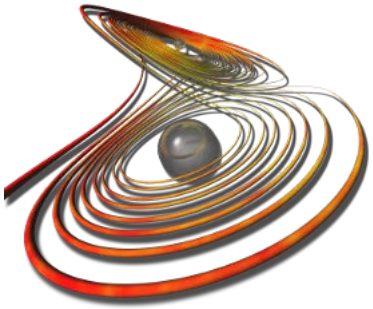
Vorstellung von Bachelor- und Masterthemen
Sommersemester 2020



Computer Graphics and Knowledge Visualization

Head of institute — Prof. Dr. Tobias Schreck
Deputy head — Prof. Dr. Dieter W. Fellner
Deputy head — Ass.Prof. Dr. Ursula Augsdörfer

Fraunhofer AUSTRIA

Fraunhofer Visual Computing

Head of institute — Dr. Eva Eggeling
Senior Researchers — Dr. Ulrich Krispel, Dr. Christoph Schinko, Dr. Volker Settgast, Dr. Torsten Ullrich

Outline

- Welcome
- Overview of thesis workflow
- Institute presentation & topics CGV
- Institute presentation & topics Fraunhofer Austria

What is a Thesis?

- Demonstrate that you can work on a larger CS-related problem
  - Tackle a relevant, current problem
  - Systematic work approach
  - Typically, involves a theoretical and a practical paer
  - Present solution
    - Documentation in form of a written thesis
    - Presentation (and defense) of the results
- Duration
  - Bachelor: 6th semester
  - Master: 4th semester
  - ECTS depending on course of study

Thesis Phases

1. Find a topic and advisor of interest
   - Thesis presentations → follow-up with contact
   - Agree on topic and supervision modalities
2. Initial research & workplan
   - Read related work
   - Review data and algorithms provided (in case)
   - Derive work plan with milestones and measurable outcomes
3. Main thesis work
   - Implementation / design
   - Evaluation
   - Documentation, thesis writing
4. Finalization stage
   - Complete the work
   - Complete the thesis
   - Agree on closing presentation or examination date
5. Follow-up scientific publication (if applicable)

Goals for Today

- Introduction of offered topics
  - Presented by advisors at CGV and Fraunhofer

→ First impression of topics

→ Possibility to ask questions and meet later with advisor

→ Get to know contact details, to follow up in case you want to work on any of the topics

3D Modelling and Processing

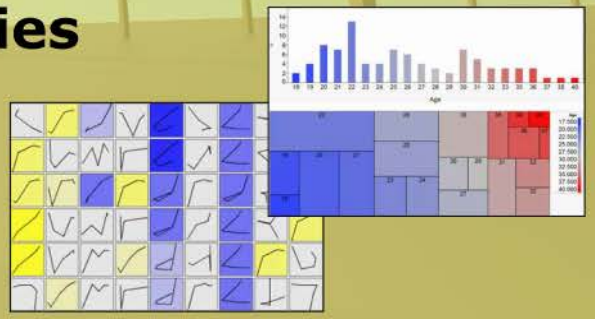
Computer Aided Geometric Design
Procedural Modelling
Physics-based Modelling
3D Object Retrieval
3D Restoration

Simulation and Analysis

Analysis and Visualization of
Geometric Information
Isogeometric Analysis
Virtual Reality

Visual Analytics and Digital Libraries

Visual-Interactive Data Exploration
Search Interfaces and
Semantic Annotation
Submission and Review System



