Introduction

Visual Analytics VU (706.720)

SS 2020

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March 3rd 2020
Organisational information
  - Theoretical part: 5 lectures (in March 2020)
  - Practical part: 3 mandatory presentations + 4 optional progress reviews
  - 4 student deliverables

Goals and topics of the course

Examples

Course structure and calendar

Student presentations

Examination and grading
Course Overview
Course

• Visual Analytics VU 706.720 (3.0 SSt, 5 ECTS credits)
• Elective (optional) course for
  ▪ Computer Science
  ▪ Software Engineering and Management
  ▪ Doctoral Studies
• Catalogues: Knowledge Technologies, Multimedia Information Systems, Web and Data Science
Lecturer

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Language

- Master course: lectures in English
- Communication in German/English
- If in German: please informally (Du)!
- Project: English
- Presentation: German/English
Organization

- Lectures
  - When: Tuesday, 10:00 – 12:00
  - Where: HS i9 (with exceptions, see time plan)
- **Registration** for the course in TUG Online until **20.03.2020** 23:59
- Course organised in 2 blocks
  1. Theoretical part: 5 lectures (in March)
     - Presence at the theoretical lectures is **highly recommended**
       - but not obligatory
  2. Practical part
     - Content: design and implementation of the visual analytics prototype
     - **Presence at 3 student presentations IS OBLIGATORY for all students**
     - Presence at 4 progress reviews is optional (but recommended)
       - Attendance at progress reviews requires notification to lecturers per email!
Structure of the Course

• Theoretical part: lectures
  ▪ Topics directly related to the projects
  ▪ Main results
    • acquisition of knowledge necessary for the practical part
    • D1 - Literature summary paper (each student works separately)

• Practical part: design and implementation of a demo (in teams of 4)
  ▪ Main results
    • D2 - Design of the VA user interface (in teams)
    • D3 - Review of another team’s design (in teams)
    • D4 - demo implementation (in teams)
    • 3 student presentations (corresponding to deliverables D2, D3, and D4)
      – Including questions and discussion with the lecturers
Structure of the Course

5 theoretical lectures:

1. Intro + Visual perception and visual encoding
2. Visualisation of multi-dimensional time series data
3. Visualisation of text corpora (incl. intro to data analytics)
4. Visual search and guided analytics
5. Visual exploration of (social-semantic) networks + Visualization using immersive technologies

5 topical areas for the practicals (in bold, above):

• Scientific literature provided for each topical area
  ▪ introduced in the corresponding theoretical lecture
  ▪ necessary for writing a paper summary
  ▪ useful for designing your visual analytics prototype
Submission of 4 deliverables by the students

1. D1: Literature summary paper
2. D2: Design of the visual analytics interface
3. D3: Review of interface design of another student team
4. D4: Demo implementation

• All submissions via TeachCenter:
  - D1 submitted by each student separately
  - D2, D3 and D4 submitted by teams (4 students per team)
Student Presentations

3 presentations held by the students:

1. Design of the visual analytics interface
2. Review of interface design of another student team
3. Presentation and live demo of the implemented prototype

- All teams members must attend the presentations
  - and all team members must talk and present
  - if someone cannot attend due to a valid reason, e.g. sickness, we will try to find another appointment
Materials and Infrastructure

- **TeachCenter**: [https://tc.tugraz.at/main/mod/folder/view.php?id=15064](https://tc.tugraz.at/main/mod/folder/view.php?id=15064)
  - Lecture slides
  - Scientific literature for the 5 topical areas
  - File and data exchange
  - Team Registration
  - Presentation slot reservation
  - Student submissions

- **Course Homepage**: [http://kti.tugraz.at/staff/vsabol/courses/va](http://kti.tugraz.at/staff/vsabol/courses/va)
  - Course description
  - Links to lecture slides and external resources
  - Project overview

**Contents** (TeachCenter, Homepage) to be refreshed by **15.03.2020**!
- will be extended over the course of the lecture
Materials and Infrastructure

