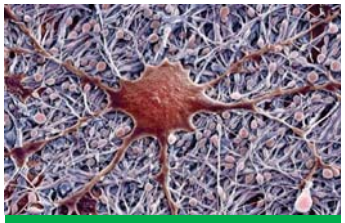
Medical Visualization Research

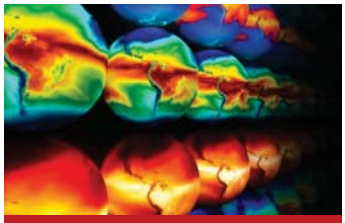
at the VisGroup @ UiB.no/ii

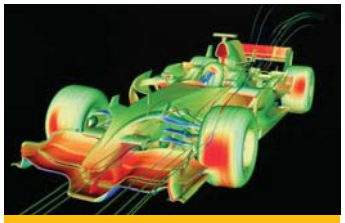
Helwig Hauser, *et al.*,
UiB Dept. of Informatics,
2015-11-25

Data, **models**, etc. → **visualization**


MEDICINE

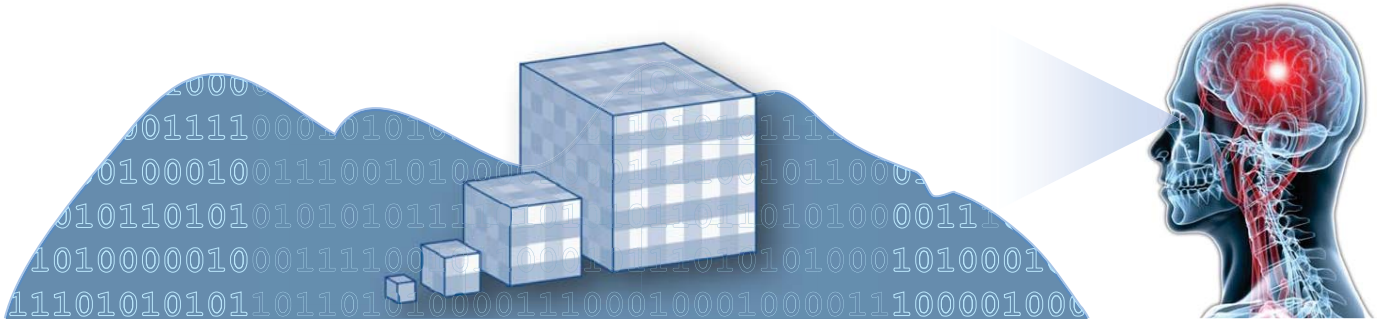

BIOLOGY


EARTH SCIENCES


ENGINEERING

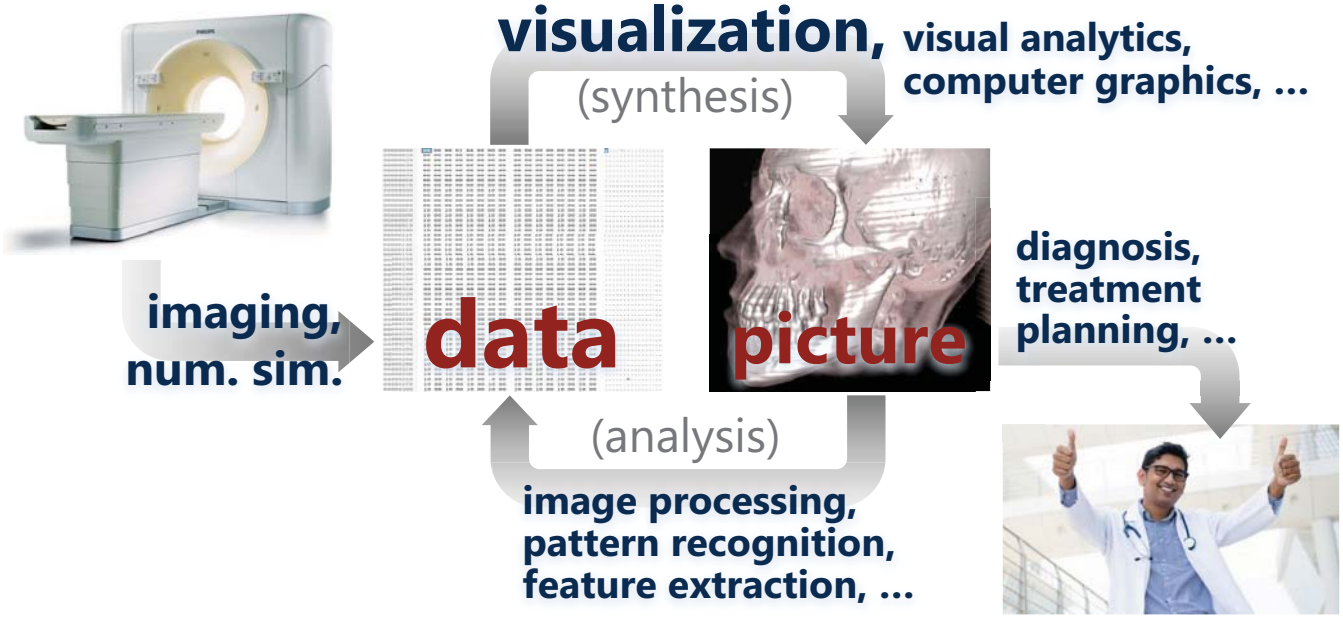
Visualization –

from data / models / … to insight



Visualization – a disambiguation

Imaging (medical imaging) delivers data (medical data)
Visualization (medical vis.) *synthesizes* ***pictures*** from ***data***
Image processing (pattern recogn., etc.) *derives* ***data*** from ***pics.***



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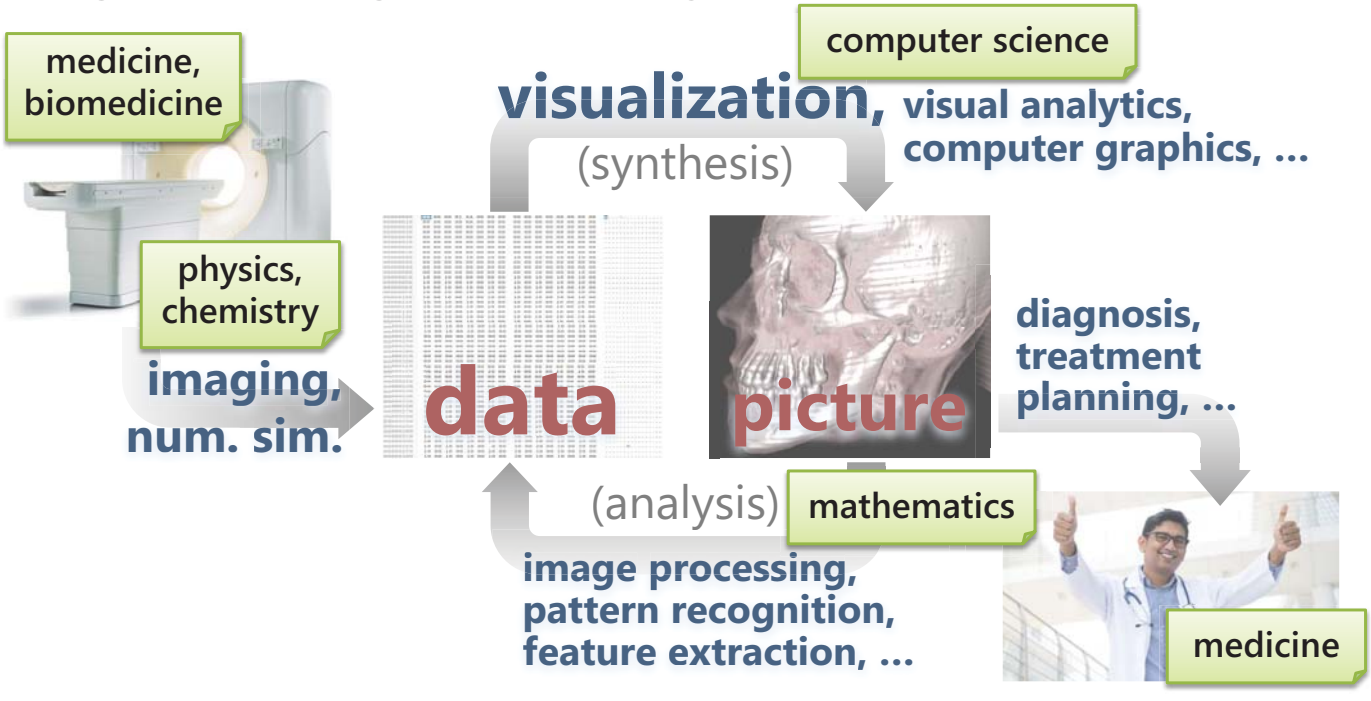


Vis.-Research at UiB—selected facts

Research group at **UiB's Dept. of Informatics** (one of six) [1]

- profs. **Helwig Hauser** (20 years in vis.) & **Stefan Bruckner** (10)
- group **established 2007** at UiB, currently **15 heads** (Oct. 2015), **12 graduated visualization PhDs** so far (2009–2014)
- **grade 4.5** (out of 5) in **NFR's 10 years evaluation** of CS in Norway
- **internationally recognized in (medical) visualization** (Dirk Bartz prize, conf. chairing, steering comm., boards, conf. org., etc.)
- collaborative research (national & int'l) with **medicine**, **biology**, etc., incl. **MEDVIZ in Bergen**
- **several larger projects** (NFR, FP7, etc.), **dozens of publs. in biomed. visualization** (>30% on L2)

