

Visual Data Analytics Introduction

Dr. Johannes Kehrer – Siemens AG, Munich

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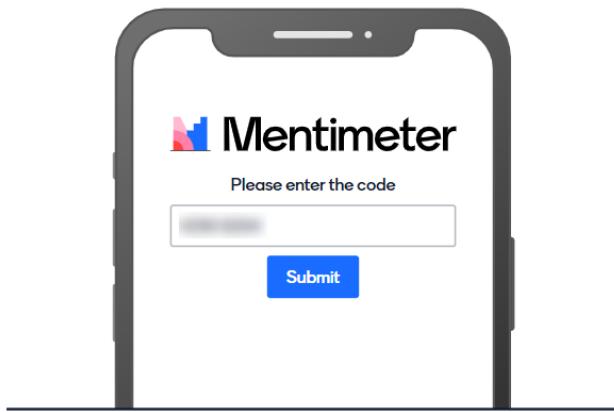
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Any comments/questions?

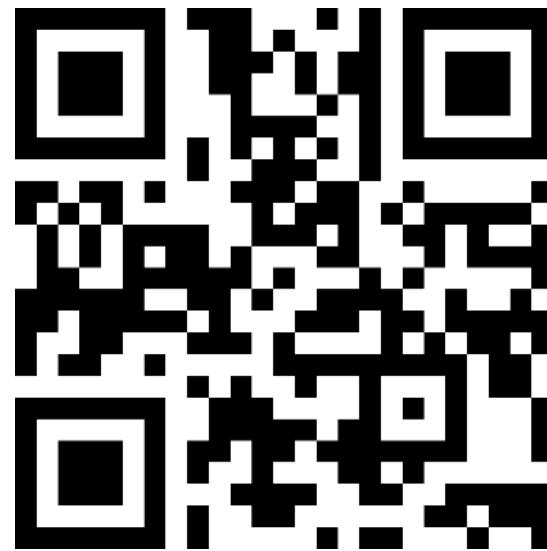
Go to

www.menti.com



Enter the code

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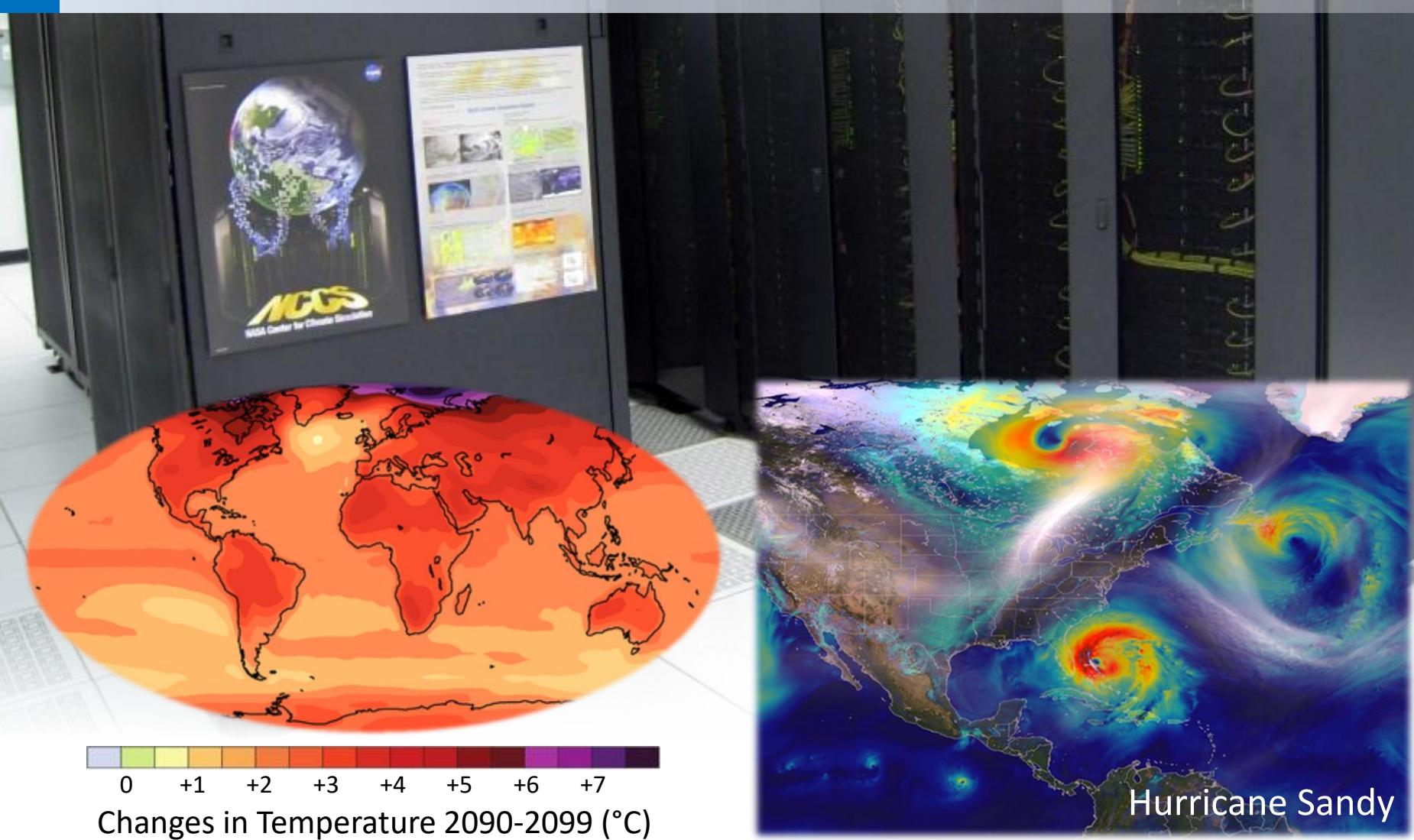
Or use QR code

