

# **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

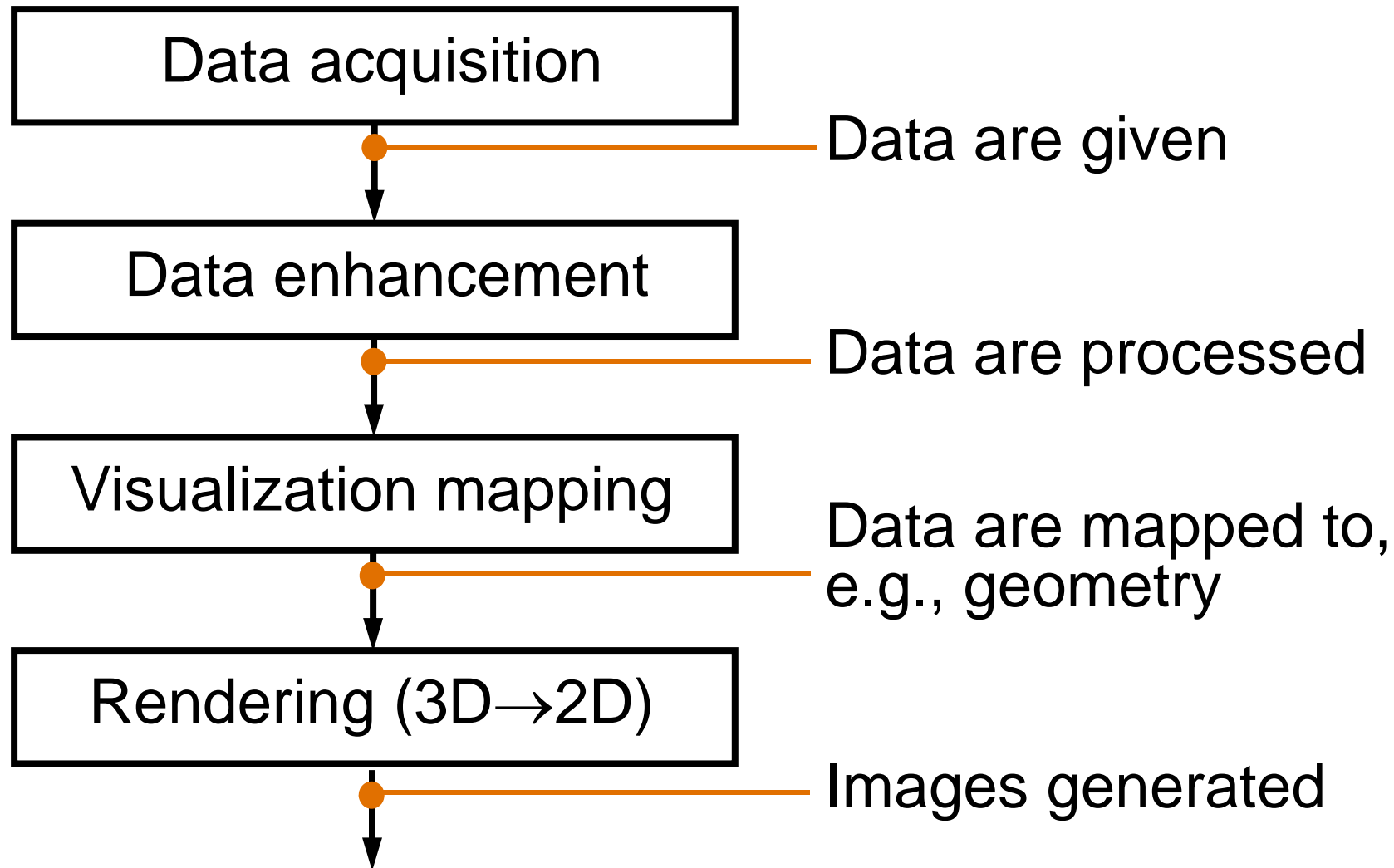
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- Information Visualization
  - Visual Analytics

nD

Usually no spatial reference

But these lines are becoming more and more blurred!