[1] www.ii.UiB.no/vis

Visualization Research @ ii.UiB.no

The purpose of visualization is insight, not pictures!
– Ben Shneiderman, 1999

Relatively new group at UiB Informatics,
today 15 heads (2 faculty, 1 ResEng, 4 PhD studs., *et al.*)

Application-oriented basic research in visualization – two aspects:

1. Researched visualization methodology **(how to visualize)**
   - **Interactive Visual Analysis, *n*D data** (H. Hauser *et al.*)
   - **Visual Knowledge Discovery, 3D data** (St. Bruckner *et al.*)
2. Applications at which this research is oriented **(for whom)**
   - **Medical Visualization** (partner in MedViz Bergen, *etc.*)
   - **GeoSciences / Oil&Gas** (*e.g.*, financed by Statoil's Akademiaavtale)
   - **Biology / Bioinformatics** (with CBU@ii *et al.*)
   - **Fluid Dynamics** (in collab. with FFI.no, for ex.)
   - **Rich Data** (interactive visual analysis)

	2010	2011	2012	2013	2014	
General	11	11	6	12	8	48
BioMed	2	5	8	12	11	38
Flows	2	5	6	1	2	16
GeoSci	1		3	4	3	11
Eng.	2	1		1		4
Marine			1			1
Climate	1					1
	19	22	24	30	24	119

ii.UiB.no/vis PhDs (12 so far)


Daniel Patel (Oct. 2009):
Expressive Vis. & Rapid Interpr. of Seismic Volumes


Jean-Paul Balabanian (Jan. 2010):
Multi-Aspect Vis.: from Linked to Integrated Views


Johannes Kehrer (May 2011):
IVA of Multi-faceted Scientific Data


Ove Daae Lampe (Nov. 2011):
IVA of Process Data


Armin Pobitzer (June 2012):
IVA of Time-dependent Flows


Paolo Angelelli (June 2012):
Visual Expl. of Human Physiology


Veronika Šoltészová (Oct. 2012):
Perception-Augmenting Illumination

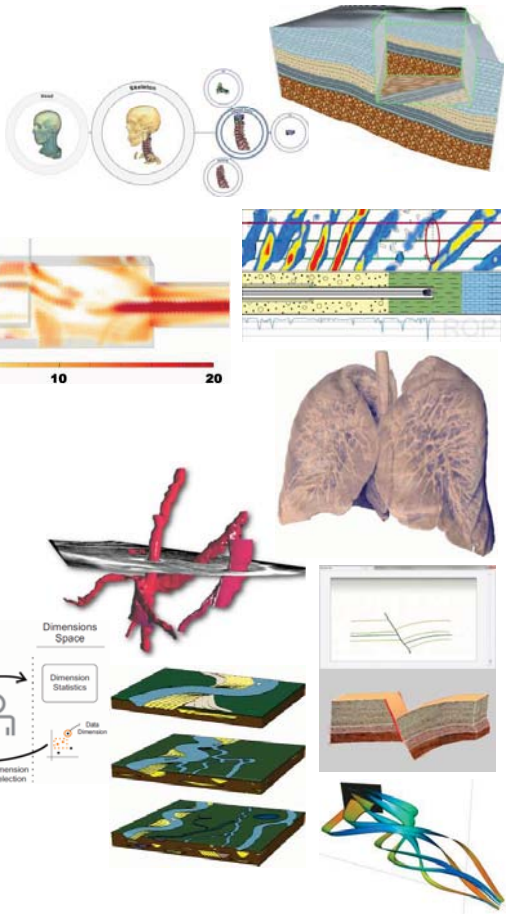

Åsmund Birkeland (May 2013):
Ultrasonic Vessel Vis.: From Extraction to Perception


Endre Lidal (May 2013):
Sketch-based Storytelling for Cognitive Problem Solving


Çağatay Turkay (Nov. 2013):
Interactive Visual Analysis of High-dimensional Data

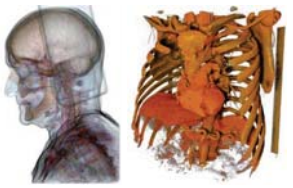

Mattia Natali (Sept. 2014):
Sketch-based Modeling and Visualization of GeoProcesses


Andrea Brambilla (Dec. 2014):
Visibility-oriented Visualization Design for Flow Illustration

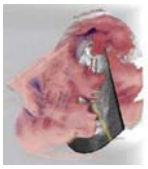


MedViz Research at UiB ii

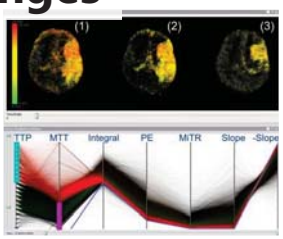
UiB Vis competence



- **medical data visualization** (CT, MRI, US, etc., but also test data, perfusion, high-dim. data, etc.)
- **visual exploration & analysis** (user-in-the-loop approach, integration of interactive & computational approaches)