Outline

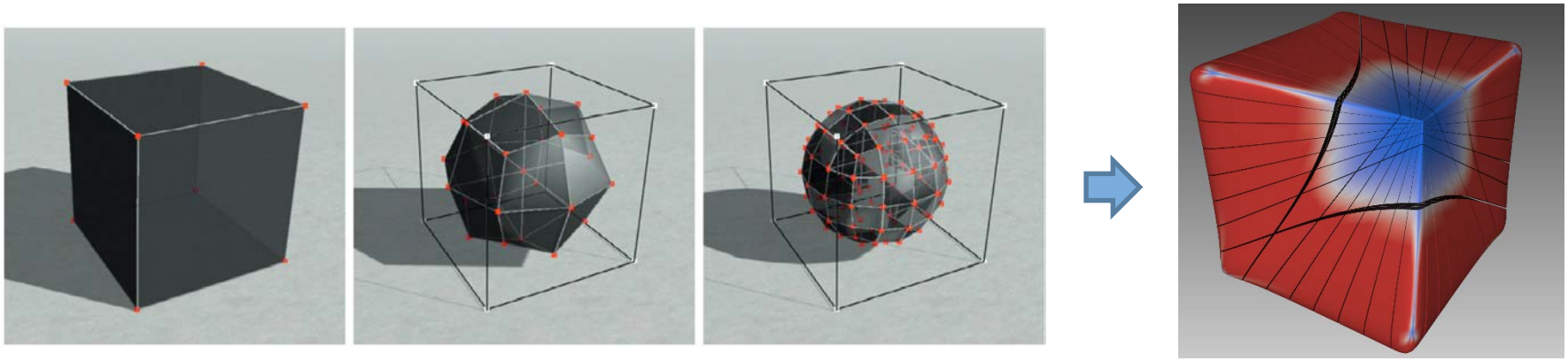
- Welcome
- Overview of thesis workflow
- Institute presentation & topics CGV
- Institute presentation & topics Fraunhofer Austria

Topics by CGV: Advisors and Areas

- Reinhold Preiner
  - *3D Geometry Processing & Interactive Visualization*
- Ursula Augsdörfer & Andreas Riffnaller-Schiefer
  - *Augmented & Virtual Reality, CAD & Simulation*
- Simon Kloiber
  - *Immersive Analytics & Virtual Reality*
- Lin Shao
  - *Visual Analytics & Data Visualization*
- Tobias Schreck
  - *3D Object Retrieval and Visual Analytics*
- Stefan Lengauer
  - *3D Object Retrieval for Cultural Heritage Applications*

Advisor: Dr. **Reinhold Preiner**
Areas: *3D Geometry Processing*
Interactive Visualization
Contact: r.preiner@cgv.tugraz.at

Nonlinear Volumetric Subdivision



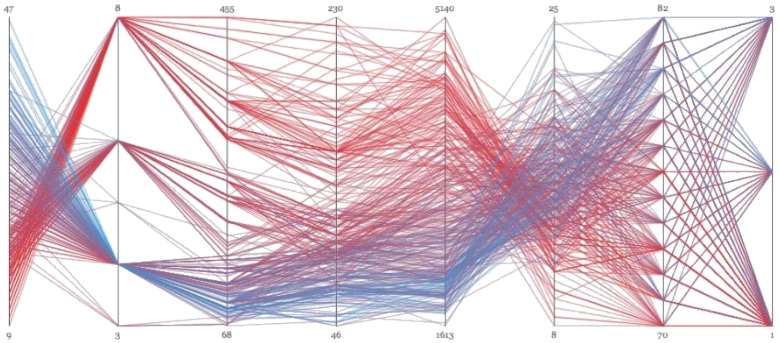
Volumetric subdivision of models into small cells.
Used in in analysis and simulation.

Your tasks

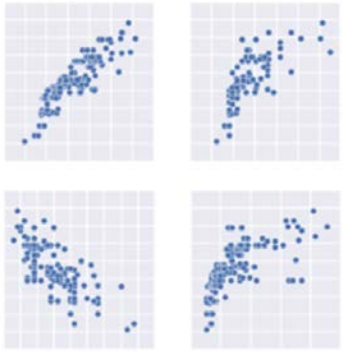
- Extend an existing volumetric framework by a nonlinear subdivision method.
- Experimental investigation of subdivision patterns.