• Lecture slides
  ▪ links also available on the lecture homepage

• Literature repository
  ▪ papers for students to read and summarize
  ▪ separate for each of the 5 topical areas
    • introduced in the corresponding theoretical lectures
  ▪ available on the TeachCenter

• Newsgroup: tu-graz.lv.va
  • News server: news.tu-graz.ac.at
  • Newsgroup is the preferred way of communication for this course
  • There is no tutor, your questions will be answered by the lecturers
Course Content
Motivation

• Creation of huge amounts of data
  ▪ Unstructured and semi-structured data: text, images etc.
    • news, enterprise documentation, scientific publications, patents etc.
    • resources described by rich metadata
  ▪ Network data
    • Highly structured: hypertext, social networks, semantic knowledge bases
  ▪ Time series data
    • sensor measurements, logs, event series, health histories
  ▪ Multi-dimensional data sets
    • tabular data sets, large number of columns (dimensions)
  ▪ Visual Search and Guidance
    • Visual specification of data patterns for search and comparison
    • Intelligent guidance of users for interactive exploration
Goals of the course

• **Goal:** learn basics on automated data analysis
  ▪ Short intro to Knowledge Discovery Process
  ▪ Processing chain involving: selection, preprocessing, transformation, mining and interpretation of data

• **Goal:** learn how to Involve humans in the analytical process
  ▪ Visual Analytics
  ▪ Use visualisation to support analysis of complex data
  ▪ Combining visual and automatic analysis methods

• **Goal:** learn how to apply Visual Analytics methods
  ▪ on different types of data
  ▪ in selected scenarios
  ▪ using Web and immersive technologies
Goals of the course

- **Goal**: learn about methods for understanding complex data
  - Document repositories and search results
  - Graph data: social networks and semantic knowledge bases
  - Sensor and event data collected by mobile devices
  - Multidimensional data: data elements described by many different features

- **Goal**: learn about presenting data and content with visual means
  - In a suitable, easy to understand way
  - Visual search and user guidance
  - Using Web technologies (primarily HTML5) and immersive technologies

- **Goal**: comprehend data as an object of interactive analysis
  - Knowledge Discovery basics (also known as data mining): algorithmic analysis
  - Visual techniques for representing specific data types
  - **Visual Analytics**: application of algorithmic and visual methods for interactive data analysis
Non-Goals (VU 706.720)

- VA is not about
  - Web programming, Web frameworks, service-oriented or enterprise architectures
  - user interface design and human-computer interaction
  - in depth discussion on knowledge discovery and information visualization

- For some of those topics see
  - 706.704 Web Technologies
  - 706.052 AK Informationssysteme (WS)
    - also deals with J2EE, architecture of Web applications, Data Warehousing etc.
  - 706.057 Information Visualisation
  - 706.301 and 706.311 Interacting with Computers 1 and 2
  - 707.003 and 707.004 Knowledge Discovery and Data Mining 1 and 2
Topics of the course

• Visual exploration of sensor and time-oriented data
  ▪ Scalable visualization of multiple sensor channels
  ▪ Search interfaces and interactive exploration of sensor data
  ▪ Aggregation and clustering of sensor data

• Personalised interfaces for high-dimensional data
  ▪ Multi-visualisation interfaces and coordinated multiple views
  ▪ Visual metaphors for multidimensional data
  ▪ Automated personalized visualisation
Topics of the course

• Introduction to automatic data analysis
  ▪ Knowledge Discovery (KDD) process
  ▪ Discussion of selected data mining algorithms (e.g. clustering, projection etc.)
  ▪ Applications on text, graph and sensor data

• Visual Analytics for text data and search results
  ▪ Interfaces for exploration of metadata-rich search results
  ▪ Dimensionality reduction algorithms
  ▪ Information landscape visualization
  ▪ Identifying dominant patterns
  ▪ Relatedness analysis
Topics of the course