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Medical scanners



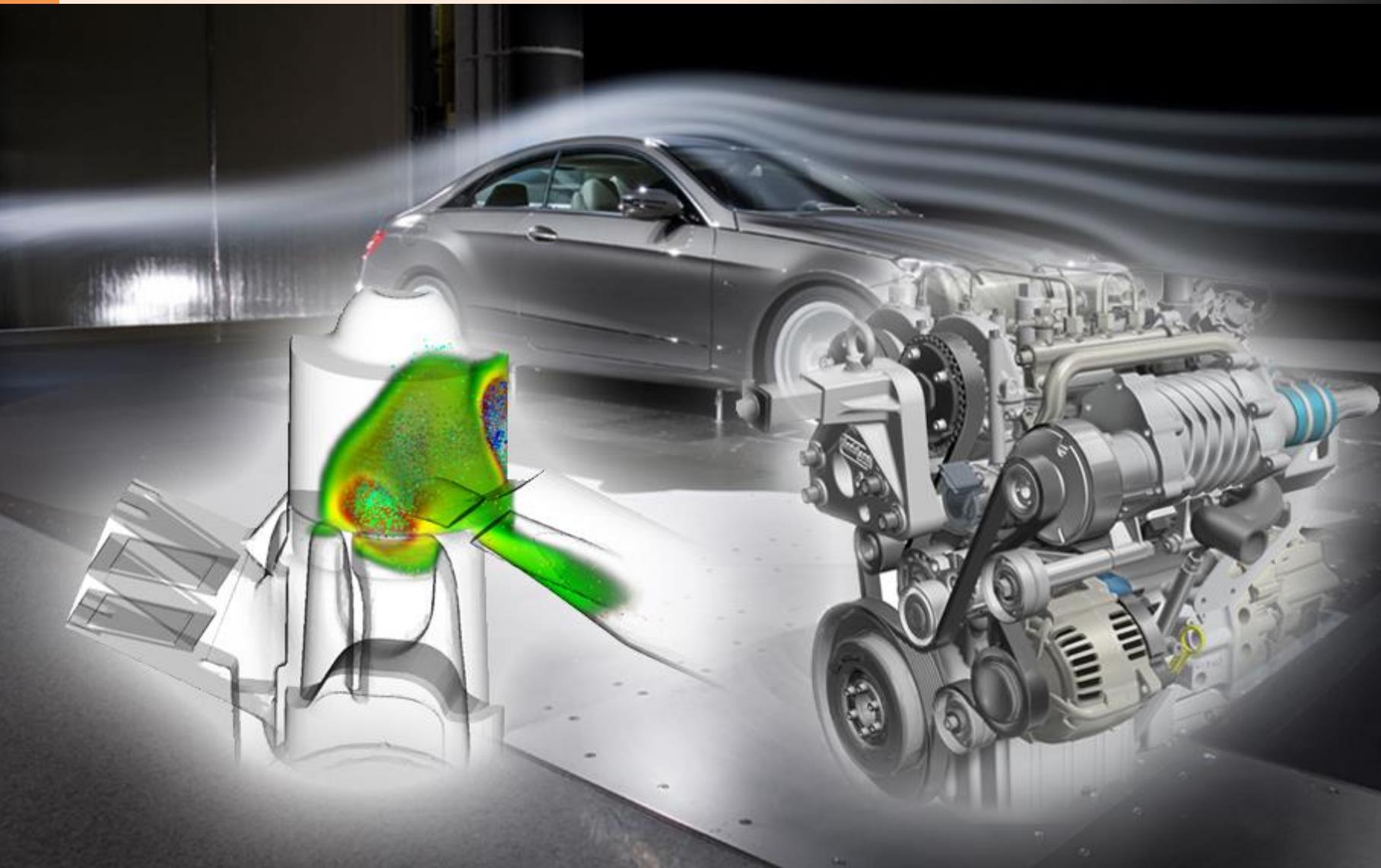
Weather & Climate Simulations



Digital Industries

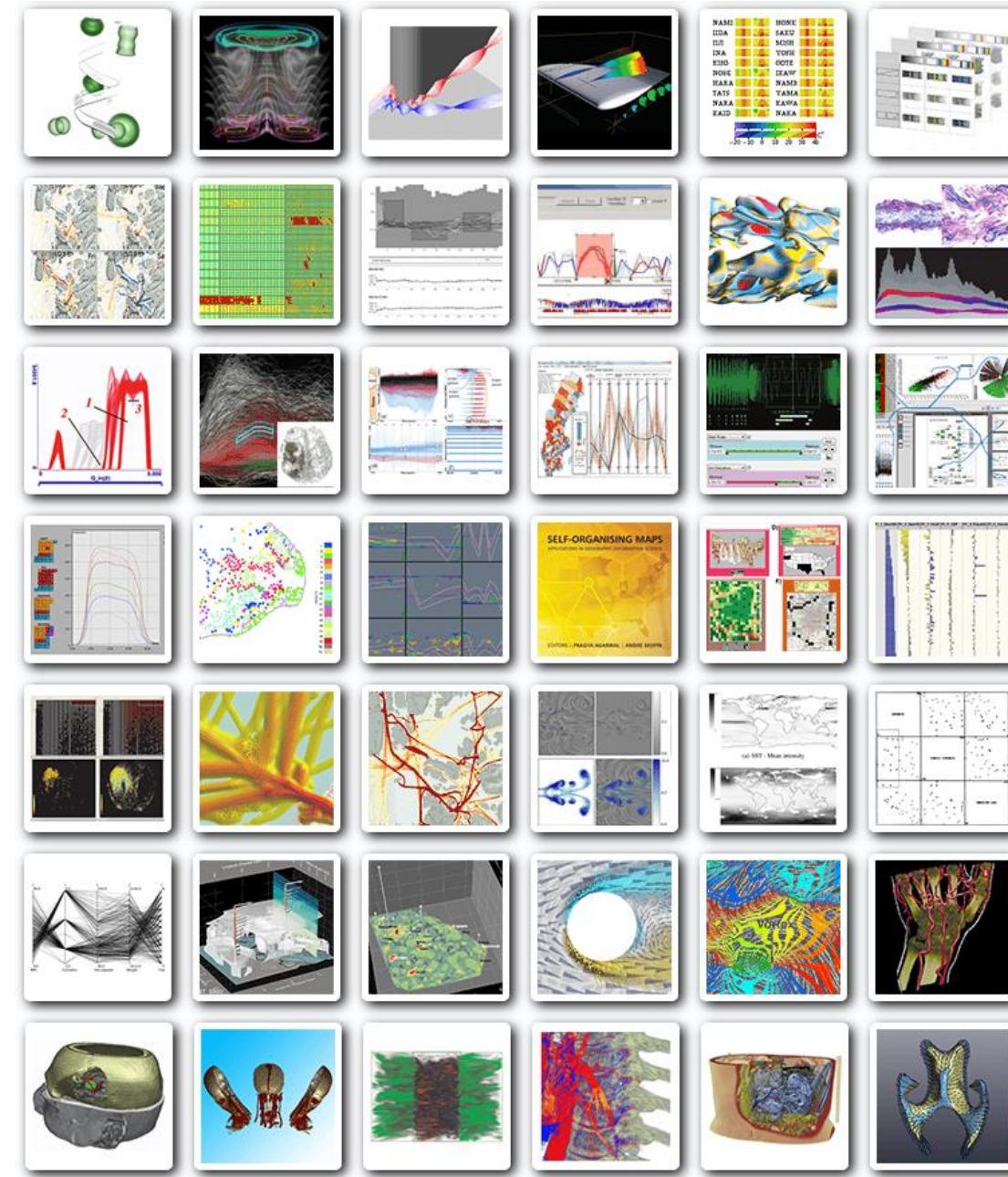


Automotive Engineering



Social networks, emails,
blogs, wikis, etc.





to vis·u·al·ize

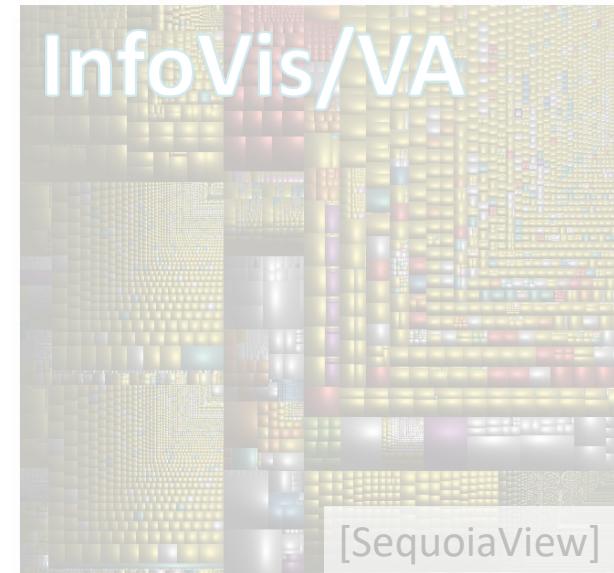
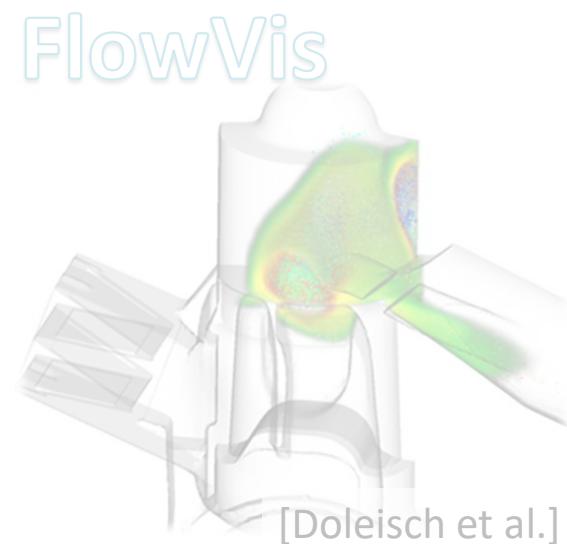
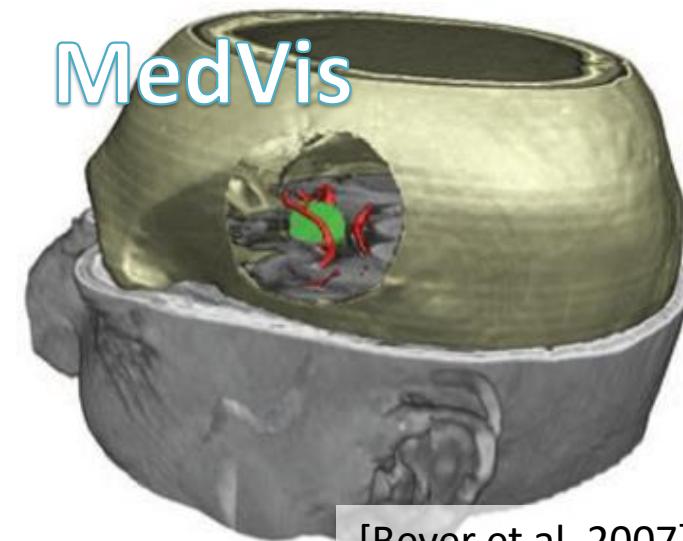
to form a **mental vision, image, or picture** of (something not visible or present to sight, or of an abstraction);

to make **visible to the mind or imagination**.

[Oxford English Dictionary]

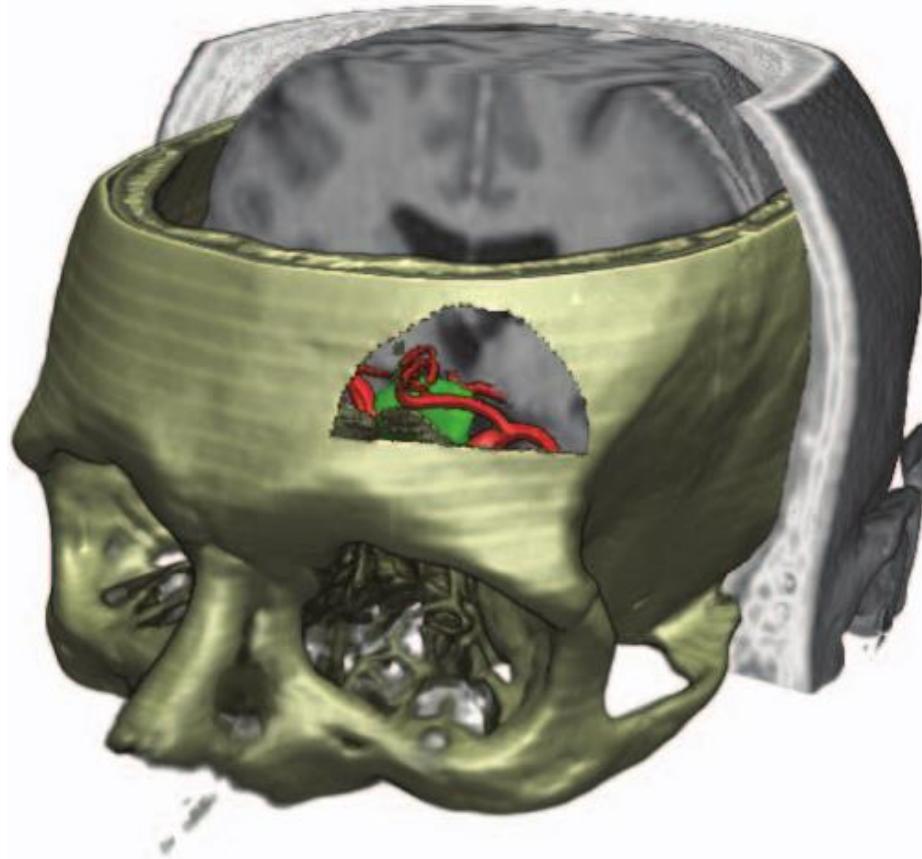
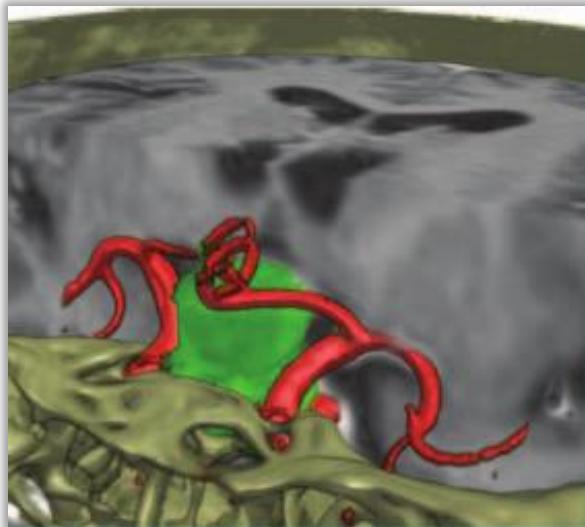
Visualization

The use of computer-supported, interactive, visual representations of data to amplify cognition



Medical Visualization – Examples

- Preoperative planning of a tumor resection



[Beyer et al. 2007]

Black/white: brain – Magnetic Resonance Imaging (MRI)
Green: tumor – MRI
Red: vessels – Magnetic Resonance Angiogram (MRA)
Brown: skull – Computer Tomography (CT)

Medical Visualization – Examples

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Ingenuity for life

- Virtual fetoscopy (4D Ultrasound)