Interactive Visual Analysis Tool

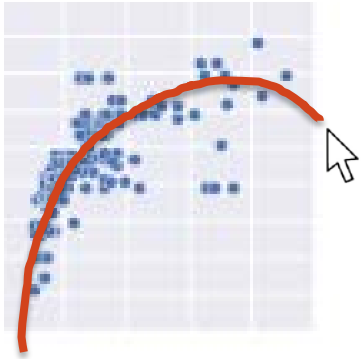
Parallel Coordinates



Scatter Plots



Sketching/
Model Regression



Explorative data analysis enabled by interactive dimensional reduction.

Your task

- Realize an interactive data analysis framework featuring
  - Combined 1D/2D/3D parallel coordinates
  - 2D/3D scatter plots
  - interactive sub-space sketching

Ma

Image-based Flattening Transfer

Image-based transfer flattening mask between objects of similar type.

Your task

- View-based pose estimation of prior models to a given image
- Interactive selection of surface regions
- Mapping of selected region mask to precomputed parametrization.

Implementation in an existing software framework.


Advisors: Ass.Prof. **Ursula Augsdörfer**
Dr. **Andreas Riffnaller-Schiefer**
Area: *Augmented & Virtual Reality*
CAD & Simulation
Contact: u.augsdorfer@cgv.tugraz.at
a.schiefer@cgv.tugraz.at

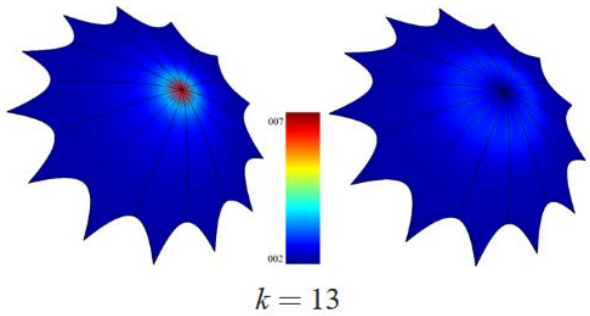
TU Graz

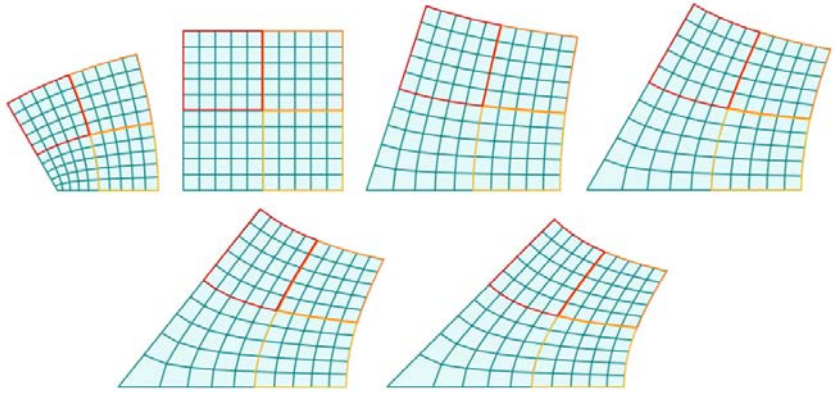
Topic: AR Object Identification

- Identify objects like e.g. LEGO parts in augmented reality
  - Extract information from AR scene
  - Search database of known objects
- Visualize information for identified part, e.g.
  - Corresponding LEGO set
  - Assembly info
  - ...