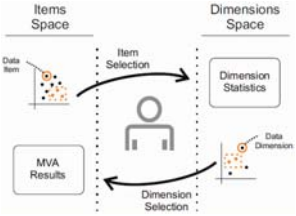
Initial research related to Medical Big Data challenges

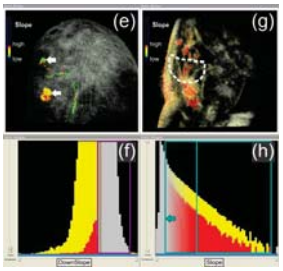


- multi-modal medical data visualization
- new model for heterogeneous data studies
- dual framework for high-dim. data analysis

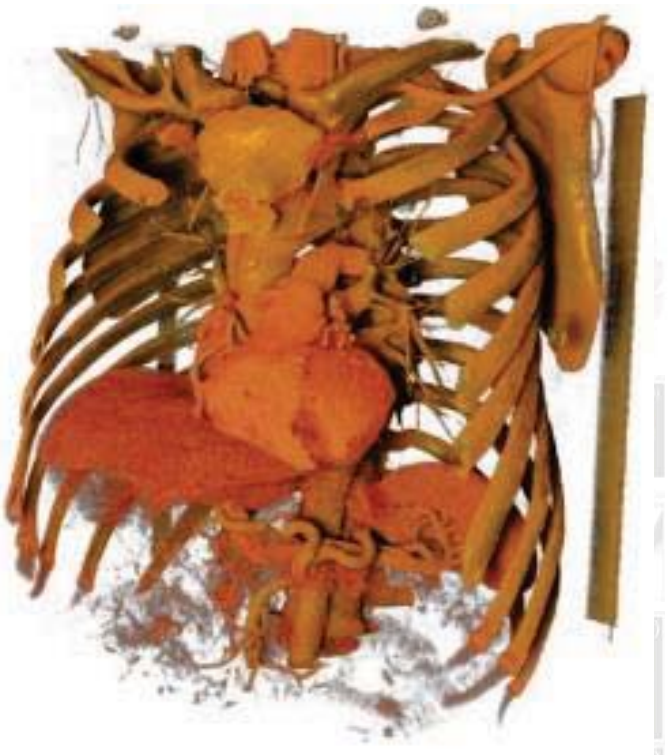
Well-working collab. with CMR

- basic research @ UiB, prototype development @ CMR



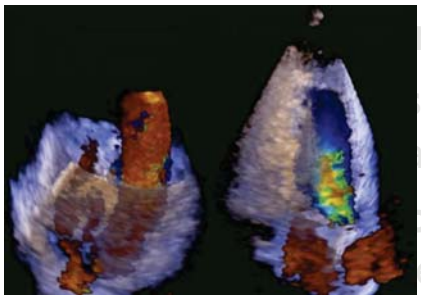


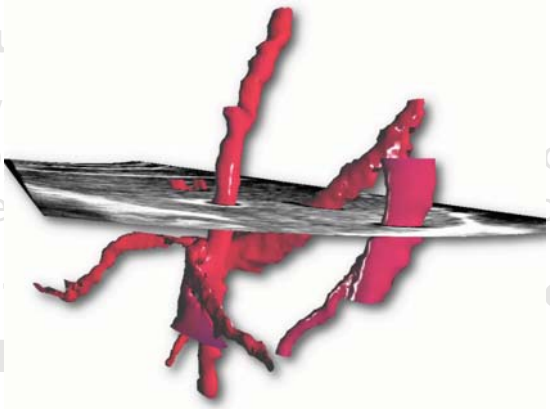
MedViz Research at UiB ii

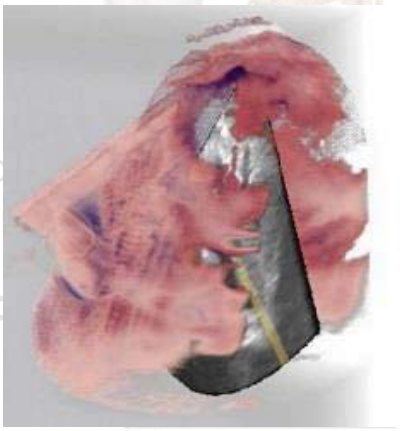