GE Healthcare Voluson HDlive

Medical Visualization – Examples

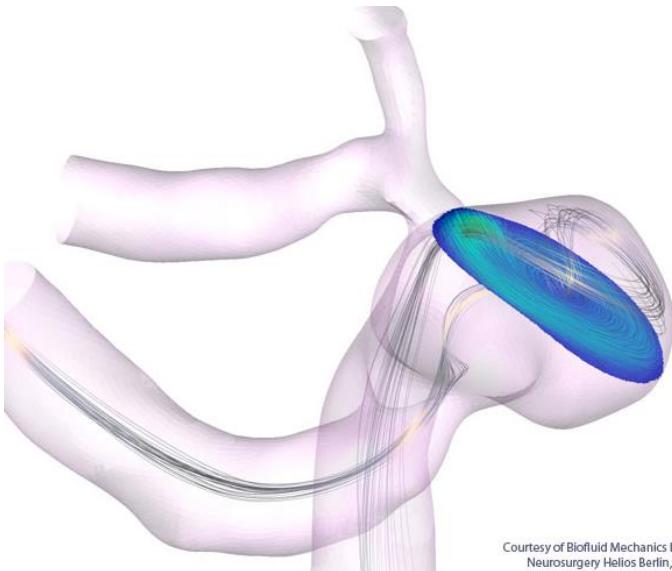
- Virtual fetoscopy (4D Ultrasound)
 - Enhance clinical confidence
 - User interest & involvement



GE Healthcare Voluson HDlive

Medical Visualization – Examples

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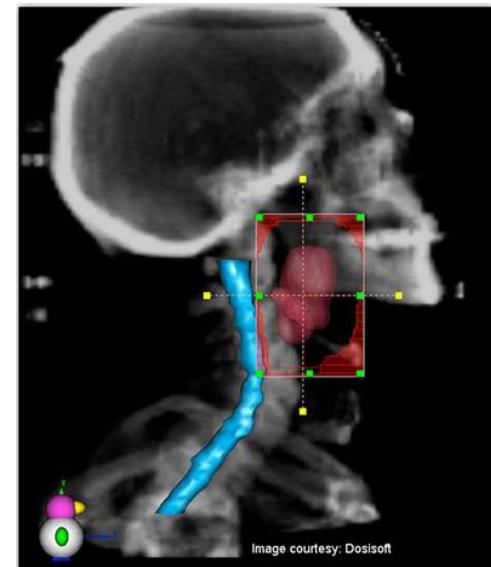


blood flow in aneurysm

Courtesy of Biofluid Mechanics Lab,
Neurosurgery Helios Berlin, ZIB

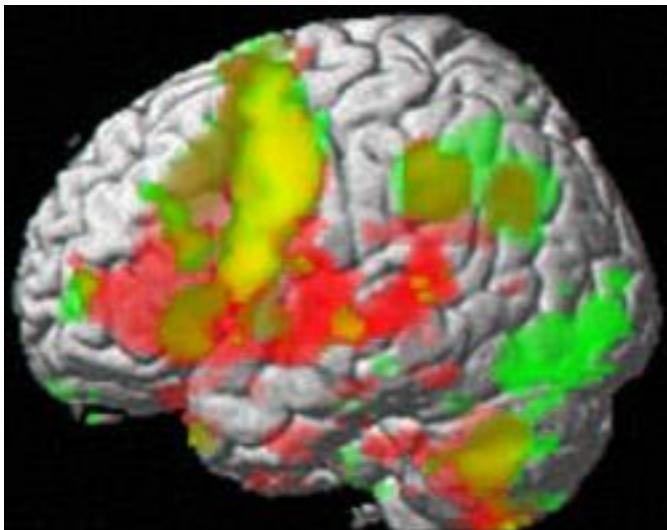


bone tissue density



surgery planning

Image courtesy: Dosisoft

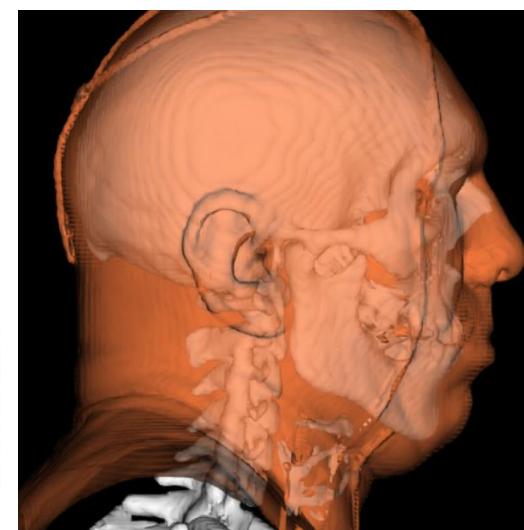


brain activity (fMRI)

Visual Dat Prof. Dr. R. vwestermann / Dr. J. Reuter



MRI scan - tissues



bone + skin surface

Visualization

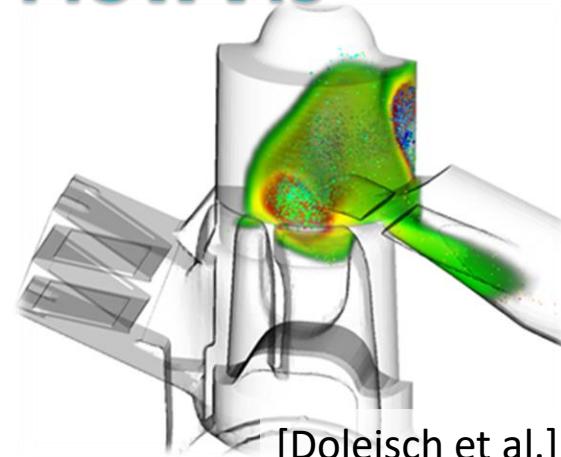
The use of computer-supported, interactive, visual representations of data to amplify cognition

MedVis



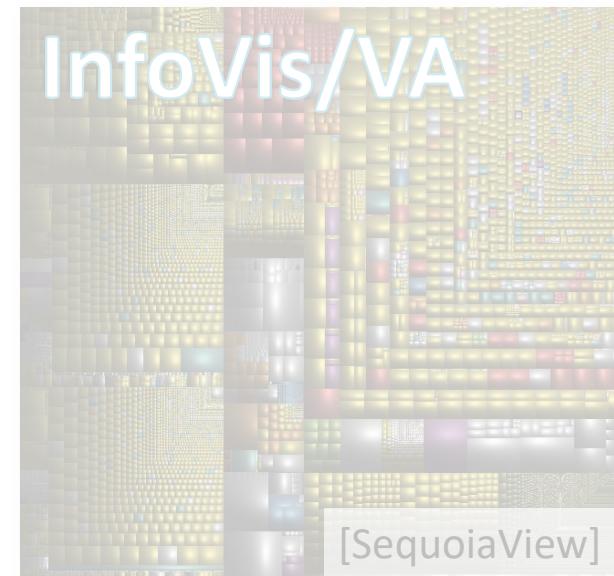
[Beyer et al. 2007]

FlowVis



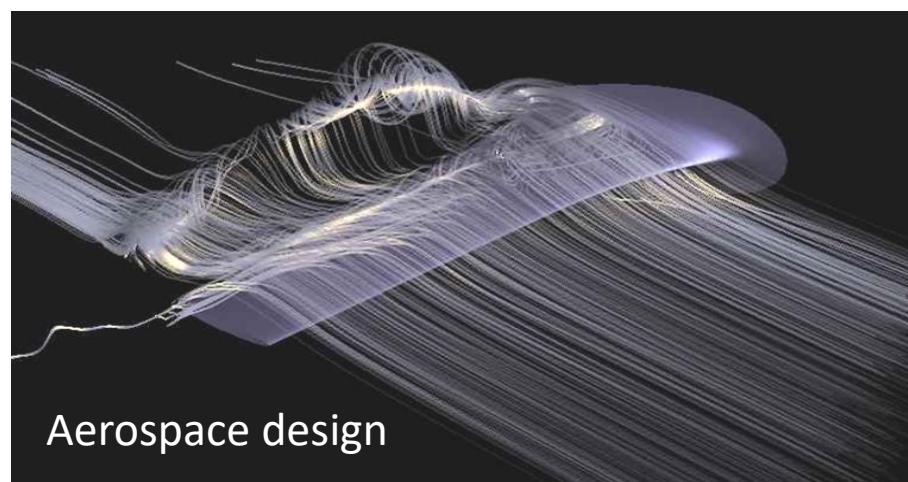
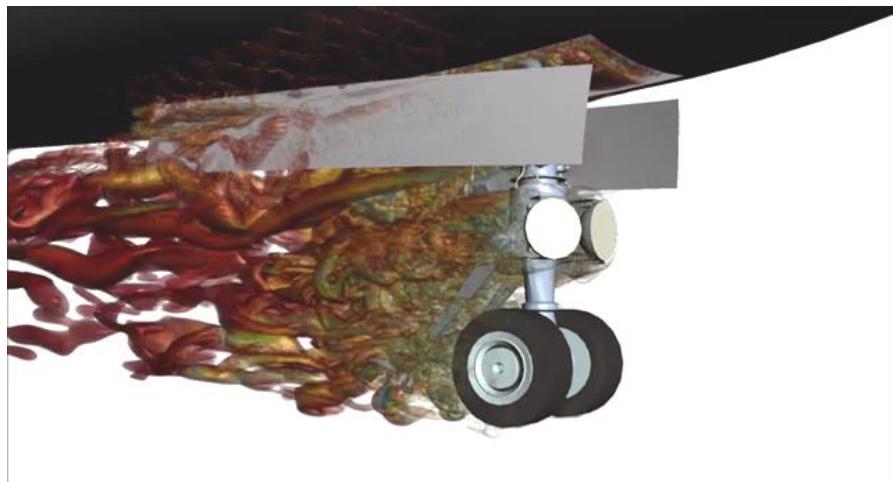
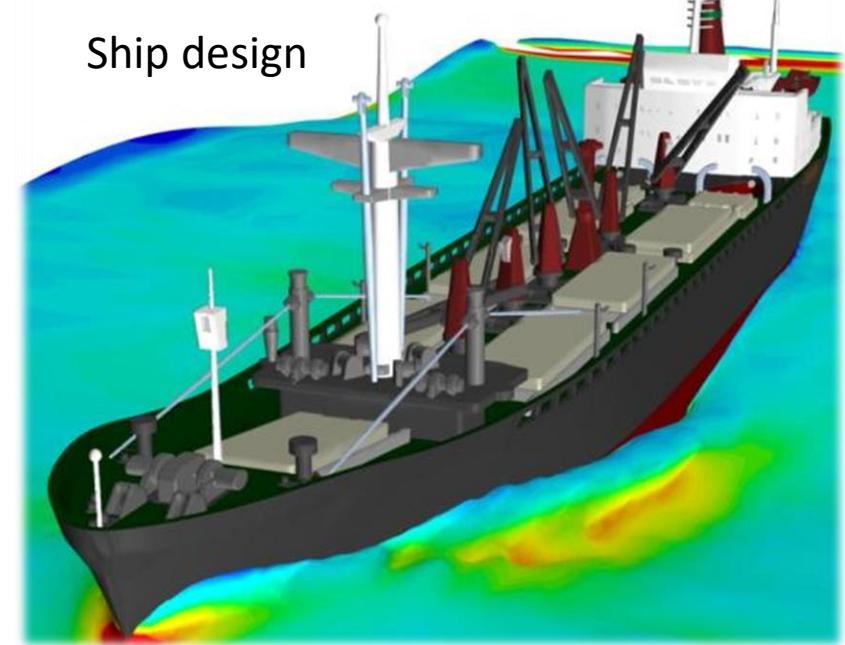
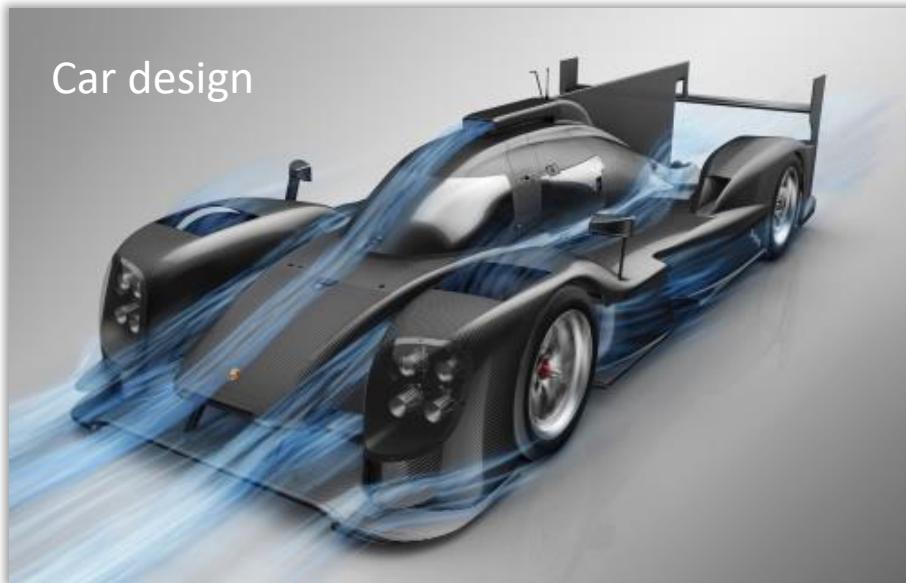
[Doleisch et al.]