Topic: Exact derivatives for Catmull-Clark

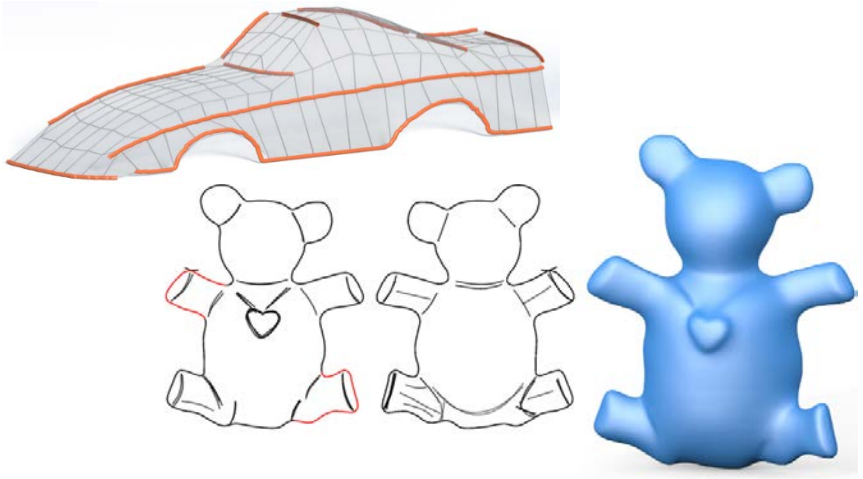
- Near extraordinary vertices (EVs), evaluated derivatives diverge
- The *characteristic map* is used for analysis of the surface near EVs
- Implement algorithms using the characteristic map to evaluate derivatives near EVs:
  - Ioana Boier-Martin and Denis Zorin: Differentiable parameterization of Catmull-Clark subdivision surfaces.
  - Anna Wawrzinek, and Konrad Polthier: Integration of generalized B-spline functions on Catmull–Clark surfaces at singularities.
- Use these derivatives as training data for a machine learning system *learning* Catmull-Clark derivatives





Topic: Modelling surfaces in VR

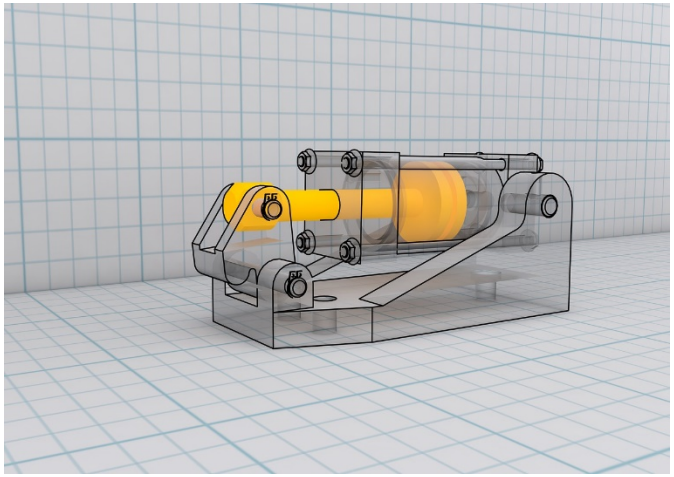
- Quickly design smooth freeform (subdivision) surfaces in VR
- Possible approach: sketching feature lines



Changjian Li, Hao Pan, Yang Liu, Xin Tong, Alla Sheffer, and Wenping Wang: Robust Flow-Guided Neural Prediction for Sketch-Based FreeformSurface Modeling.

or

- Interface for precise CAD modelling in VR
- Explore typical CAD modelling tools in VR