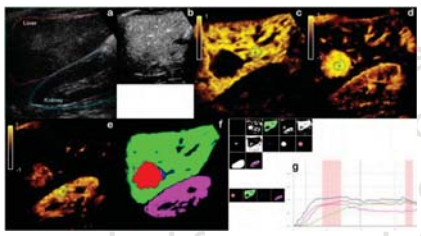
high-quality morphology visualization

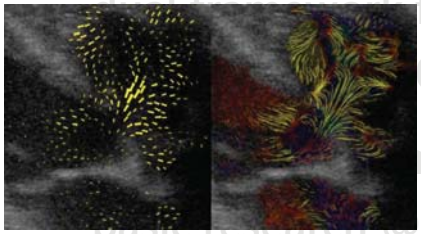
MedViz Research at UiB ii





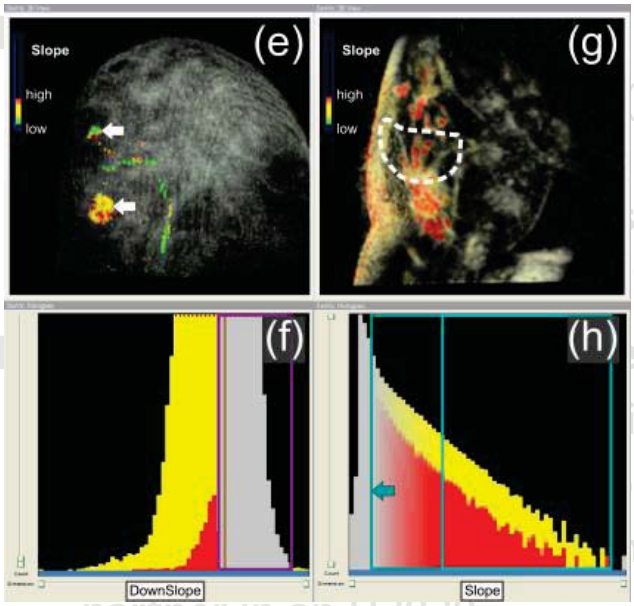


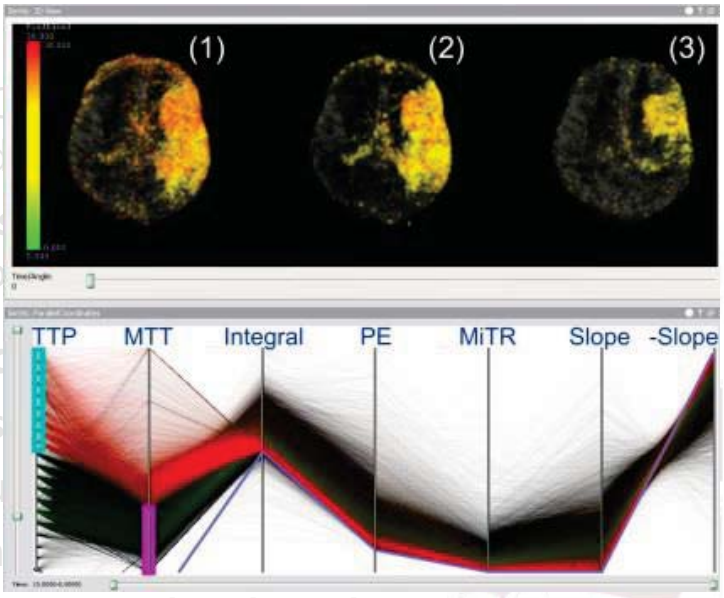




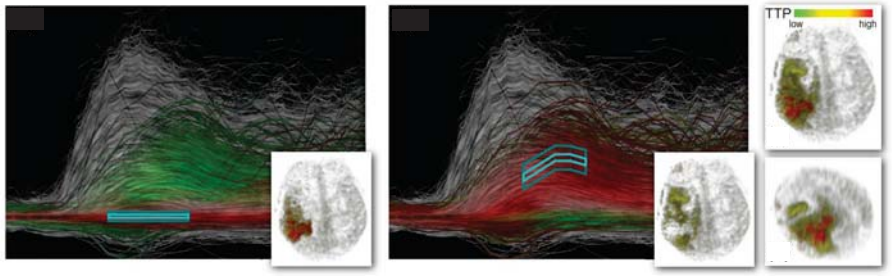
multi-modal ultrasound visualization

MedViz Research at UiB ii





dynamic perfusion analysis



MedViz Research at UiB ii

High-dim. data, for example

- **biological microarray data, medical sequencing data**
- **epidemiological data** (cohort studies)

etc.