InfoVis/VA



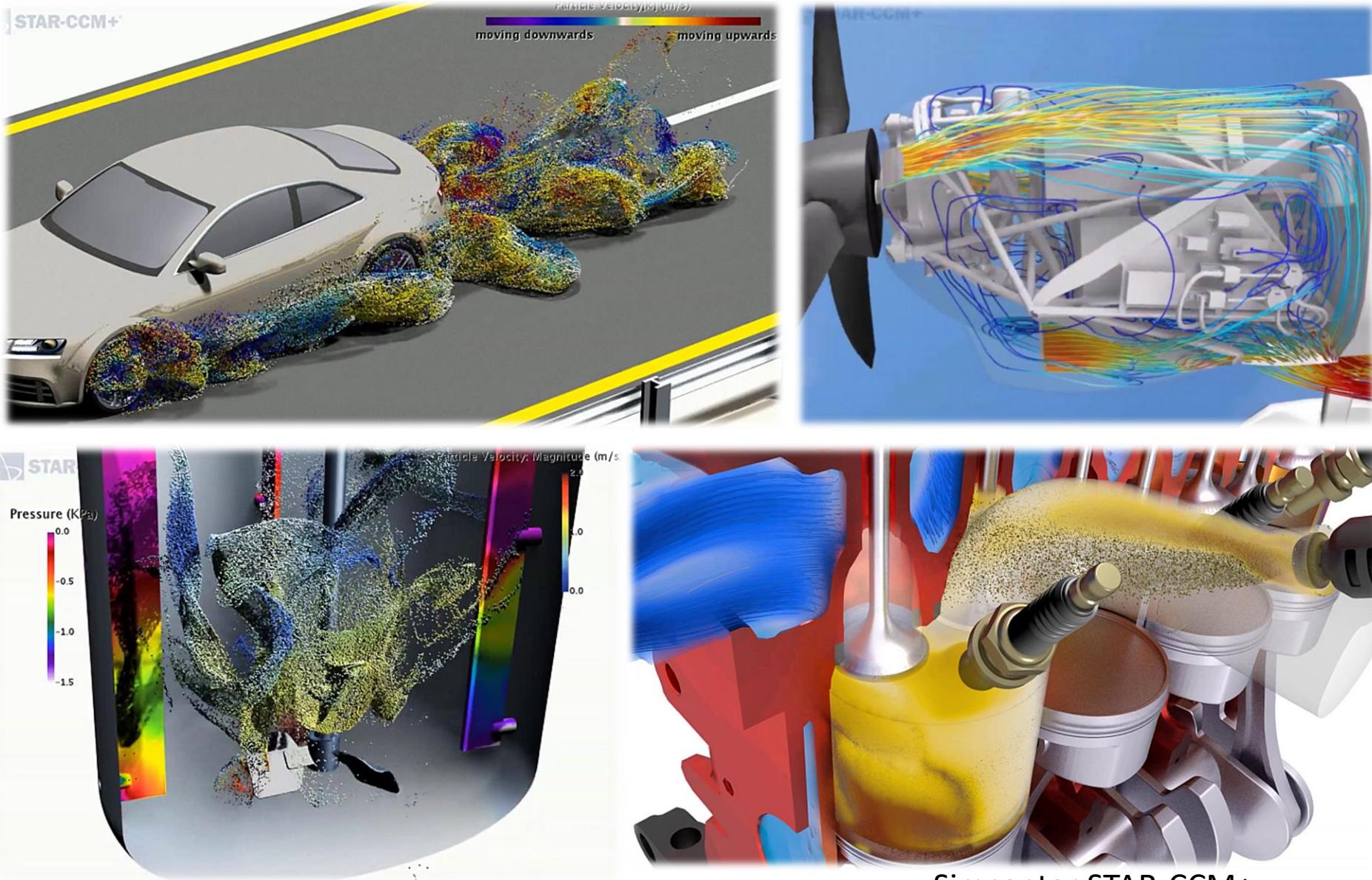
[SequoiaView]

Flow Visualization – Examples



Flow Visualization – Examples

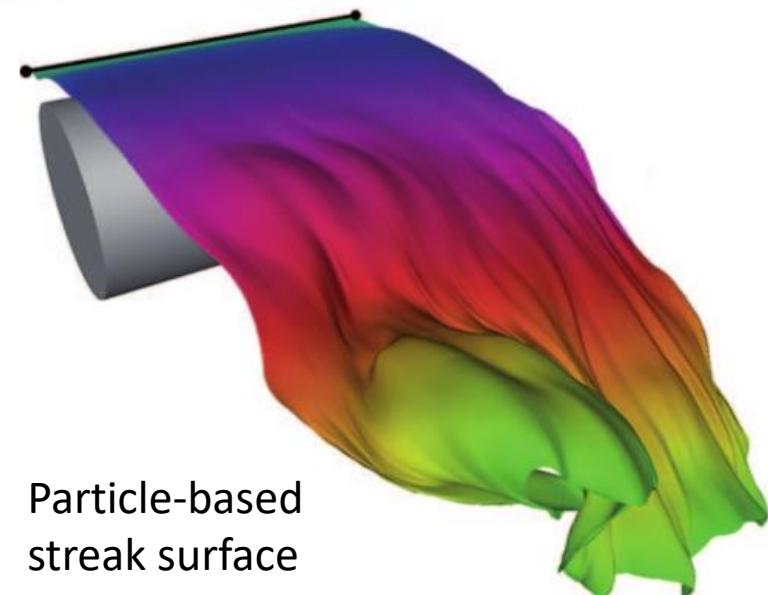
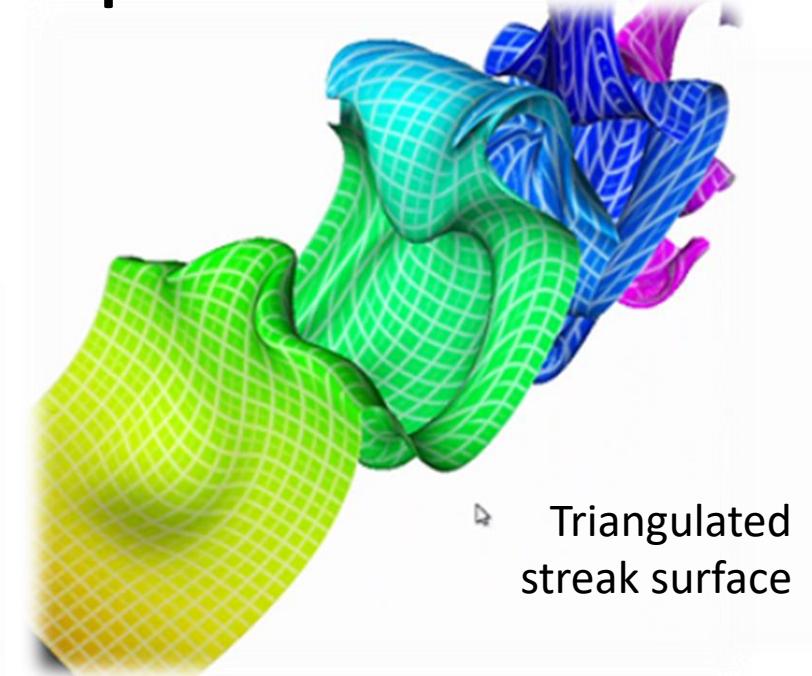
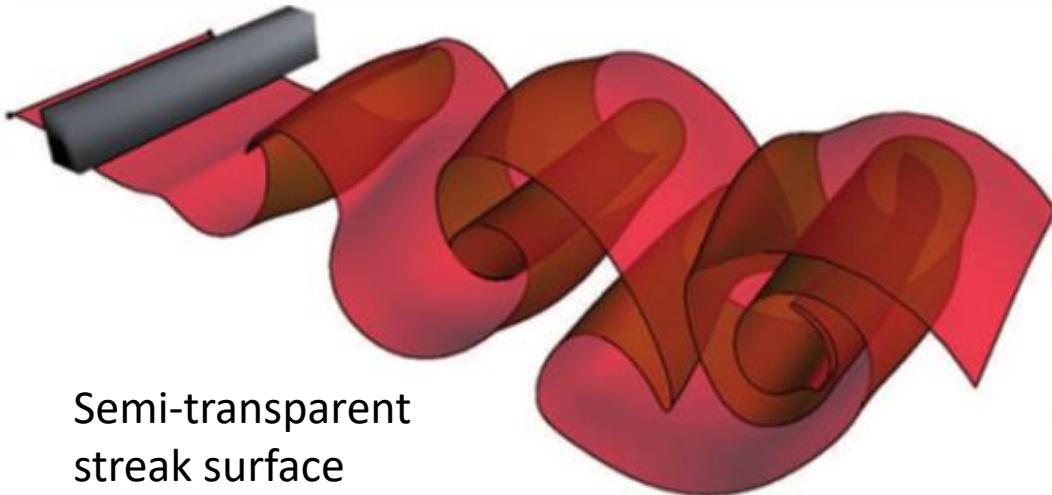
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Simcenter STAR-CCM+
<https://youtu.be/443kbDFPjUo>