Advisor: Dipl.-Ing. **Simon Kloiber**

Area: *Immersive Analytics*
Virtual Reality

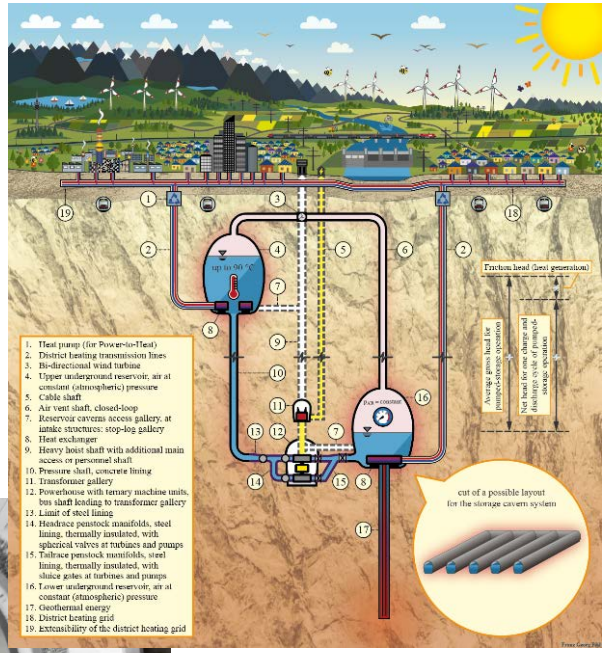
Contact: s.kloiber@cgv.tugraz.at

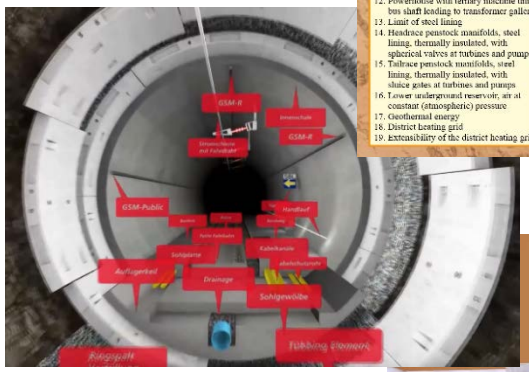
TU Graz

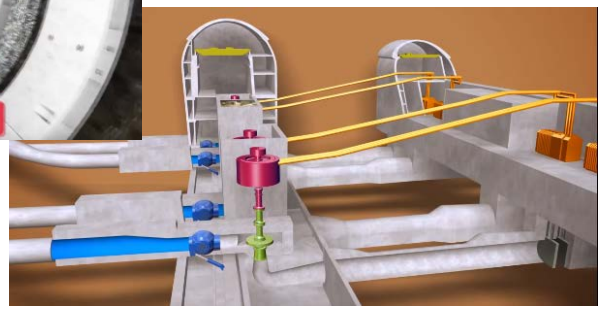
Topic: Immersive Pump Storage Education

Project Definition

- Create educational web application in 3D / VR to present a hot water pump storage system
  - Create CAD model
  - Find engaging interactions
  - Animate important processes
  - Visualize energy sources and carriers







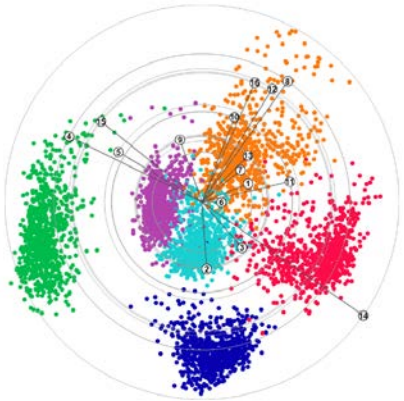
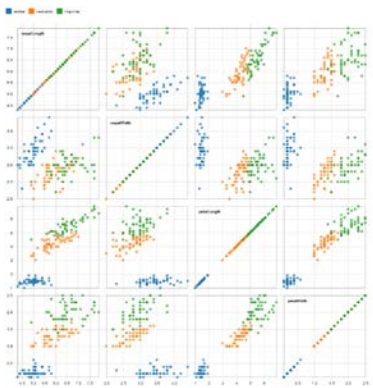
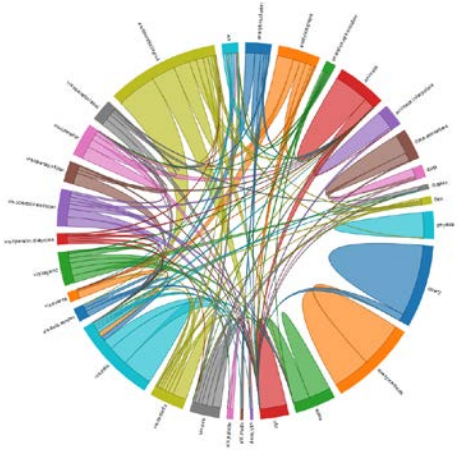
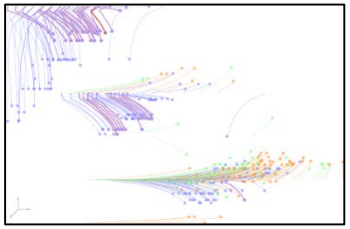
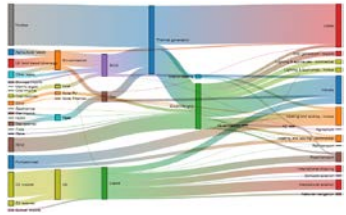
In conjunction with Franz Georg Pikl of the Insitute of Hydraulic Engineering and Water Resources Management

Advisor: **Lin Shao**, M.Sc.