# The Visualization Pipeline – Overview

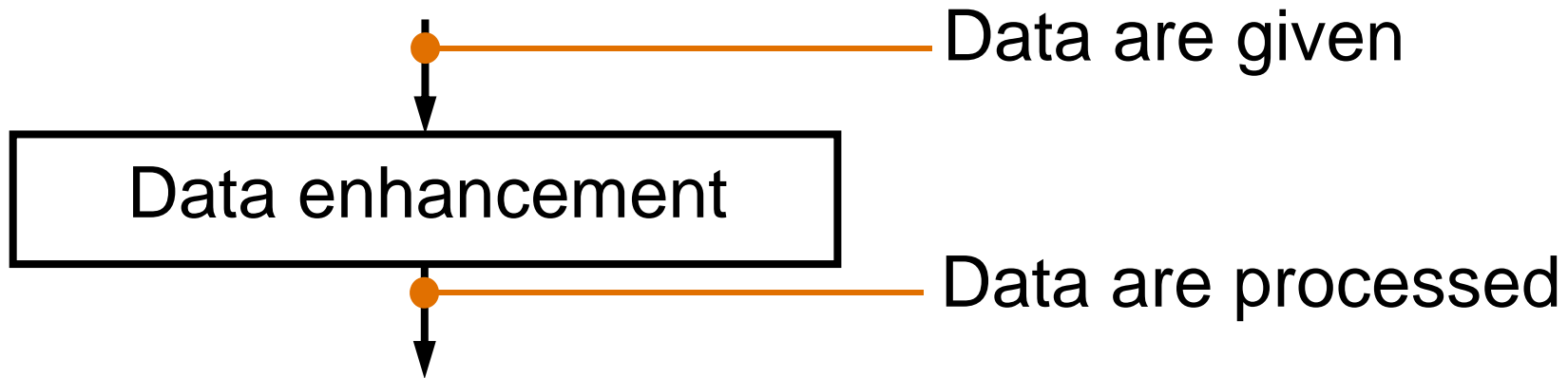


# The Visualization Pipeline – Stage 1



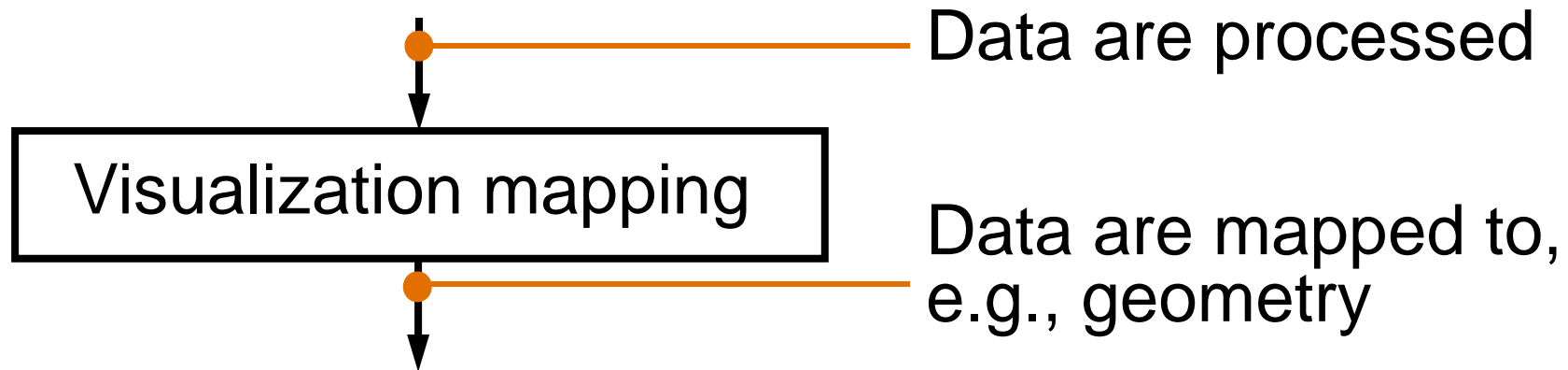
- Measurements, e.g., CT/MRI
- Simulation, e.g., flow simulation
- Modeling, e.g., game theory