Flow Visualization – Examples

- Visualization of complex flows



Visualization

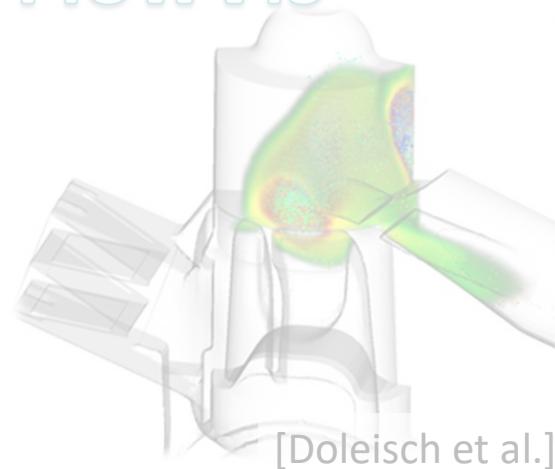
The use of computer-supported, interactive, visual representations of data to amplify cognition

MedVis



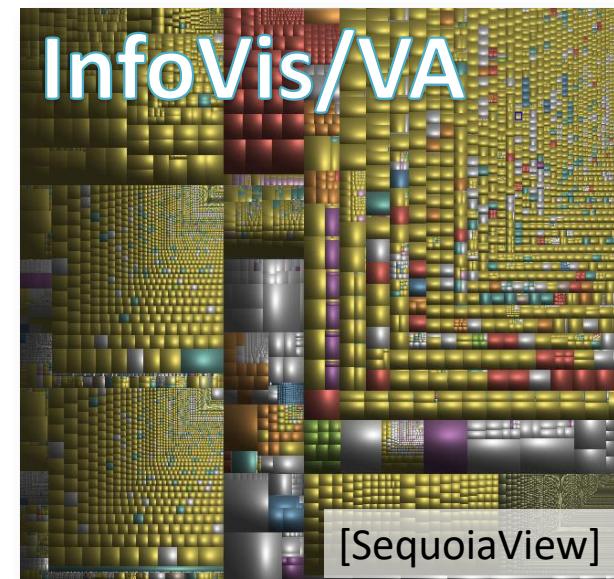
[Beyer et al. 2007]

FlowVis



[Doleisch et al.]

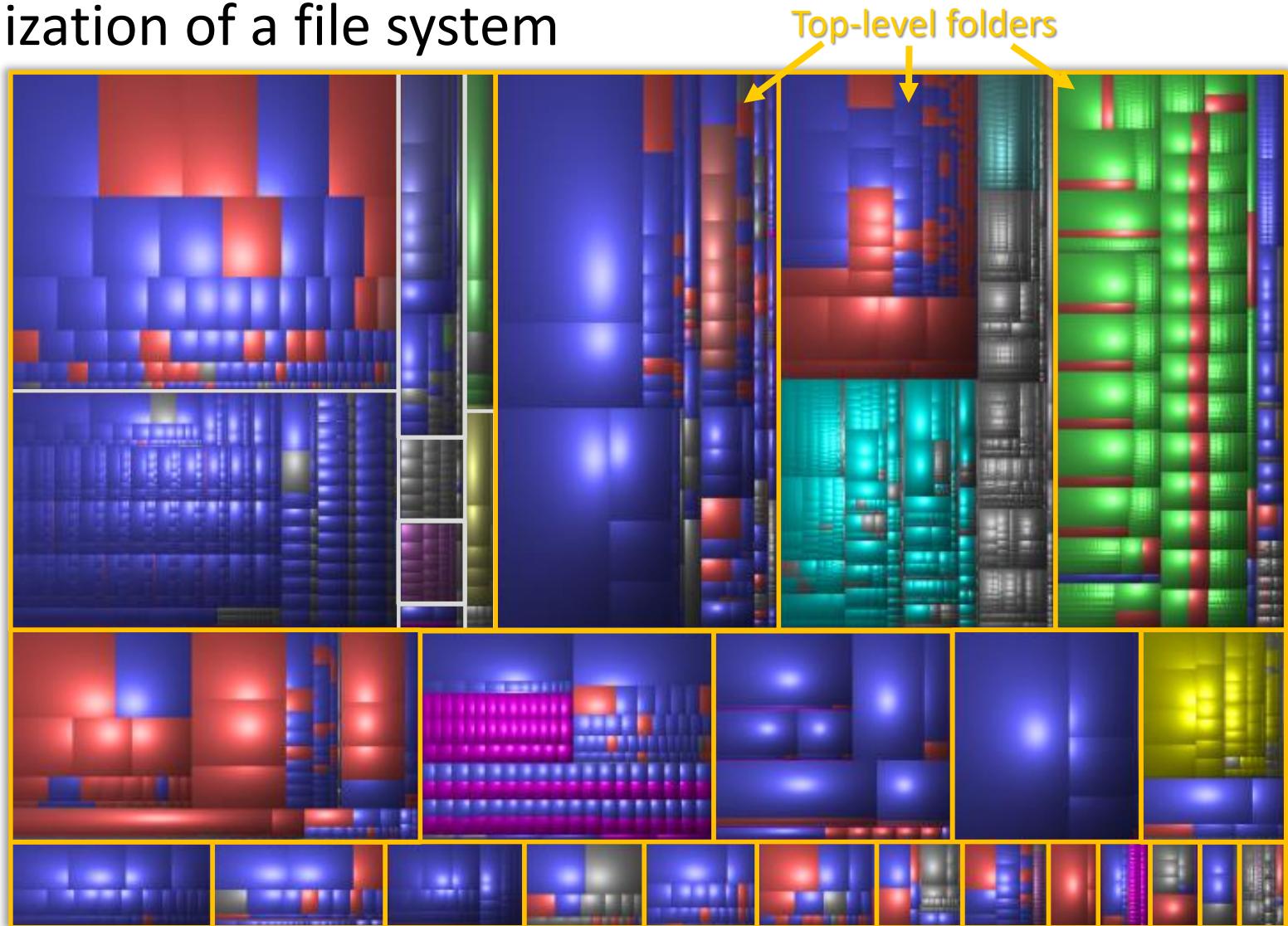
InfoVis/VA



[SequoiaView]

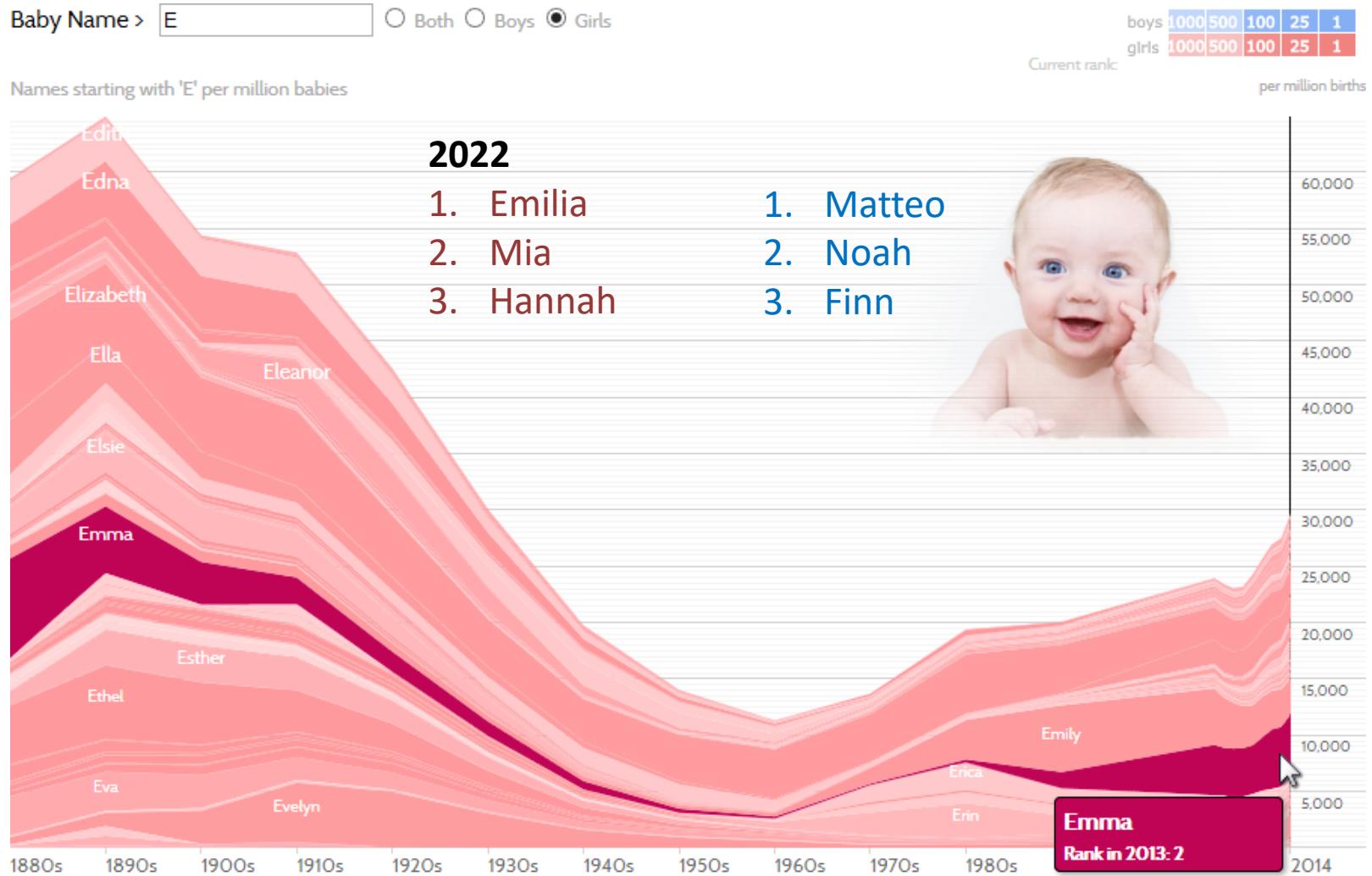
InfoVis/VA – Examples

- Visualization of a file system



InfoVis/VA – Examples

- NameGrapher



M. Wattenberg, namerology.com/baby-name-grapher/

Preventive Maintenance using AI

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- Sensor data are collected in many fields to monitor operation, e.g., car manufacturing, oil & gas production, heavy industries, automation systems
- AI methods can help to detect abnormal behavior, prevent failures, and optimize operation
- Technical interpretation by domain experts needed

Why Visualization?