Challenge:

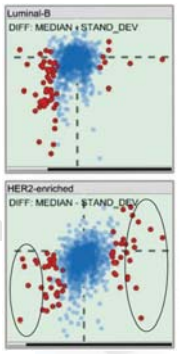
- **most analysis methods are not made for *many* dims.!**
  (std. MVA approaches, *i.e.*, multi-variate analysis, like PCA, *etc.*, do not scale)

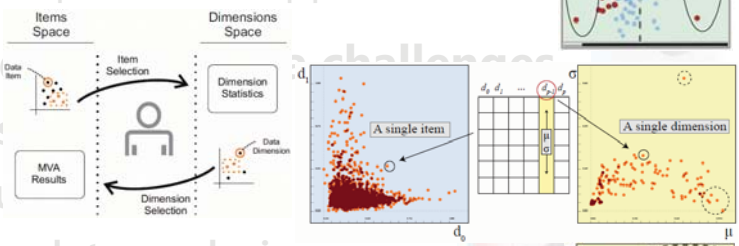
New approach:

- **dual analysis framework**

Achievements:

- **hypothesis generation for high-dimensional data**
- **identifying discriminating dimensions/factors**
- **supervised dimension reduction, clustering**



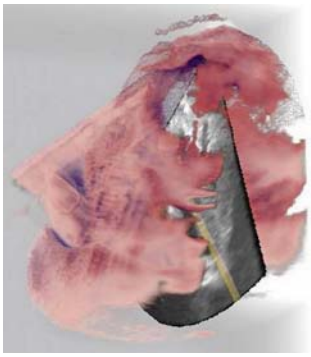


high-dimensional data analysis

Related Vis.-Research at UiB (1)

IllustraSound: NFR-funded project [1]

- aim: **new visualization solutions** for the **interactive illustration** of **data from ultrasonography**
- **2 PhD students (V. Šoltészová, Å. Birkeland), int'l Dirk Bartz prize** (Eurographics Medical Prize)
- **high-quality visualization of time-dependent 3D US data**,
- **partners in Bergen** (gastroenterology center *et al.*, MedViz), in **Munich, Germany,** and in **Vienna, Austria**

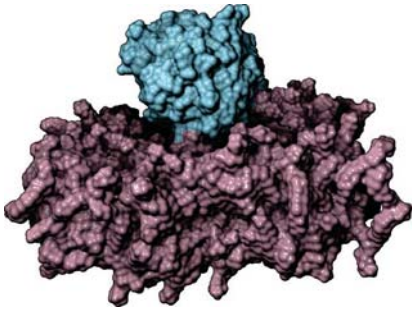


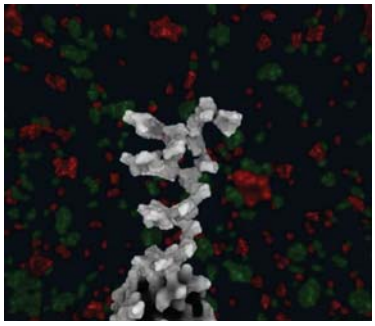
[1] www.ii.UiB.no/vis/projects/illustrasound

Related Vis.-Research at UiB (2)

PhysioIllustration: NFR-funded project [1]

- aim: **new visualization solutions** for the **interactive illustration** of physiological processes
- total budget incl. **8.8 MNOK** funding from NFR, 2012–
- selected efforts towards **molecular biology**, as well as towards larger scales
- **partners in Bergen** (molecular biology et al.), in Tromsø (modeling), and in Vienna, Austria (illustration, etc.)



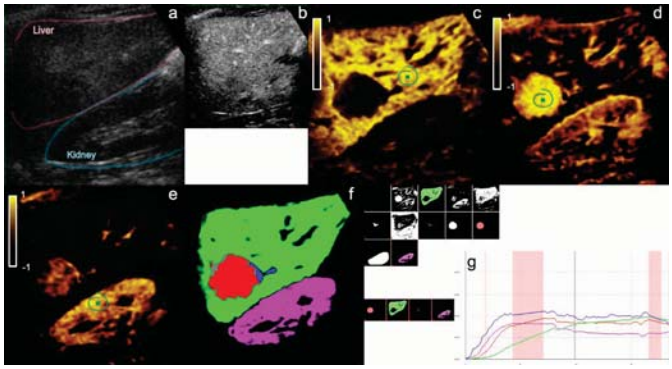


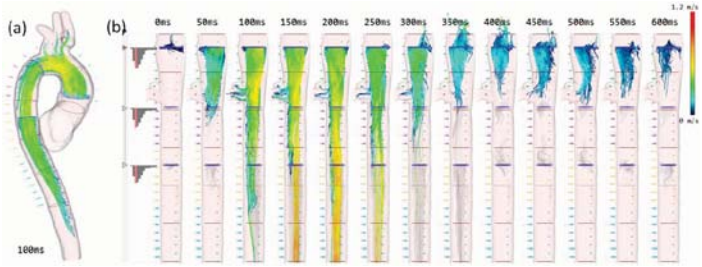
[1] www.ii.UiB.no/vis/projects/physioillustration

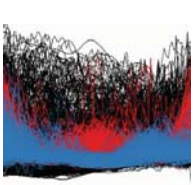
Related Vis.-Research at UiB (3)

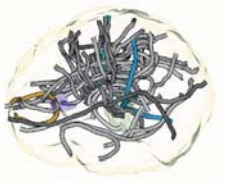
PhD thesis "**Visual Exploration of Human Physiology**: Visualizing Perfusion, Blood Flow and Aging" [1]