# 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, ...

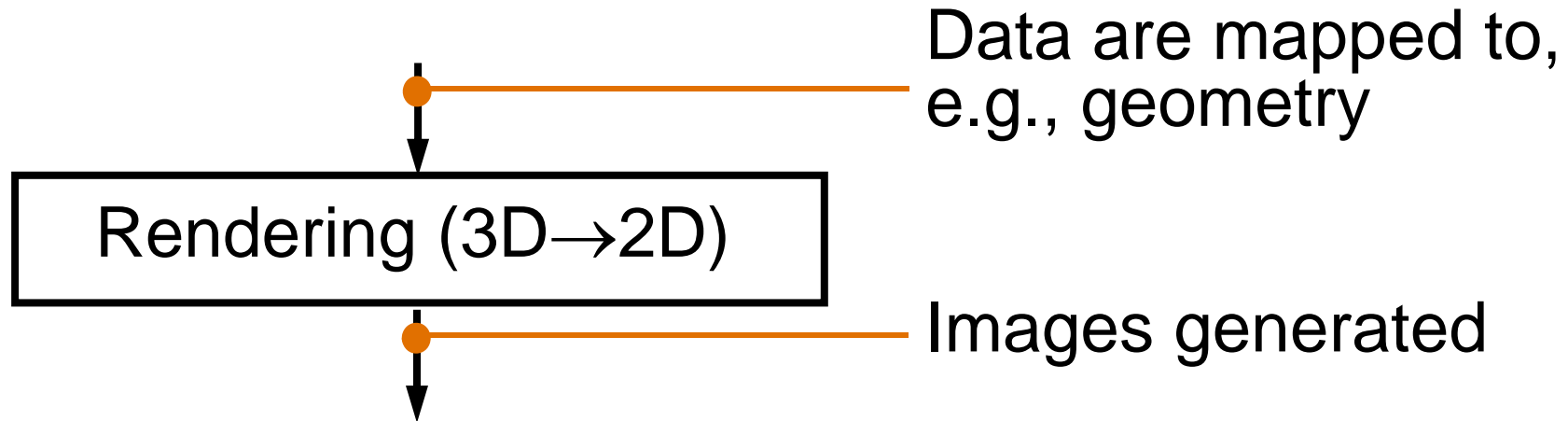
# The Visualization Pipeline – Stage 3



## 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

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- Off-line Visualization

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

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- Passive Visualization

- Viewing of the visualization results



# Interactive Visualization



Only data generation is separated:

- Off-line data generation

- Measurements, Simulation, Modeling

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- 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



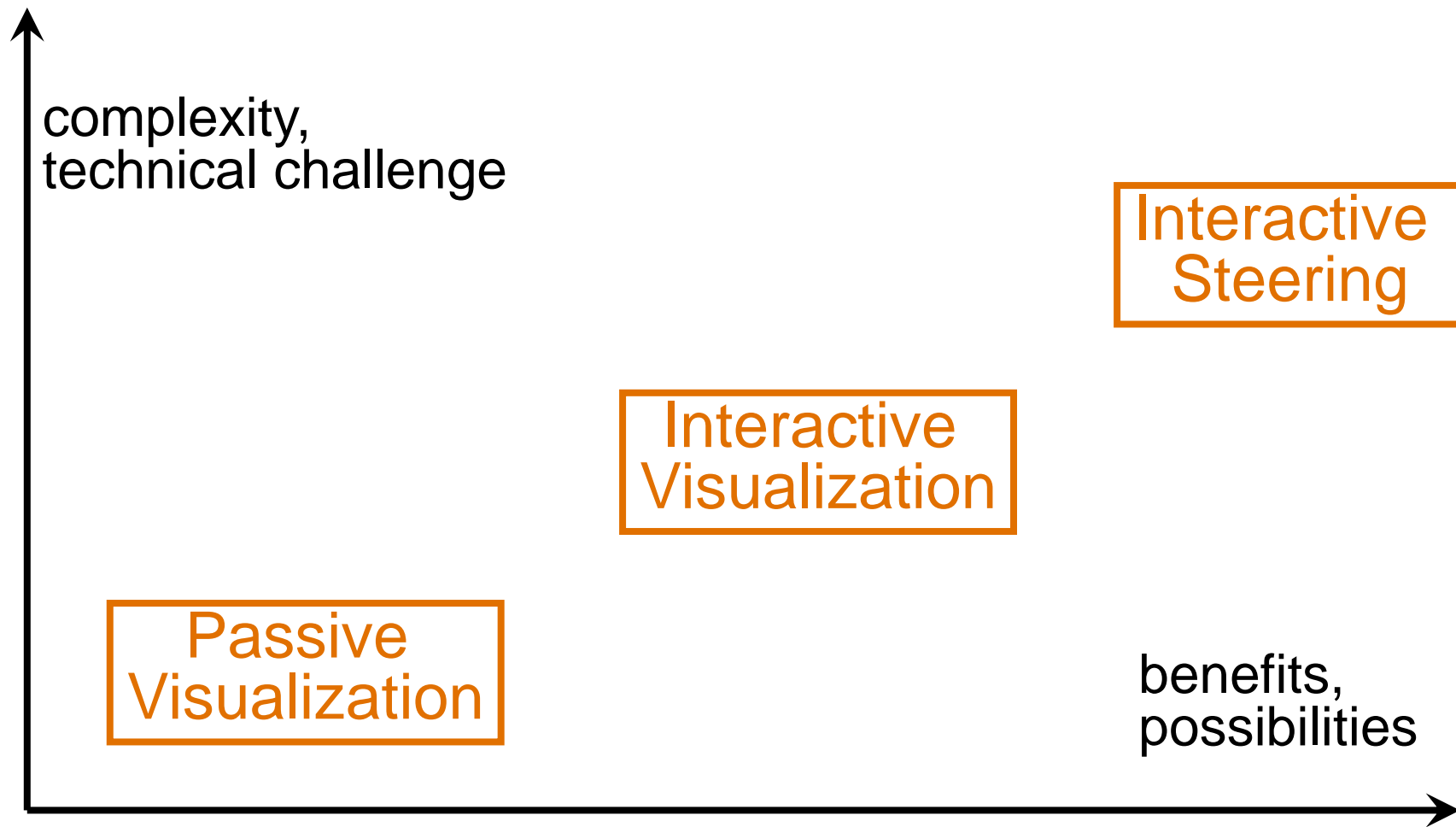
All three steps coupled:

- **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

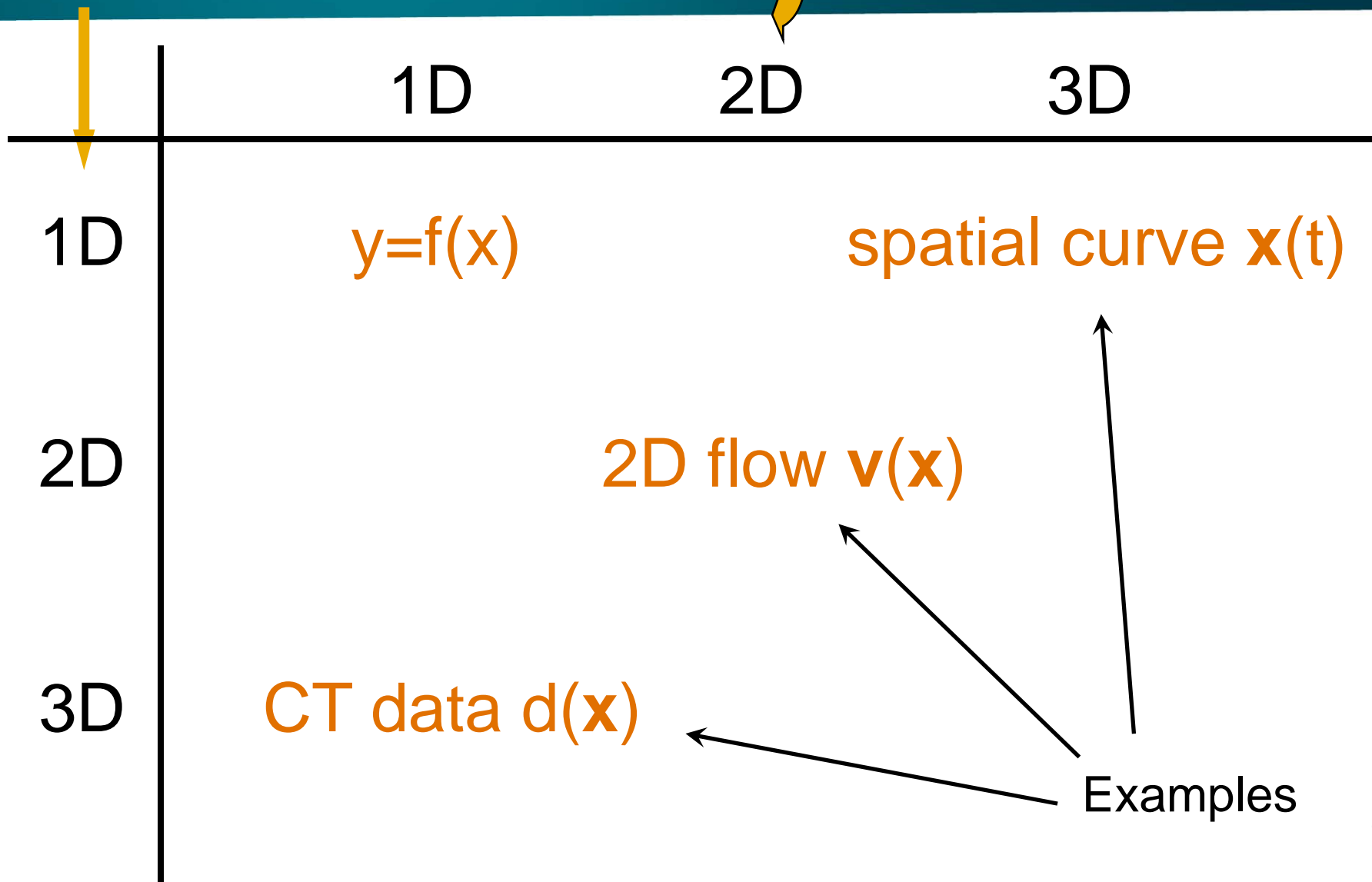


What type of data?

- **Data types:**
  - Scalar = numerical value  
(natural, integer, rational, real, complex numbers)
  - Non-numerical (categorical) values
  - Multi-dimensional values (n-dim. vectors,  $n \times n$ -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

- Helwig Hauser
- Eduard Gröller
- Daniel Weiskopf
- Torsten Möller
- Ronny Peikert
- Philipp Muigg
- Christof Rezk-Salama