“A picture is worth a thousand words”

“The purpose of visualization is **insight**, not pictures.”

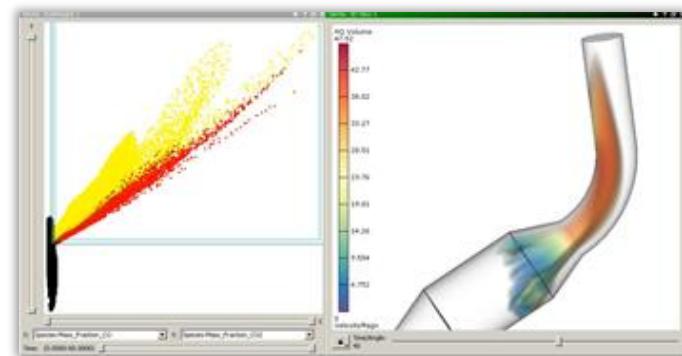
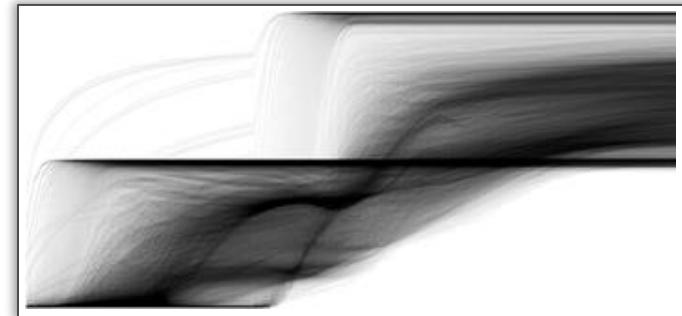
[B. Shneiderman]

- Vision is the dominant sense for acquiring information from our world
- Nearly $\frac{1}{3}$ of our brain is devoted to processing visual information
(8% for touch, 3% for hearing)



Why visualization matters?

- Visualization ...
 - lets you see things that would rather go unnoticed (data trends, outliers, dependencies, etc.)
 - gives answers faster
 - lets you interact with your data, study causes and effects, etc.
 - helps to deal with increasing size and diversity of data
 - produces pretty, informative, & interactive pictures



Big Data and Visualization

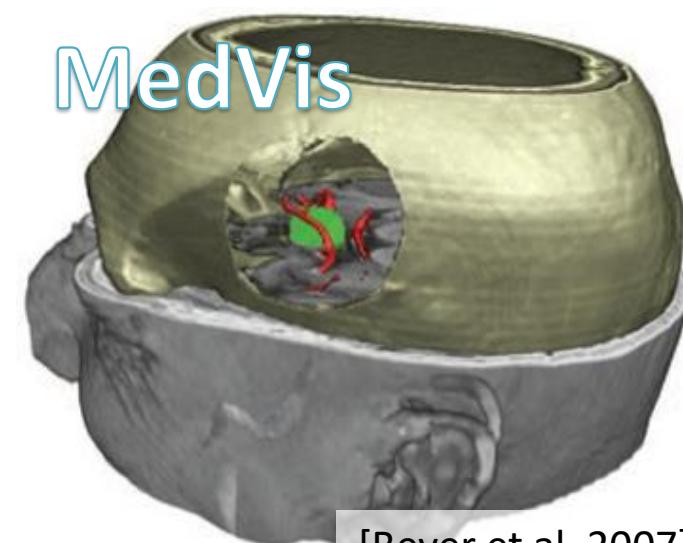
“The ability to take data—to be able to **understand** it, to **process** it, to **extract value** from it, to **visualize** it, to **communicate** it—that’s going to be a hugely important skill in the next decades, ... because now we really do have **essentially free and ubiquitous data**.”

Hal Varian, Google's Chief Economist
The McKinsey Quarterly, Jan 2009

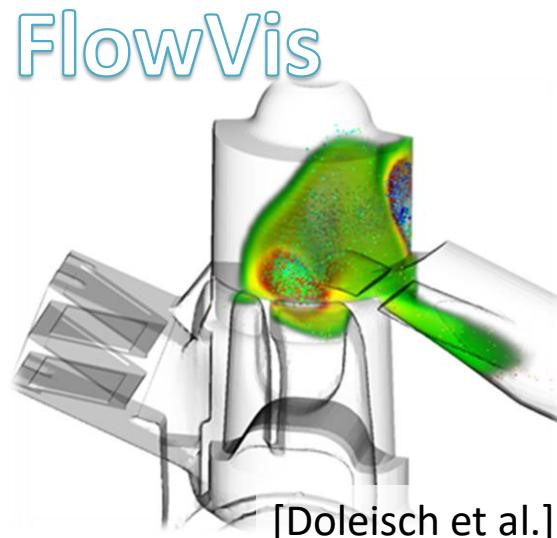


This course – goals

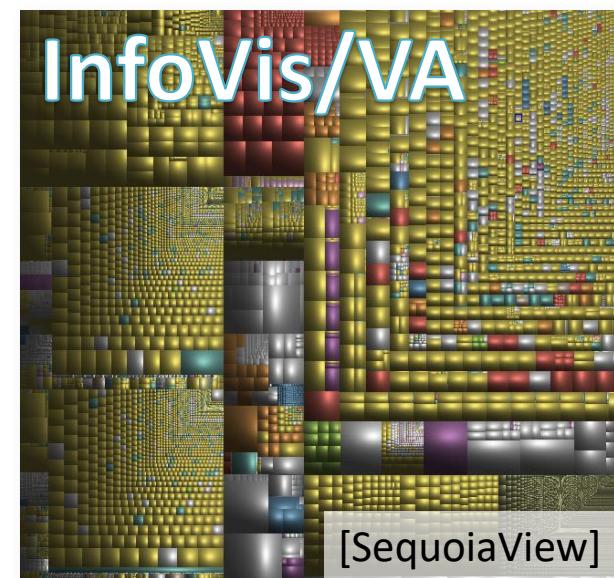
- Understand basic visualization algorithms in different domains (flow/volume visualization, visual analytics)
- Learn which techniques to use for which type of data
- Practical exercise: experiment with visualization software systems on your own initiative



[Beyer et al. 2007]



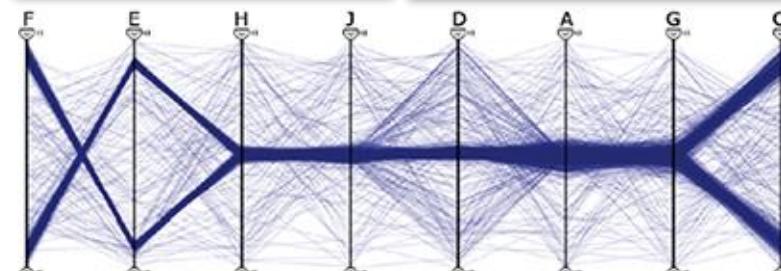
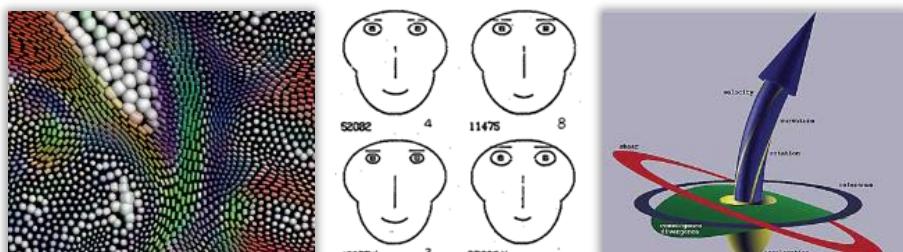
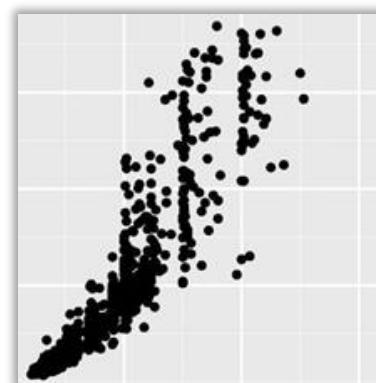
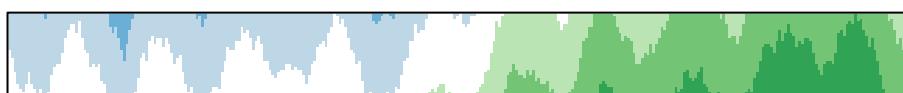
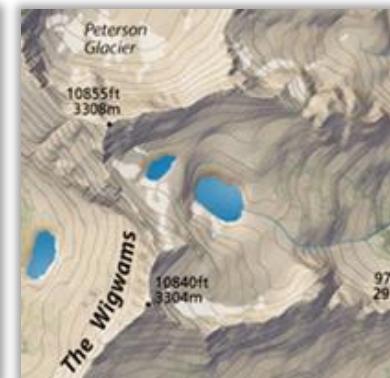
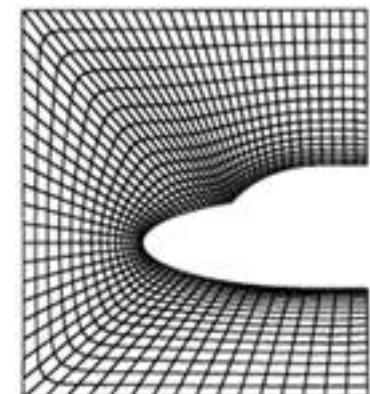
[Doleisch et al.]