Area: *Visual Analytics*
Data Visualization

Contact: l.shao@cgv.tugraz.at

Evaluation in Visual Analytics

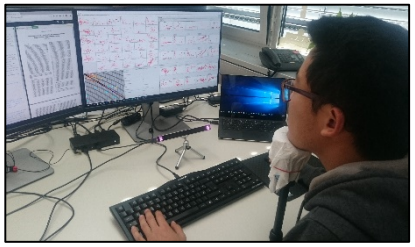






Comparison of different state-of-the-art visual analytics techniques

Your Task

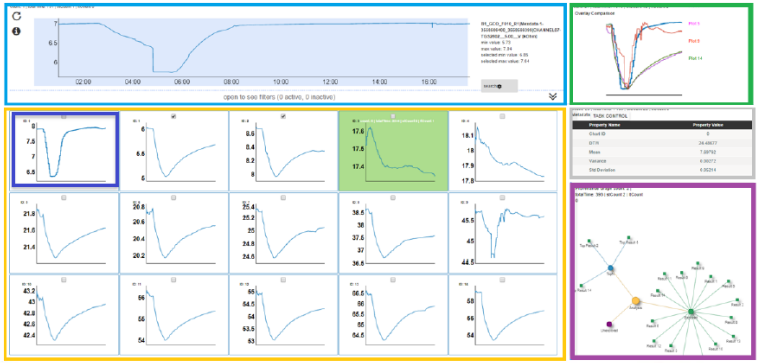
- Develop a visual analytics system for high-dimensional data
- Compare your developed technique with existing CGV systems
- Conduct a user study
  - Analyze user behavior during retrieval tasks
  - Discover pros/cons of one technique over another

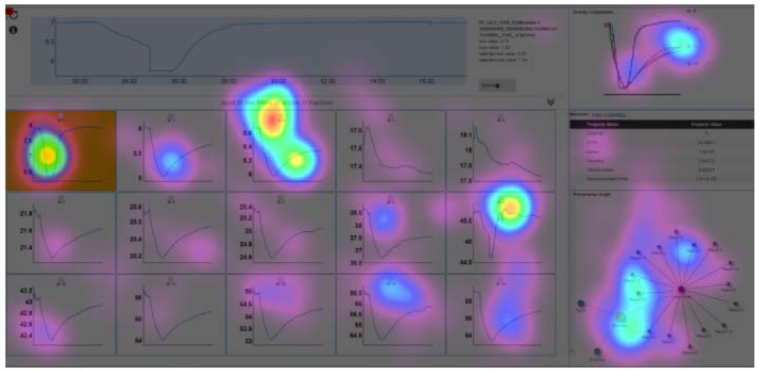
Eye-Tracking based Recommendations for High-Dimensional Analysis



Your Task

- Develop a visual analytics system including eye-tracking
- Analyze user behavior during retrieval tasks
- Identify area of interest (AOI) of users
- Compute similarity feature for local patterns in time series
- Create recommendations for analysis/exploration





