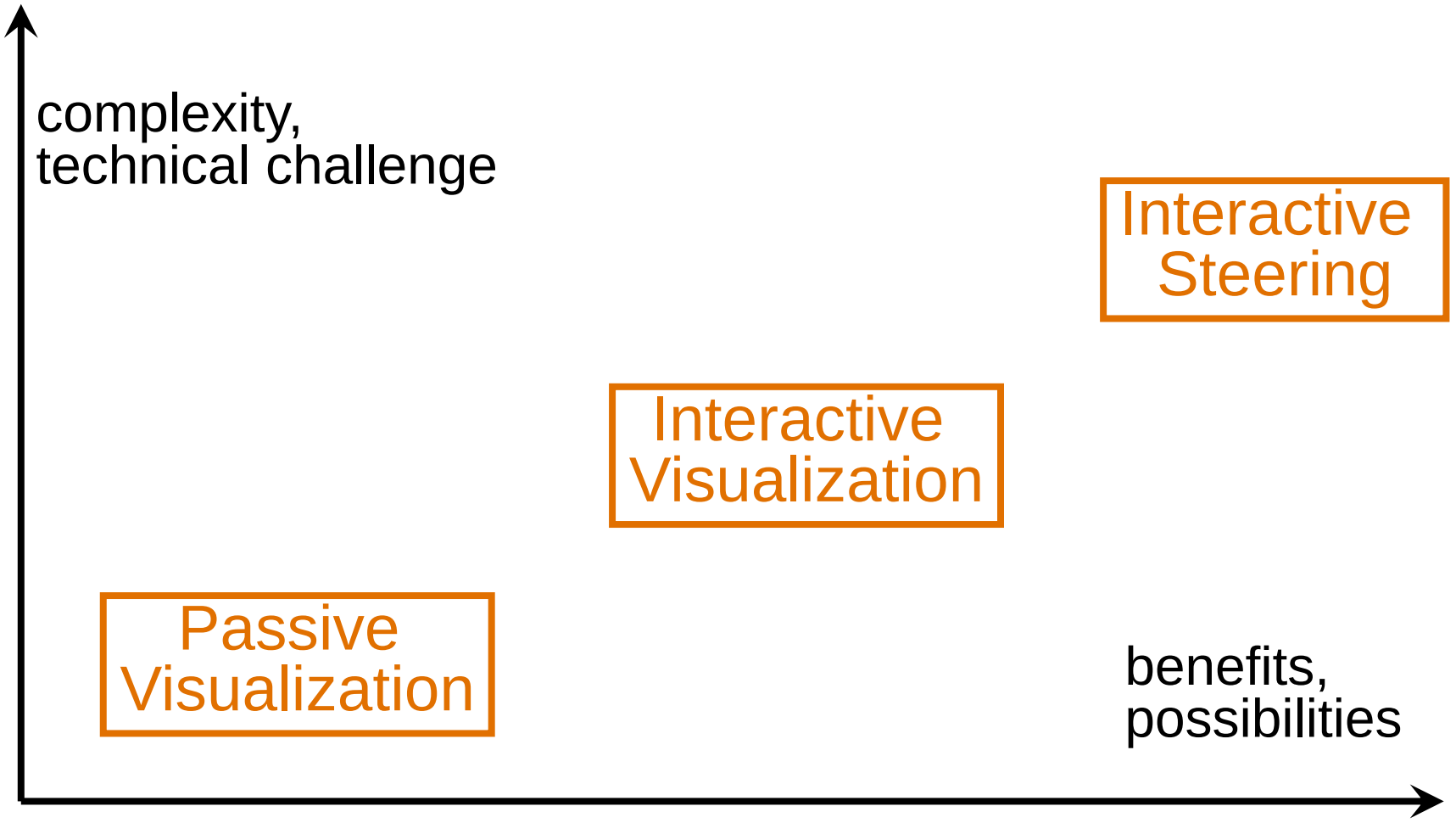
Interactive Steering

All three steps coupled:

- Interactive steering
  - Simulation and/or modelling (measuring) generate data “on the fly”
  - Interactive visualization allows “real-time” insight into the data
  - Extended possibilities:
    user can interfere with the simulation and/or the modeling, change the design, ...
  - Often requires lots of effort, very costly



Visualization Scenarios



Data – General Information

Data:

- Focus of visualization,
  everything is centered around the data
- Driving factor (besides user) in choice and attribution of the visualization technique
- Important questions:
  - Where do the data “live” (**data space**)
  - **Type** of the data
  - Which **representation** makes sense
    (secondary aspect)

Data Space

Where do the data “live”?