- by **Paolo Angelelli** *et al.* (in 2012)
- pioneering **new visualization solutions** for the visualization of **physiological data from medicine**
- in collaboration with the **IllustraSound project**, **MedViz** in Bergen, and partners from **Magdeburg**, Germany







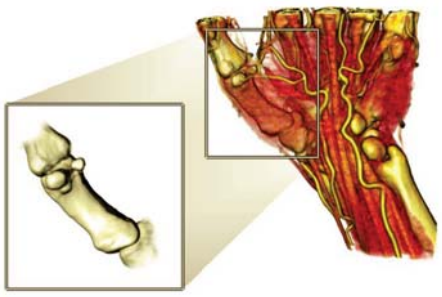


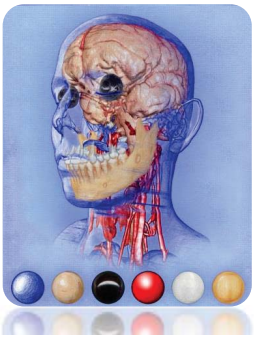
[1] www.ii.UiB.no/vis/publications/publication/2012/angelelli12thesis

Related Vis.-Research at UiB (4)

Illustative visualization: interactive presentation of complex 3D datasets in an easily-understandable way using illustration techniques (e.g., for patient education)

- **GPU-based methods** for generating **cutaway views**, **exploded views**, **stylized shading**, etc.
- **VolumeShop** software framework: rapid-prototyping toolkit with a rich library of visualization techniques

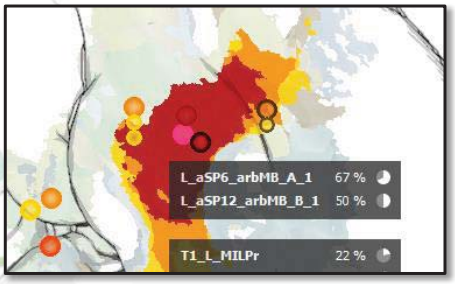




Related Vis.-Research at UiB (5)

Collaboration Visual Exploration of Neural Circuit Data

- visual exploration and analysis of **confocal microscopy data** and **annotated anatomical structures** [1,2]
- intuitive tools for **potential connectivity exploration** and **quantification**
- together with **neurobiology and technology partners from Austria**

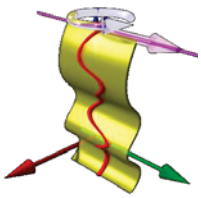


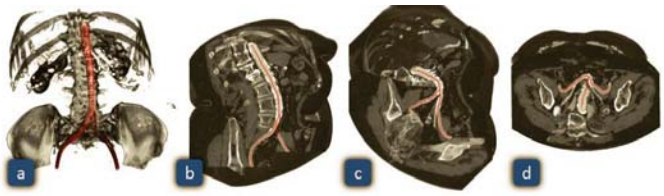
[1] http://www.ii.uib.no/vis/team/bruckner/publication/Bruckner-2009-BVQ
[2] http://www.ii.uib.no/vis/team/bruckner/publication/Swoboda-2014-VQA

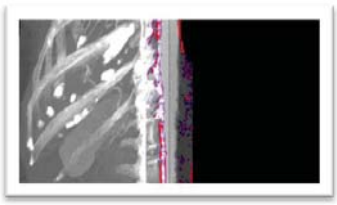
Related Vis.-Research at UiB (6)

AngioVis: advanced visualization and smart interaction for improved diagnosis of vascular decease

- next-generation radiology workstation, in daily clinical use

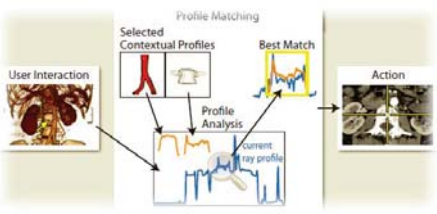


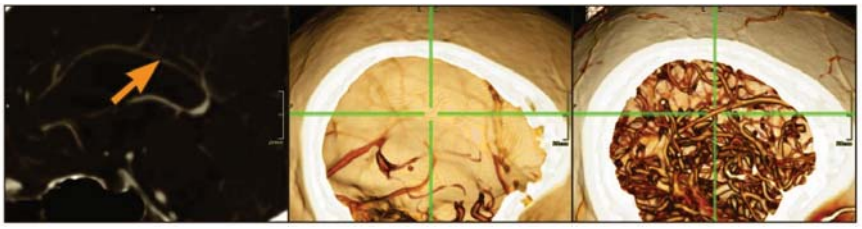




LiveSync: synchronized interaction with 2D and 3D images in medical workstations

- integrated into AFGA HealthCare software, several patents

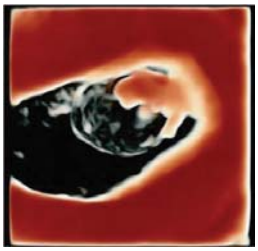




Visualization and Innovation (1)