[SequoiaView]

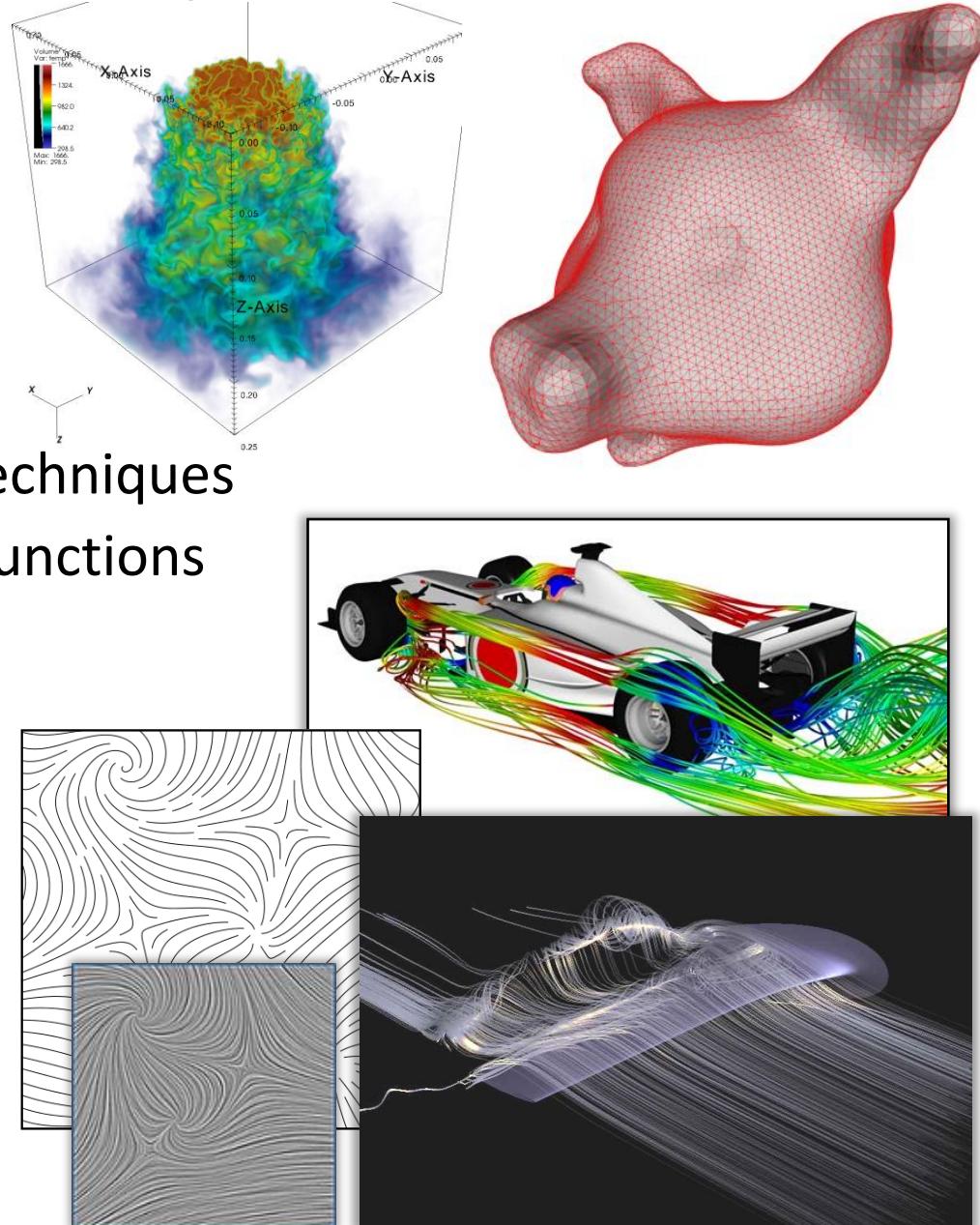
This course – overview part I

- Fundamentals of data visualization
 - Visualization examples, data sources, vis pipeline, data representation and classification
- Data reconstruction
 - Scattered data interpolation, triangulation, grids, cell-wise interpolation
- Basic data mapping techniques
 - Color coding, scatter plots, glyphs, diagrams, contour lines, etc.



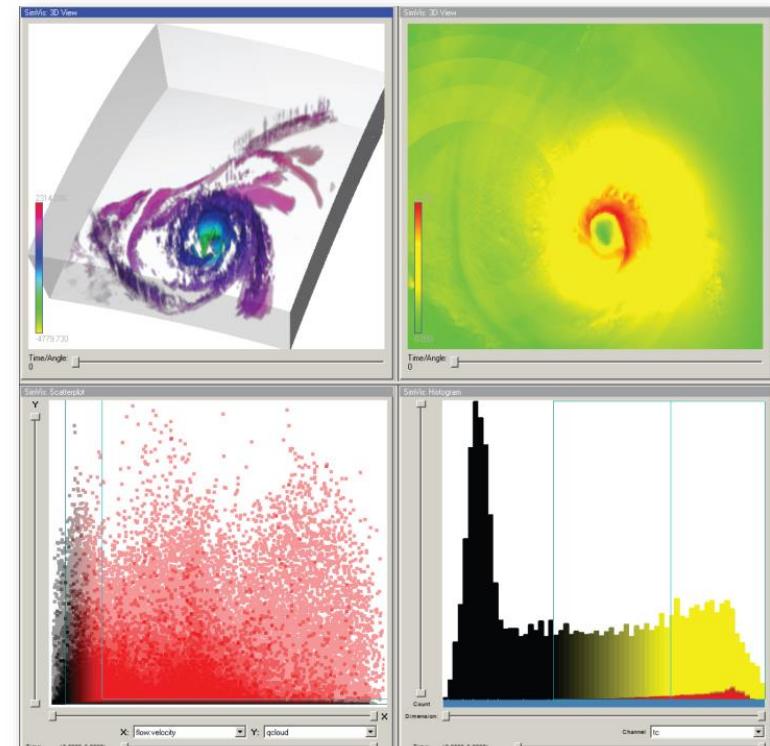
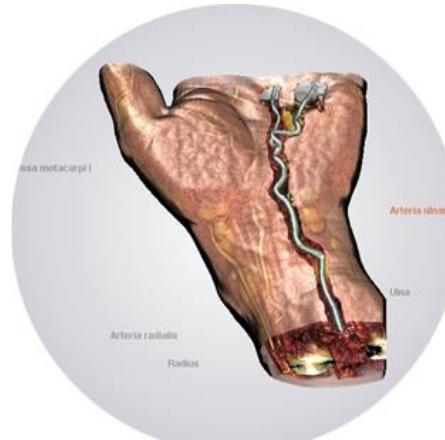
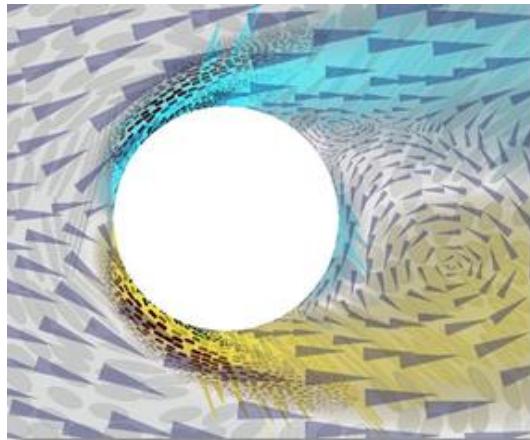
This course – overview part II

- Volume visualization
 - Data acquisition
 - Iso-surface rendering
 - Lighting and shading
 - Direct volume rendering techniques
 - Classification via transfer functions
- Flow visualization
 - Characteristic lines
 - Particle tracing
 - Vector field topology
 - Line integral convolution



This course – overview part III

- Visual Analysis/Analytics of Scientific Data
 - Combination of visual and computational analysis methods
 - Coordinated multiple views, linking & brushing, focus+context visualization, etc.
 - Spatiotemporal, multi-variate, multi-modal, & multi-run data



This course

- Announcements, slides, exercise via Moodle:
<https://www.moodle.tum.de/course/view.php?id=80170>
- Lectures will be both **on-campus** and **streamed online** via TUM-Live (livestream & video on demand)
- You can ask questions regarding the current lecture via Menti or the Moodle question forum

The course is self-contained

This course – prerequisites

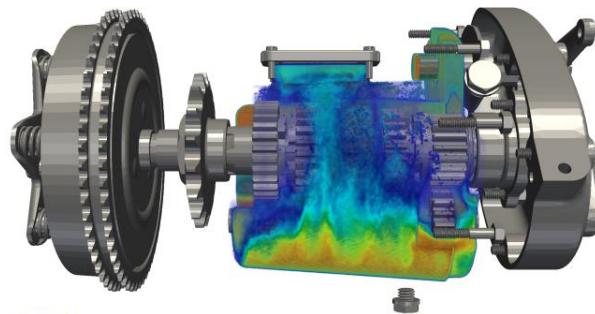
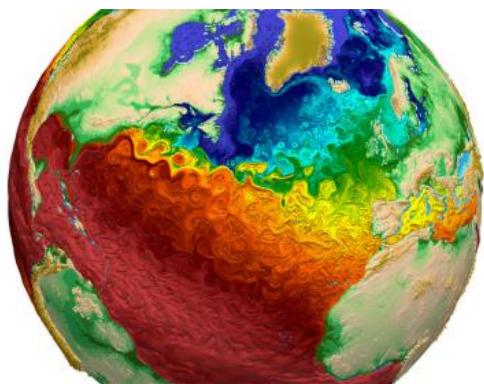
- Analysis, Linear Algebra
- No programming required
- Willingness to learn new software & tools
 - This can be time consuming
 - You will need to build skills by yourself



This course – practical exercise

- Experiment with vis. software on your own initiative
- You get several data sets
- You use different techniques to visualize these data sets in [ParaView](#), [ImageVis3D](#) and/or [Tableau](#)
- Until the end of the semester, you wrap up your experience in a 3-5 page summary, including images and explanations of what you have done
- Practical exercise not mandatory, **but**
 - you can obtain a bonus of 0.3 on a successfully passed exam, if the practical exercise has been passed
 - there can be questions about ParaView, ImageVis3D & Tableau at the exam!

- History
 - 2000 collaborative project between Kitware Inc. and Los Alamos National Laboratory
 - 2002 first release
- Supports many platforms (Windows, Linux, etc.)
- Supports parallel computer architectures
- Supports many different visualization techniques



- History
 - Project at the Scientific Computing and Imaging Institute at the University of Utah
 - Roots at the Chair for Computer Graphics and Visualization at TUM
- Supports many platforms (Windows, Linux, etc.)
- Graphics hardware acceleration for volume visualization
- Supports large data sets