• **Search Interfaces and Guided Visualization**
  - Sketch- and example based interface for pattern specification
  - Visual comparison of search results
  - Eye tracking as UI modality
  - Search-based recommending and relevance feedback
  - View quality measures for exploration guidance
Topics of the course

• Explorative Visualization of Network data
  ▪ Visualization of social networks and semantic databases (ontologies)
  ▪ Graph layout and clutter reduction techniques
  ▪ Interactive techniques for graph navigation

• Immersive and Mobile Visualisation
  ▪ Visualization metaphors for mobile devices
  ▪ Immersive analytics and multimodal interaction models
  ▪ Blending physical and virtual environments
Examples
Example - Geovisualisation

- Which is the happiest city in the USA?
- Sentiment detection to extract “happiness” from geo-tagged tweets
- Geo-visualisation with colour coding to convey “happiness”
Example – EEXCESS Recommendation Dashboard

- **Multiple visualisations**
  - Timeline
  - GeoView
  - BarChart
- **Filtering of recommendations**
- **Organising recommendations in collections**
Example – uRank

- Content-based exploration of recommendations
- Significantly easier to use than list scanning

1. Pick keywords
2. Change weights
3. Re-ranking of documents
4. Inspection: highlight keywords in content

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Example - WebGraph

- Extract entities (NLP) and relationships (co-occurrence) from text
- Graph visualisation showing semantic relationships
  - Icon and colour coding for relation and node types, edge bundling reduces clutter
  - Interaction: focused navigation using “blossoms” (see Chile)
Example – Adaptive Visualization

- Automatic visualisation of tabular data sets
  - Suggestion and configuration of visualisations depending on data characteristics, personal preferences
- Filtering and Aggregation
- Interactive analysis over multiple data dimensions
  - Multiple coordinated views technology
Example – Time Series Visualization

- Visual comparison of large time series
  - Long and many series
  - From Line Charts to Pixel-displays
- Adaptive representation
  - Pixel-oriented display
  - Scale grid per interestingness of data segment
  - Alignments for comparing multiple series
- Results
  - Applied on stock market data
  - Spot interesting data sections
  - Drill-down exploration
Example – Time Series Visualization

- Feature-based similarity function for time series curves
- Overviewing of time series shapes using Self-Organizing Map algorithm
- Retrieval using example data or query editor
Example – Time Series Visual Retrieval

- Visual retrieval in scatter plot spaces
- Sketch interface to query for patterns of interest
- Online matching searches candidates after each stroke
- Shape suggestions on the fly
Example – Eye Tracking-based Data Exploration

- Eye tracking to monitor user attention
- Learning user interest from gaze points
- Recommendation
  - Dissimilar views to guide overview of search space
  - Refine search
Example - Virtual / Augmented Reality

rendered data

video image

rendered data registered over video image
Example - Industrial applications: Monitoring & inspection
Augmentation Technology

head mounted
handheld
projector

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Deliverables
Student Submissions

Theoretical, design, review, and implementation work

4 deliverables:

- D1: Literature summary paper (PDF)
- D2: Design of the visual analytics interface (presentation slides)
- D3: Review of interface design of another student teams (PDF, slides)
- D4: Demo implementation (incl. sources, code docu and report)
Student Submissions

REMEMBER:

- **D1**: each student works separately
  - Submission is per student
- **D2, D3, and D4**: team work in **groups of 4 students**
  - For D2 and D4: each team chooses **1 topical area** presented in lectures
    1. Visualisation of multi-dimensional time series data
    2. Visualisation of text corpora (and search results)
    3. Visual search and guided analytics
    4. Visual exploration of (social-semantic) networks
    5. Visualization using immersive technologies
  - For D3: you will be assigned another team’s design for review
  - Submissions are per team
Student Submissions – D1

D1: Literature summary paper (PDF)

- Task: read, summarize and discuss 1 (or more) paper(s)
  - Write a 5-6 pages summary
  - of a paper from your team’s topical area
- Deliver the paper in PDF format: a scientific paper-like document including
  - Title
  - Author
  - Abstract
  - Main content: summary of a scientific publication corresponding to your topic
  - References: scientific papers, technical reports, software libraries, data sets...
D2: Design the visual interface for your demo

