

AMCS / CS 247 – Scientific Visualization

Lecture 4: Introduction, Pt. 4;

Data Representation, Pt. 1

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Reading Assignment #2 (until Feb 6)



Read (required):

- Data Visualization book, finish Chapter 2
- Data Visualization book, Chapter 4 until 4.1 (inclusive)
- Continue familiarizing yourself with OpenGL if you do not know it !

Programming Assignments Schedule (tentative)



Assignment 1:

- Volume slice viewer

due: Feb 5

Assignment 2:

- Iso-contours and iso-surface rendering

due: Feb 26

Assignment 3:

- Volume ray-casting

due: Mar 26

Assignment 4:

- Flow vis 1 (hedgehog plots, streamlines, pathlines)

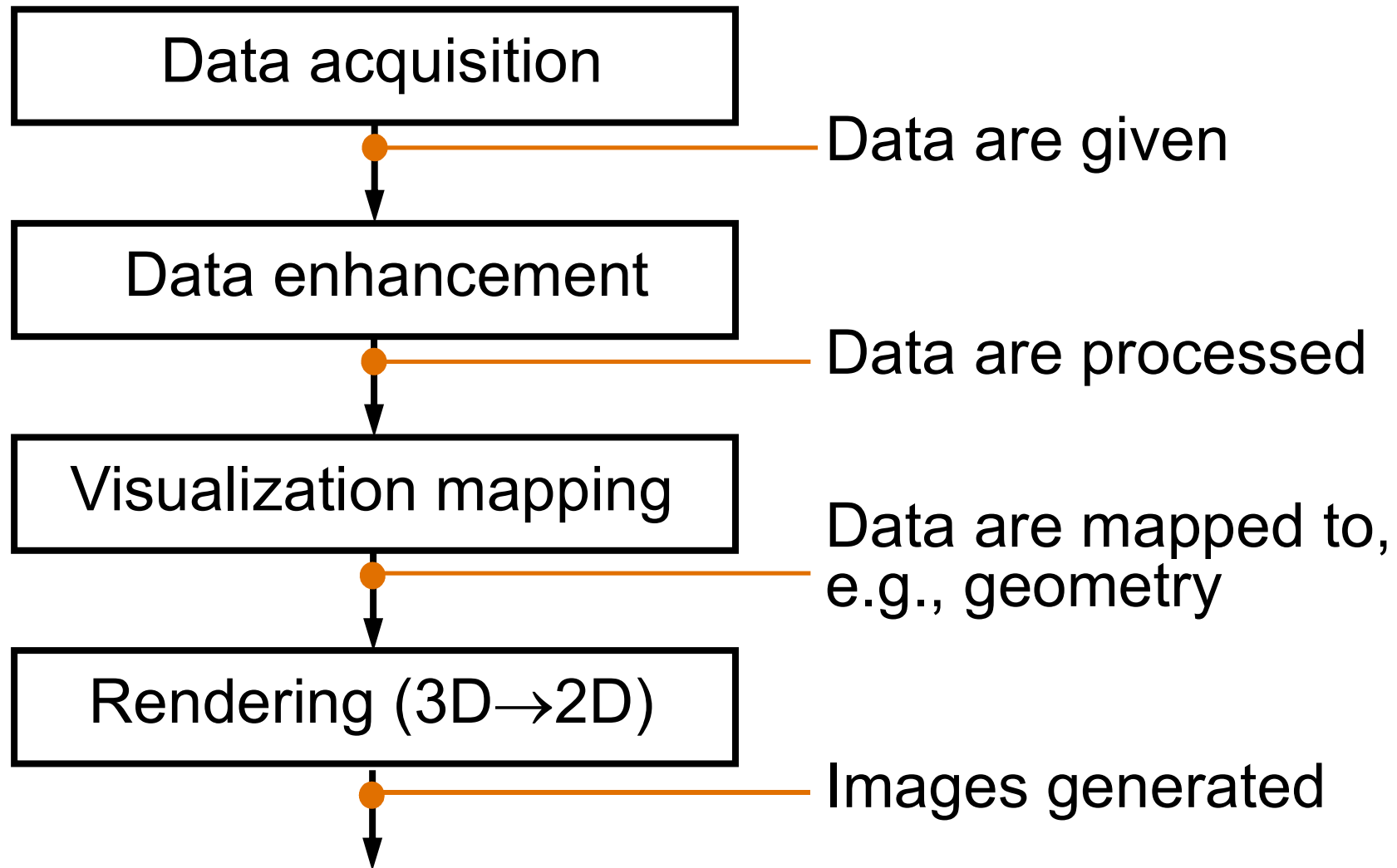
due: Apr 16

Assignment 5:

- Flow vis 2 (LIC with color coding)

due: Apr 30

The Visualization Pipeline – Overview



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



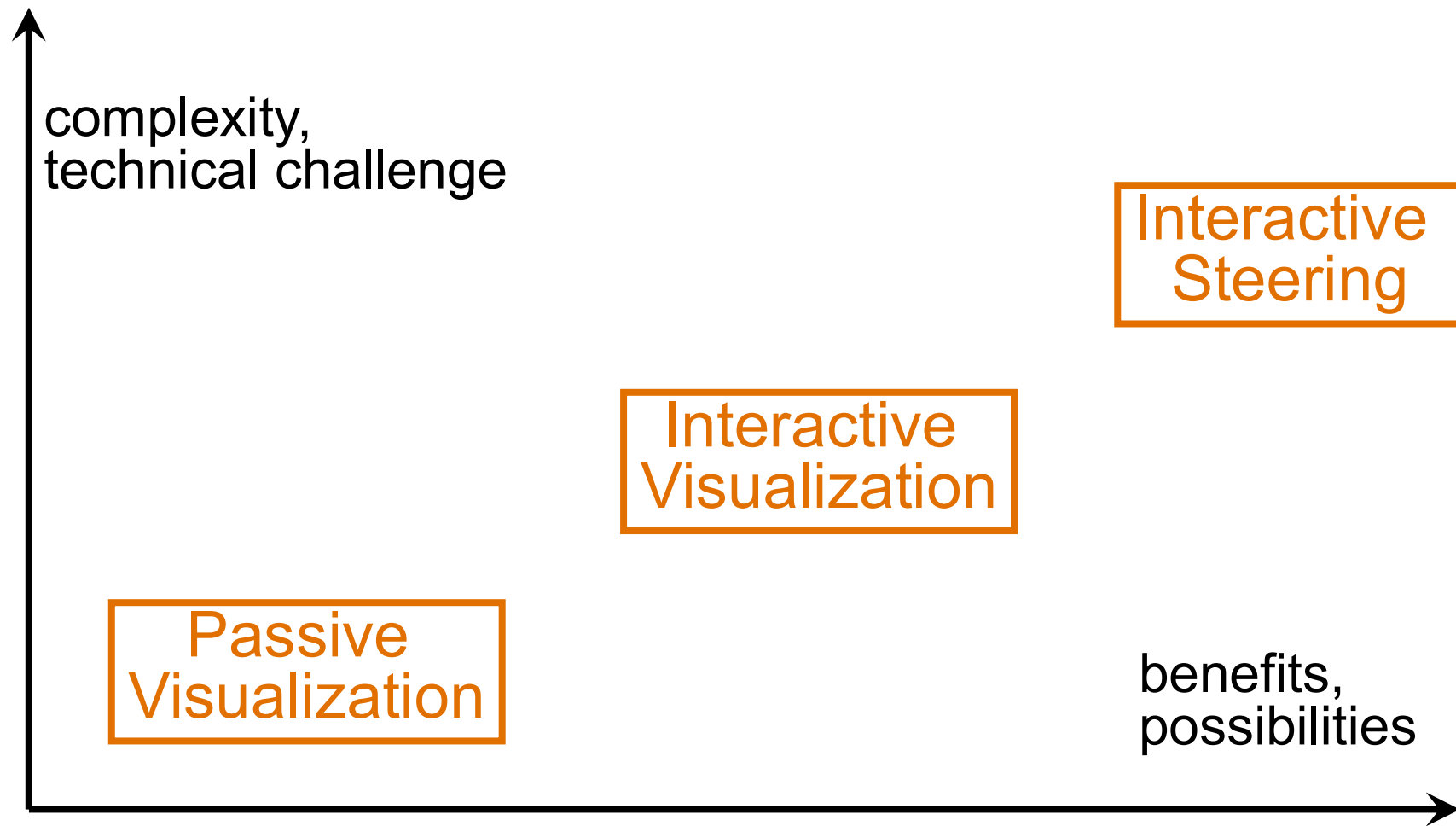
All three steps coupled:

- **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)