Advisor: Prof. Dr. **Tobias Schreck**

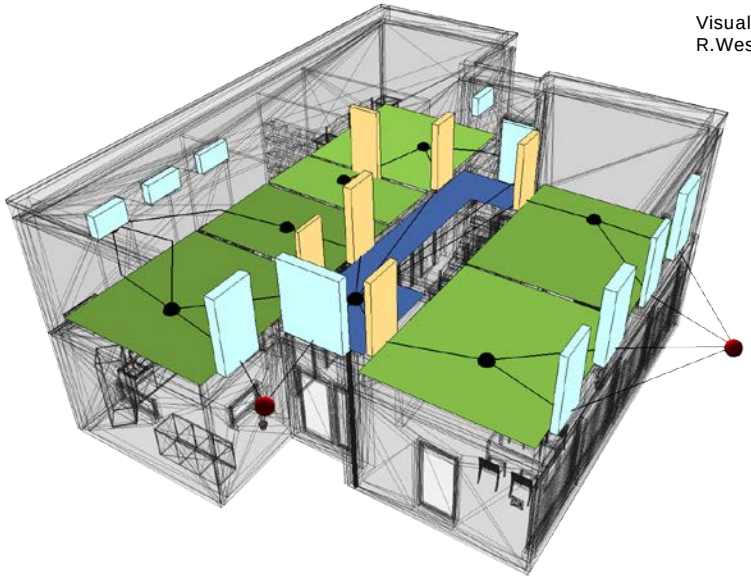
Area: *3D Object Retrieval*
Data Visualization

Contact: t.schreck@cgv.tugraz.at

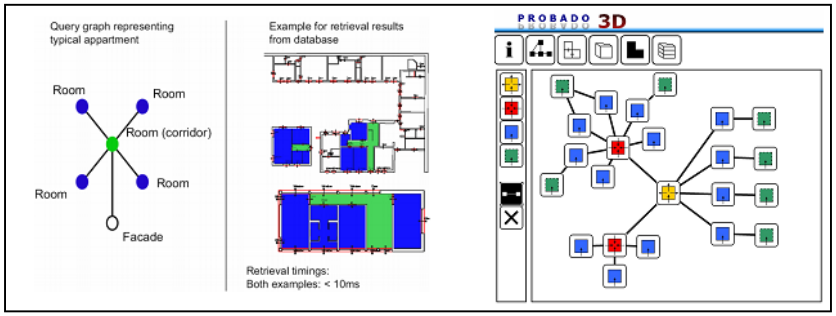
Topic: Comparison of Buildings by their 3D Structures

Project Definition

- We have a database of 3D building models and room connectivity graphs
- Implement a graph-based similarity function to compare room connectivity
- Implement a method to visualize room connectivity structures and to compare them
- Use cluster analysis to automatically derive and evaluate structure taxonomy