- Include the intended **use case** description
- Provide a short list of **user requirements**
- Main part: produce **mock-ups** showing the design of your visualizations & UI
  - Produce mock-ups by hand or with tools (e.g. see [https://blog.prototypr.io/4-best-web-ui-mockup-tools-for-free-89a1513c3fcd](https://blog.prototypr.io/4-best-web-ui-mockup-tools-for-free-89a1513c3fcd))
- **Implementation plan**: tasks, technologies, time estimates, group member responsibilities
- Deliver in the form of a slide presentation (PowerPoint or similar)
D3: Review of interface design of another student team

- **Main part:** review of the design presented by another team **according to**
  - **Visual perception and visual encoding guidelines** presented in the 1st lecture
  - **Well-known usability heuristics** for
    - **user interface design**
    - **visualization design**
  - Provide suggestions for improvements to your colleagues

- Lecturers will provide you with another team’s design-slides
- Deliver in the form of a PDF document and slide presentation
Student Submissions

• D4: Implementation of a **prototype for visual data analysis**
  - **Source code**
  - Code **documentation** (in the sources)
  - **Working demo** (binaries)
  - Short **project report** (PDF)
    - Motivation and goals: which problem you are solving for the chosen data
    - Design of your solution: mock-up images and user requirements
    - Description of your implementation: methodology, algorithms, tech. details
    - Use case description: how your demo is used to perform data analysis
    - Discussion and outlook: what worked well, what could be improved

➤ **Note: in the theoretical lectures you will receive**
  - ideas for project implementation incl. related scientific literature
  - software frameworks to use
  - data sets to analyse
Student Presentations
1 - Visual Design Presentation

- 1st mandatory presentation
- Goal: present the design of the visualization interface
  - explain and justify your design decisions
    - based on the available literature (TeachCenter)
    - include an implementation plan (what, how, by when, and by whom)
- Receive feedback from the lecturers
  - feel free to ask anything
- Expect questions related to
  - your visual design and the demo idea
  - corresponding scientific literature (for the State-of-the-Art summary paper)
- Finalize the content and scope of your demo implementation
  - leave with a “contract” specifying what you will be implementing
1 - Visual Design Presentation

• Duration: 15 minutes per team
  ▪ Short presentation using slides: 5 minutes (strict)
  ▪ Discussion with lecturers: ca. 10 minutes
• When and where
  ▪ **21.04.2020** from 10:00 to 12:00
  ▪ in Seminarraum CGV (ID02104), Inffeldgasse 16, 2nd floor
  ▪ additional appointment might be necessary due to a large number of teams
    • place and time to be announced!
• **All team members must attend and present**
• Time slot reservation in TeachCenter
2 - Design Review Presentation

- 2nd mandatory presentation
- Goal: present your feedback to the design of another team
  - justify it
    - based on the well-know design guidelines and usability heuristics
  - provide suggestions for improvements
- Receive input from the lecturers on your review
- Expect questions related to
  - visual design guidelines and usability heuristics
2 - Design Review Presentation

- Duration: 15 minutes per team
  - Short presentation using slides: 5 minutes
  - Discussion with lecturers: ca. 10 minutes

- When and where
  - **28.04.2020** from 10:00 to 12:00
  - in Seminarraum CGV (ID02104), Inffeldgasse 16, 2nd floor
  - additional appointment might be necessary due to a large number of teams
    - place and time to be announced!