HDLive: real-time realistic volume visualization from live 4D ultrasound data

- high-quality rendering with at a fraction of the cost of previous methods
- research and technology transfer project with **GE Healthcare** & **TU Wien**
- successfully deployed and available on **GE Voluson** US scanners [1]



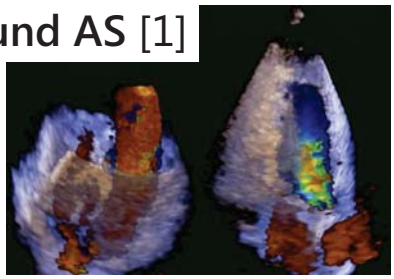
Picture of the month in the journal *Ultrasound in Obstetrics & Gynecology*, vol. 38, no. 5

[1] www3.gehealthcare.com/.../HDLive

Visualization and Innovation (2)

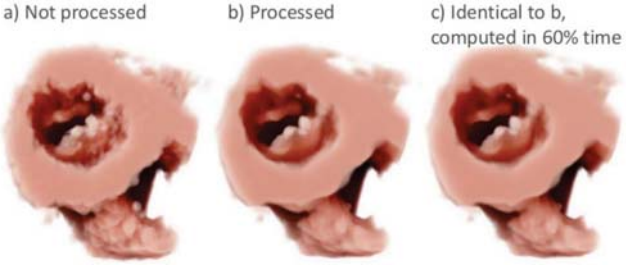
BIA project on high-quality cardiac visualization:

- together with **GE Healthcare VingMed Ultrasound AS** [1]
- focus on **cardiac ultrasound images**
- one PostDoc (Paolo Angelelli) in Bergen



VERDIKT Results project on commercializing earlier research results:

- together with **CMR** [2], **Haukeland** [3], **BTO** [4], **GE** [1]
- focus on **visibility-driven 3D ultrasound visualization**
- patent applied



[1] www.GE.com/no/contact/index.html
[2] www.CMR.no
[3] www.Helse-Bergen.no
[4] BergenTO.no

Related Networking / Outreach / …

Events (co-)organized by the UiB VisGroup:

- **EuroVis 2011** (in Bergen) [1] –
  Europe's central conference on visualization!
- **annual MedViz conference** (in Bergen) [2]
- **VisBio 2013** (in Bergen) [3]
  and **VisBio 2014** (in Vienna)
- **VCBM 2016** (in Bergen, also in coop. with MedViz) [4]:
  Visual Computing for Biology and Medicine

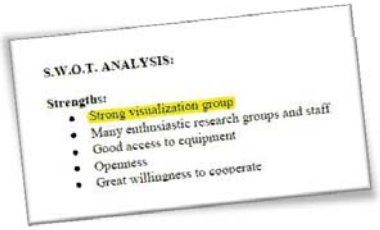
[1] www.UiB.no/eurovis2011
[2] MedViz.UiB.no
[3] www.ii.UiB.no/vis/events/VisBio13
[4] www.VCBM.org

UiB Visualization and MedViz

VisGroup: part of MedViz since its foundation
(HH member of MedViz leader team since 2007)

IllustraSound: 1 of 3 lighthouse projects
(in coop. with HUS and CMR)

Visualization: #1-strength of MedViz
(Nordic evaluation report of MedViz in 2013)


S.W.O.T. ANALYSIS:

Strengths:

- Strong visualization group
- Many enthusiastic research groups and staff
- Good access to equipment
- Openness
- Great willingness to cooperate

Coordinated Seminars
(about one every two weeks):

- MedViz Seminar
- Visual Computing Forum

[1] www.ii.UiB.no/vis/vcf

2015-01-16	MedViz	Jarle Rørvik, Eli Eikefjord, Erlend Hodneland, Are Losnegård
2015-02-06	**VCF**	Erlend Hodneland (MedViz)
2015-02-20	MedViz	Bjørn Tore Gjertsen, Emmet Mc Cormack, Spiros Kotopoulis (HUS)
2015-02-06	**VCF**	Barbora Kozlikova (Brno)
2015-03-20	MedViz	Stefan Bruckner, Sergej Stoppel, Veronika Šoltészová (**VisGroup**)
2015-02-06	**VCF**	Július Parulek (Metas & UiB)
2015-04-24	MedViz	Judit Haász & Arvid Lundervold (BioMed)
2015-05-20	**VCF**	Lars Linsen (Bremen)
2015-05-29	MedViz	Jeremie Fromageau (London), Roald Flesland Havre (HUS)
2015-08-28	**VCF**	Ivan Viola (Wien & UiB)

Acknowledgements & Contact

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Thank you!