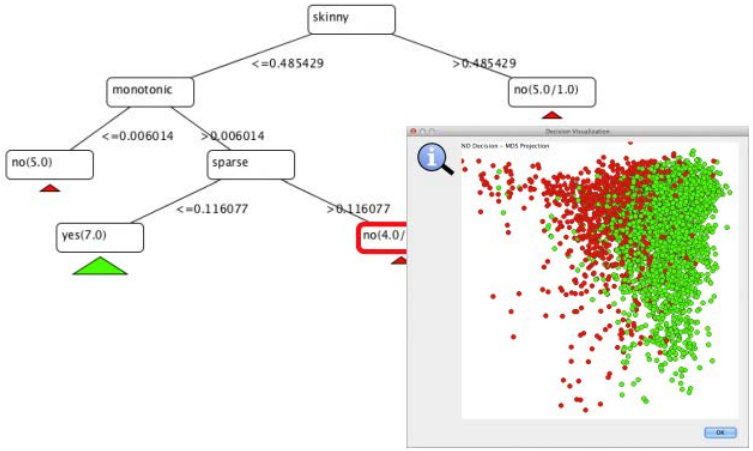
Visualization by
R.Wessel, Uni Bonn



Topic: Learning Interestingness From User Interaction

Project Definition

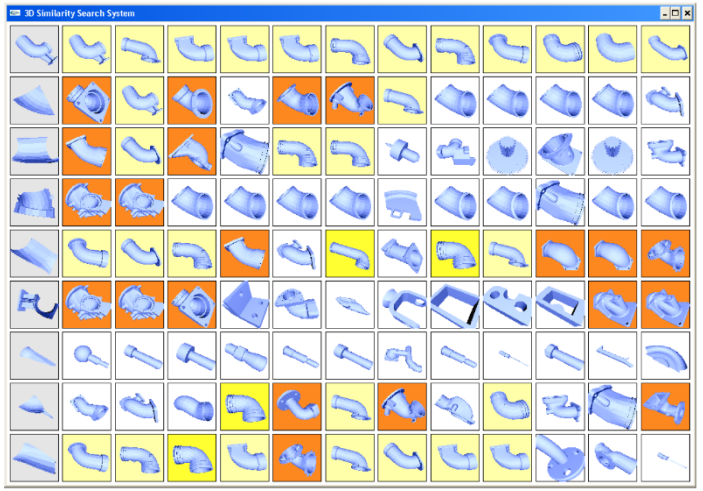
- Implement a basic visual exploration system
- Implement a logging of user operations during exploration
  - E.g., where and how long a user zooms in
- Train a model of interestingness from log data
  - E.g., using decision trees

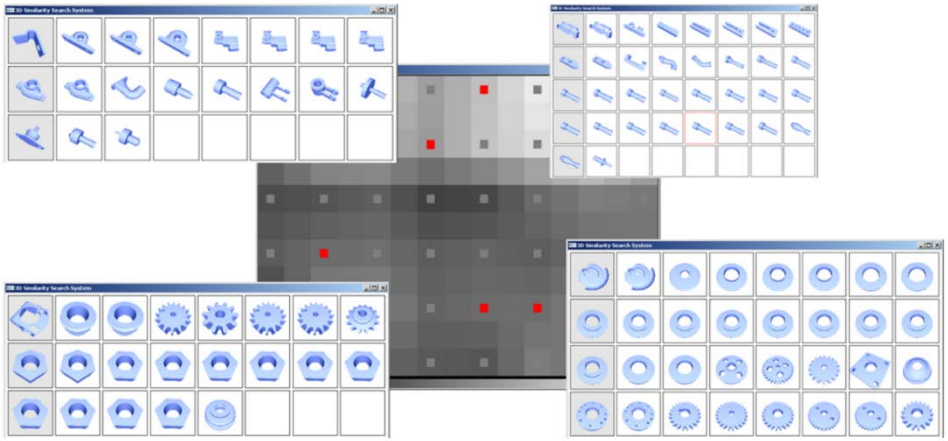


Topic: Visualization of 3D Repositories

Project Definition

- Implement a descriptor for 3D objects
- Implement a visual cluster analysis approach to group and visualize large numbers of objects
- Define appropriate user interaction for navigation
- Apply on real 3D data, e.g., from Mechanical Engineering





Advisor: M.Sc. **Stefan Lengauer**

Area: *3D Object Retrieval*
Cultural Heritage Applications

Contact: s.lengauer@cgv.tugraz.at

Topic: Object Detection and Semantic Segmentation of Tourist Pictures

Project Definition

- Survey state of the art semantic segmentation and pose estimation methods
- Implement one ore two approaches
- Evaluate the applicability for tourist pictures depicting cultural heritage objects

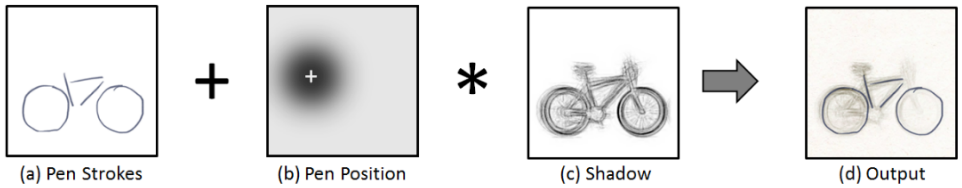
Images:
https://flickr.com

N. Hyeonwoo et al., 2015.

Topic: Sketch-Interface for Similarity Retrieval

Project Definition

- Investigate state of the art methods for sketch-completion (i.e. Shadowdraw)
- Conceptualize and implement a suitable user interface
- Evaluate applicability and benefits for similarity retrieval



L. Yong Jae et al., 2011.

Slides available online:

https://www.tugraz.at/institute/cgv/teaching/bachelormaster-topics/

- Please contact advisors for more information

- Thank you and best of success!