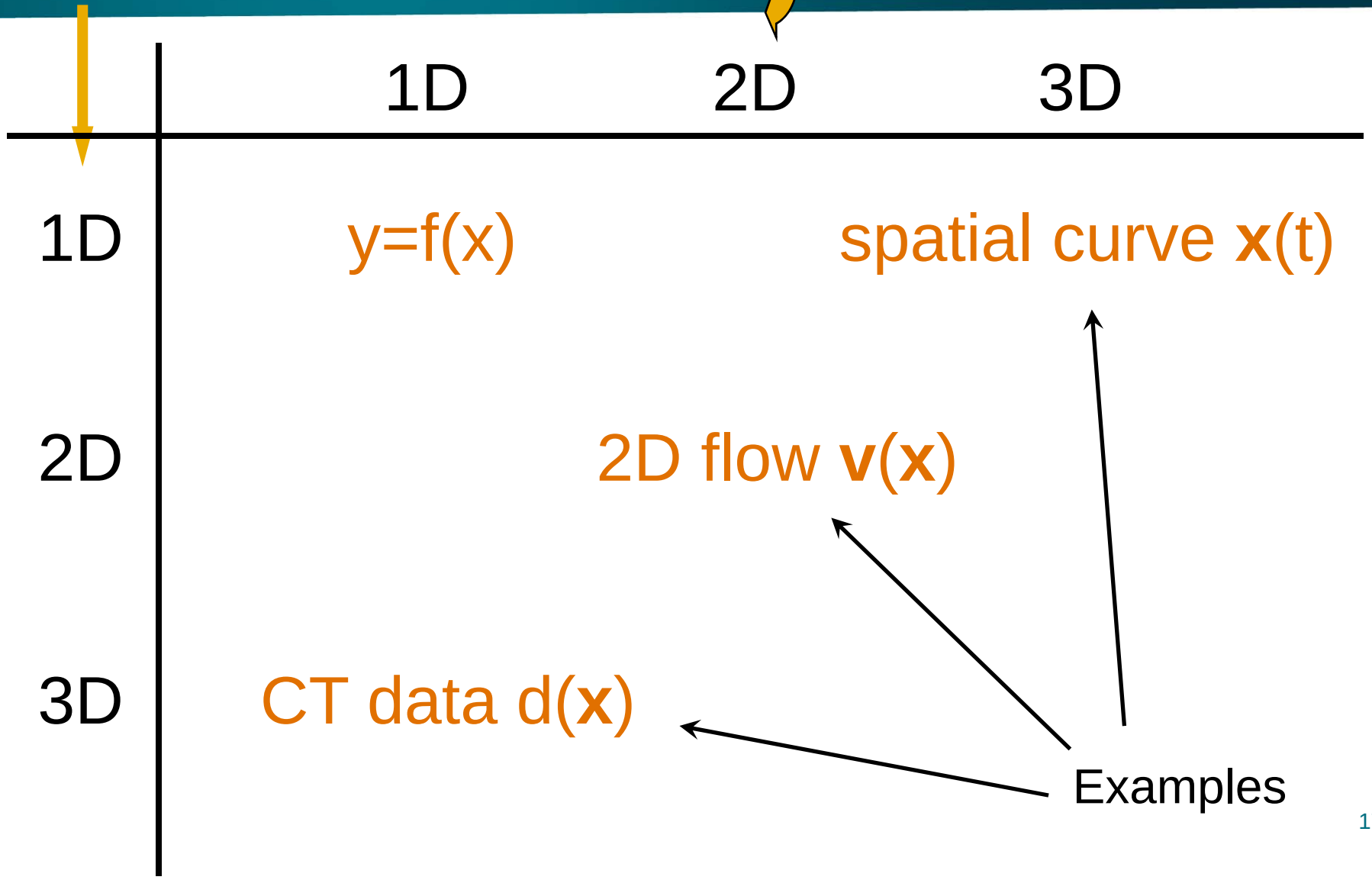
- Inherent spatial domain (**SciVis**):
  - 2D/3D data space given
  - examples: medical data, flow simulation data, GIS data, etc.
- No inherent spatial reference (**InfoVis**):
  - abstract data,
    spatial embedding through visualization
  - example: data bases
- **Aspects**: dimensionality, domain, coordinates,
  region of influence (local, global)

Data Type

What type of data?

- **Data types**:
  - Scalar = numerical value
    (natural, integer, rational, real, complex numbers)
  - Non-numerical (categorical) values
  - Multi-dimensional values (n-dim. vectors, n × n-dim. tensors of data from same type)
  - Multi-modal values (vectors of data with varying type [e.g., row in a table])
- **Aspects**: dimensionality, codomain (range)

Data Space vs. Data Type



Thank you.

Thanks for material

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- Ronny Peikert
- Philipp Muigg
- Christof Rezk-Salama