- All team members must attend and present

- Time slot reservation in TeachCenter
Progress Reviews

- Progress review(s) - optional participation
- Goal: brief report on how your implementation work is proceeding
  - Discuss issues you have encountered
  - Obtain feedback, ideas and tips from the lecturers
- When and where
  - 05.05., 12.05, 26.05. and 16.06.2020 from 10:00 – 12:00
  - HS i9, Inffeldgasse 13, ground floor
  - Optional: requires a prior email notification to the lecturers
3 - Final Presentation and Demo

- 3rd **mandatory** presentation
- Goal: presentation of your implementation results
  - A few slides
    - Motivation: what problem did you address (and why)
    - Solution description
      - Methods: how you addressed particular problems?
      - Implementation: how did you implement the demo (architecture, libraries etc.)?
- Discussion:
  - advantages/disadvantages of your approach
  - what went well, what were the difficulties?
  - what would you add if you had more time?
- **Live demo**: show your implementation in action
3 - Final Presentation and Demo

• Duration: 15 minutes per team
  ▪ Presentation and live demo: **max. 10 minutes** (sharp)
  ▪ Oral exam: 5 minutes
    • in the form of question answering and discussion of results

• Expect questions on
  ▪ appropriateness and quality of the resulting visual data representation
  ▪ interaction techniques and usability considerations
  ▪ implementation details

• Important for a good mark
  ▪ Argue why you did something (the way you did it)
  ▪ Discuss advantages/disadvantages and possible improvements
3 - Final Presentation and Demo

- When and where
  - **23.06.2020** from 10:00 to 12:00
  - in HS i9, Inffeldgasse 13, ground floor
  - additional appointment might be necessary due to a large number of teams
    - Place and time to be announced!

- **All team members must attend and present**

- Time slot reservation in TeachCenter
Timetable
Course Calendar

Theoretical block

• 03.03.2020
  ▪ Intro: Course organisation and schedule, examination mode, topics overview (Vedran)
  ▪ Visual perception and visual encoding (Eduardo)
• 10.03.2020: Time series visualization (Tobias)
• 17.03.2020: Text visualization, incl. short intro to data analytics (Vedran)
• 24.03.2020: Visual search and guided analytics (Tobias)
• 31.03.2020
  ▪ Graph and network visualization (Vedran)
  ▪ Visualization using immersive technologies (Eduardo)
Practical block

- **21.04.2020**: Design of the visual interface – student presentations
- **28.04.2020**: Design review of another team’s interface – student presentations
- 05.05., 12.05., 26.05., 16.06.2020 progress review and discussion
  - Optional - please announce your attendance per Email to lecturers!
- **23.06.2020**: Final project presentation and live demo of the prototype

**REMEMBER:**

- Presentations on 21.04, 28.04 and 23.06. are obligatory for all students
Deadlines

• **VU registration in TUG online: until 20.03.2020**
  ▪ Lecturers can register you for the course after that (write an email)

• **Team Building (4 persons per team): 21.04.2020**
  ▪ Team registration in the TeachCenter
  ▪ Include your team name and member information
  ▪ You will receive a team number

• **Submission D1 - State of the art summary paper: 21.04.2020**
  ▪ PDF document (each student submits separately)

• **Submission D2 - Design of the visual analytics interface: 21.04.2020**
  ▪ Presentation slides (one submission per team)

• **Submission D3 - Review of interface design of another team: 28.04.2020**
  ▪ Presentation slides (one submission per team)

• **Submission D4 – Demo implementation: 23.06.2020**
  ▪ Zip file that includes: implementation code, documentation, project report
    (one submission per team)
Grading and Exploitation
Grading

• Weighting of student contributions
  ▪ Summary paper: 20%
  ▪ Visual design (incl. presentation): 15%
  ▪ Review of other team’s design (incl. presentation): 10%
  ▪ Prototype implementation: 40%
  ▪ Final project presentation and answering questions: 15%

• Grading
  ▪ 0 – 50: 5
  ▪ 51 – 62: 4
  ▪ 63 – 74: 3
  ▪ 75 – 87: 2
  ▪ 88 – 100: 1
Exploit your Project Results

- Develop your Visual Analytics projects further
  - as Bachelor or Master’s Thesis
  - as contribution to EU or national research projects
  - open-source the code base
  - perform usability evaluations
  - possibility for scientific publication (if results adequate)
Questions?