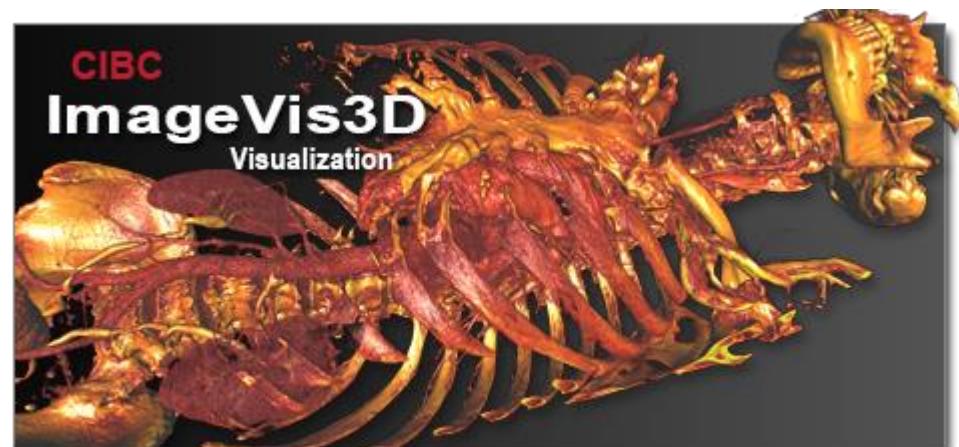
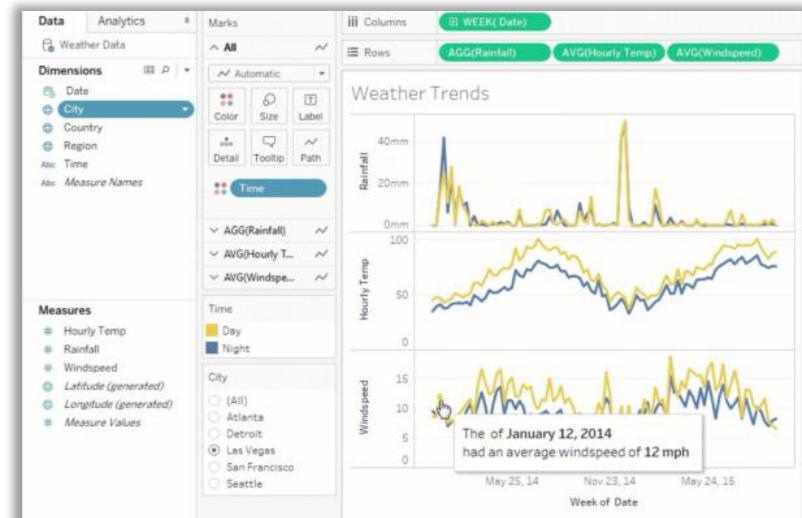
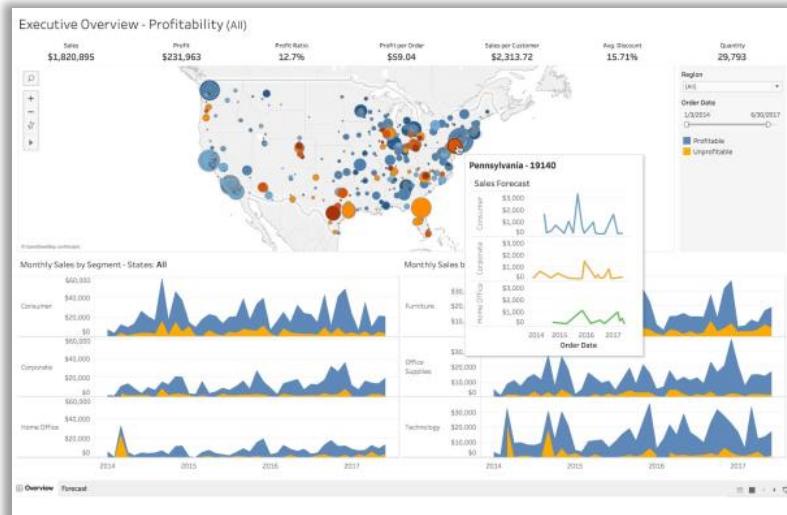


Tableau Desktop

www.tableau.com

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Ingenuity for life

- History
 - Roots at Stanford University (Polaris System)
 - Founded in 2003
- Commercial visual analytics platform for business intelligence
- Explore and understand data using visual dashboards



This course – exams

- **Written exam:**
currently planned on-campus,
no materials allowed
date and time to be announced

Registration via [tumonline](#) (mandatory)

- If you fail ...
 - Oral or written repetition in the semester break

This course – literature

Computer graphics

- Foley, Van Dam, Feiner, Hughes:
Computer Graphics: Principles and Practice, Addison-Wesley, 3rd edition
- Watt, Watt:
Computer Graphics, Addison-Wesley
- Glassner:
Principles of digital image synthesis, Morgan Kaufman
- Encarnaçao, Klein, Strasser:
Graphische Datenverarbeitung, Oldenburg Verlag, 4. Auflage
- Griebel, Bungartz, Zenger:
Computer Graphik, Vieweg Verlag

This course – literature

Books on Visualization

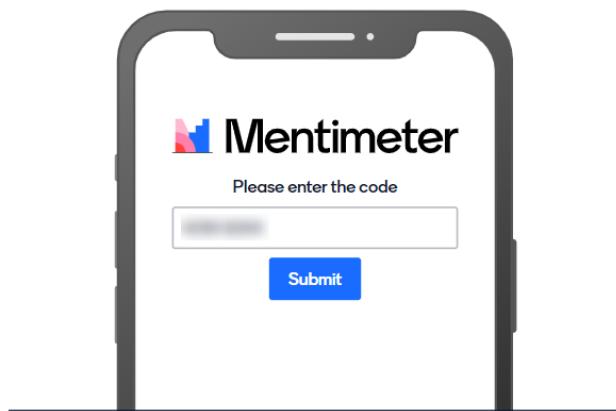
- T. Munzner: [Visualization Analysis & Design](#), CRC Press
- C. Hansen, C. Johnson (Ed.): [The Visualization Handbook](#), Elsevier
- H. Schumann, W. Müller: [Visualisierung - Grundlagen und allgemeine Methoden](#), Springer-Verlag
- G.M. Nielson, H. Hagen, H. Müller: [Scientific Visualization](#), IEEE CS Press
- R.S. Gallagher (Ed.): [Computer Visualization: Graphics Techniques for Scientific and Engineering Analysis](#), CRC Press
- R.A. Earnshaw, N. Wiseman (Eds.): [An Introductory Guide to Scientific Visualization](#), Springer-Verlag
- K.W. Brodlie et al. (Eds.): [Scientific Visualization - Techniques and Applications](#), Springer-Verlag
- E. Tufte: [The visual display of quantitative information](#), Graphics Press

Check the library and the web for literature!

What is your field of study?

Go to

www.menti.com



Enter the code

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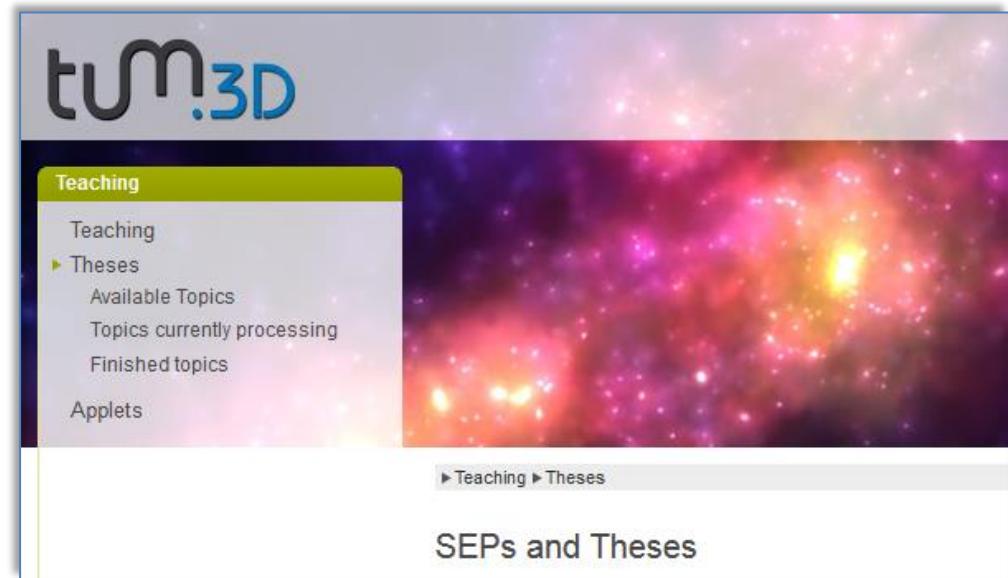
Or use QR code

This course – lecturer

- Dr. Johannes Kehrer
 - Siemens Technology
 - kehrer.johannes@siemens.com
 - Meeting by appointment

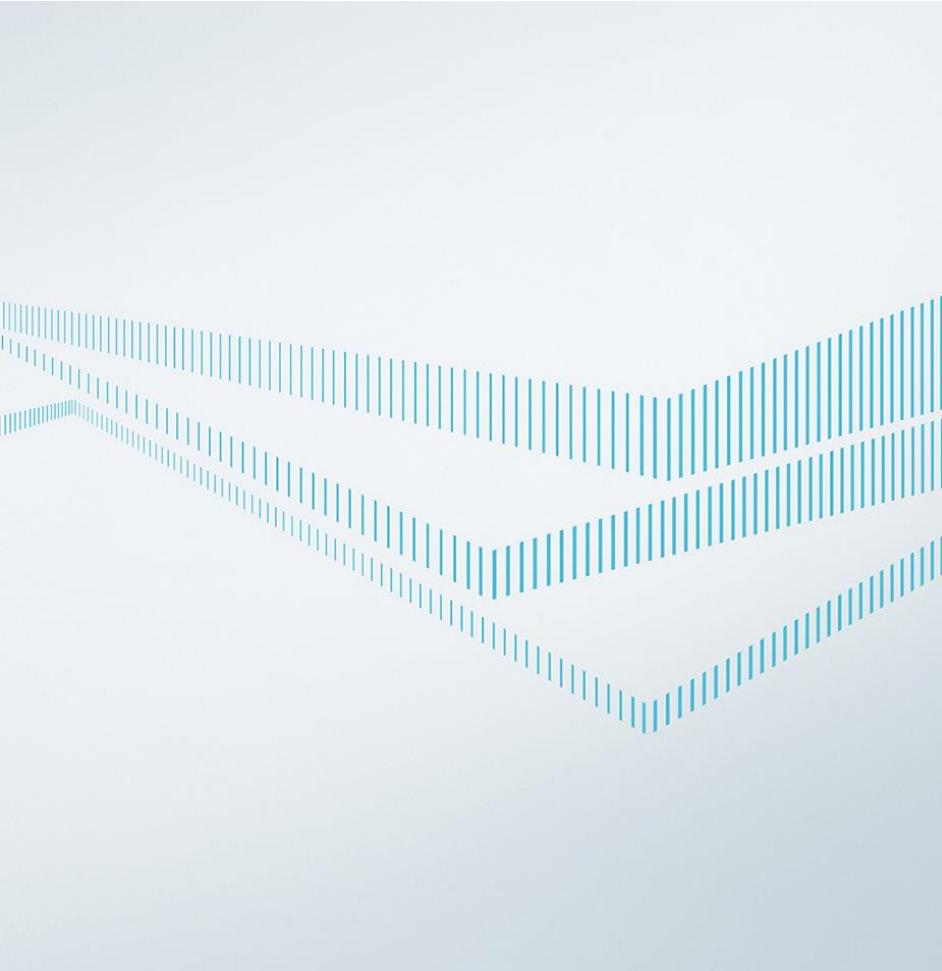


- Diploma theses and project work
 - Many topics are available
 - Check websites
 - wwwcg.in.tum.de
 - Come and talk to us!



The screenshot shows a mobile-style website for "tum.3D". The header features the "tum.3D" logo. A navigation bar at the top includes links for "Teaching" (highlighted in green), "Theses", "Applets", and "Contact". Below the header, there's a main content area with a colorful, star-filled background. At the bottom, a footer bar contains the text "► Teaching ► Theses".

Contact information



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