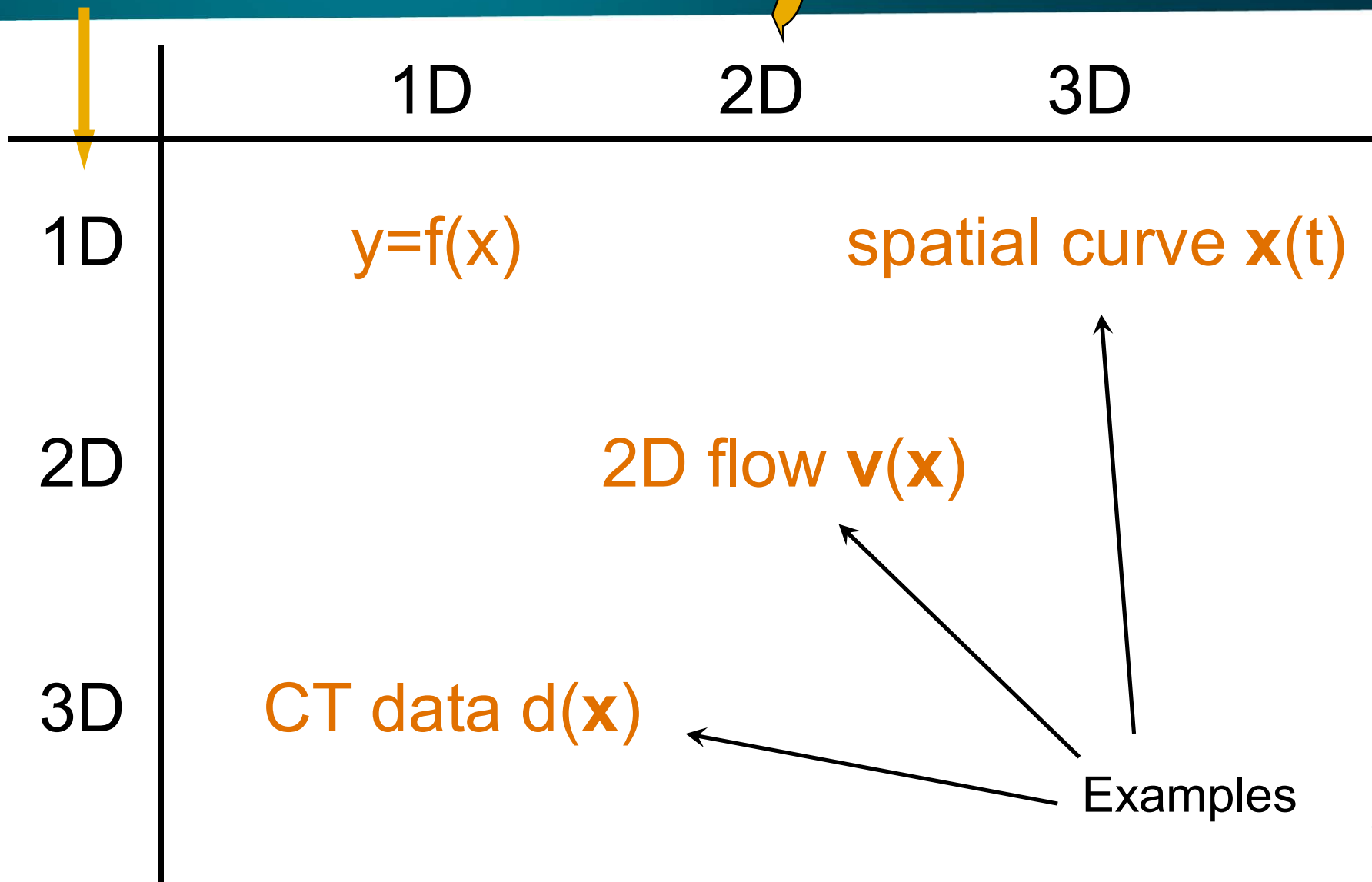
Data Type



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, $n \times n$ -dim. tensors of data from same type)
 - Multi-modal values (vectors of data with varying type [e.g., row in a table])
- **Aspects:** dimensionality, co-domain (range)

Data Space vs. Data Type



Visualization Examples



data	description	visualization example
$\mathbb{N}^1 \rightarrow \mathbb{R}^1$	value series	bar chart, pie chart, etc.
$\mathbb{R}^1 \rightarrow \mathbb{R}^1$	function over \mathbb{R}	(line) graph
$\mathbb{R}^2 \rightarrow \mathbb{R}^1$	function over \mathbb{R}^2	2D-height map in 3D, contour lines in 2D, false color map
$\mathbb{R}^2 \rightarrow \mathbb{R}^2$	2D vector field	hedgehog plot, LIC, streamlets, etc.
$\mathbb{R}^3 \rightarrow \mathbb{R}^1$	3D densities	iso-surfaces in 3D, volume rendering

Thank you.

Thanks for material

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