Introduction to Visual Analytics

What is Visual Analytics and why it is needed

Visual Analytics

- Is the science of analytical reasoning ***facilitated by interactive visual interfaces***
- Has an analytical reasoning process carried out by human to derive a decision
- Involves **Interaction** with **visual representation** of data that **changes the course of action**.
- Aims to reach ***the best/a good decision fast*****.**

Visual Analytics

- Is needed in many areas such as
  - Security (Physical, Cyber, Bio, etc)
  - Health
  - Financial
  - Environment
  - Education
- Is needed when the decision makers need to make a good/the best decision fast.

Visual Analytics needs Interactive Visualization

- **Visualization** :
  - converting data to pictures/images
- **Interaction** :
  - methos to alter/enhance the visual representation based on a new query

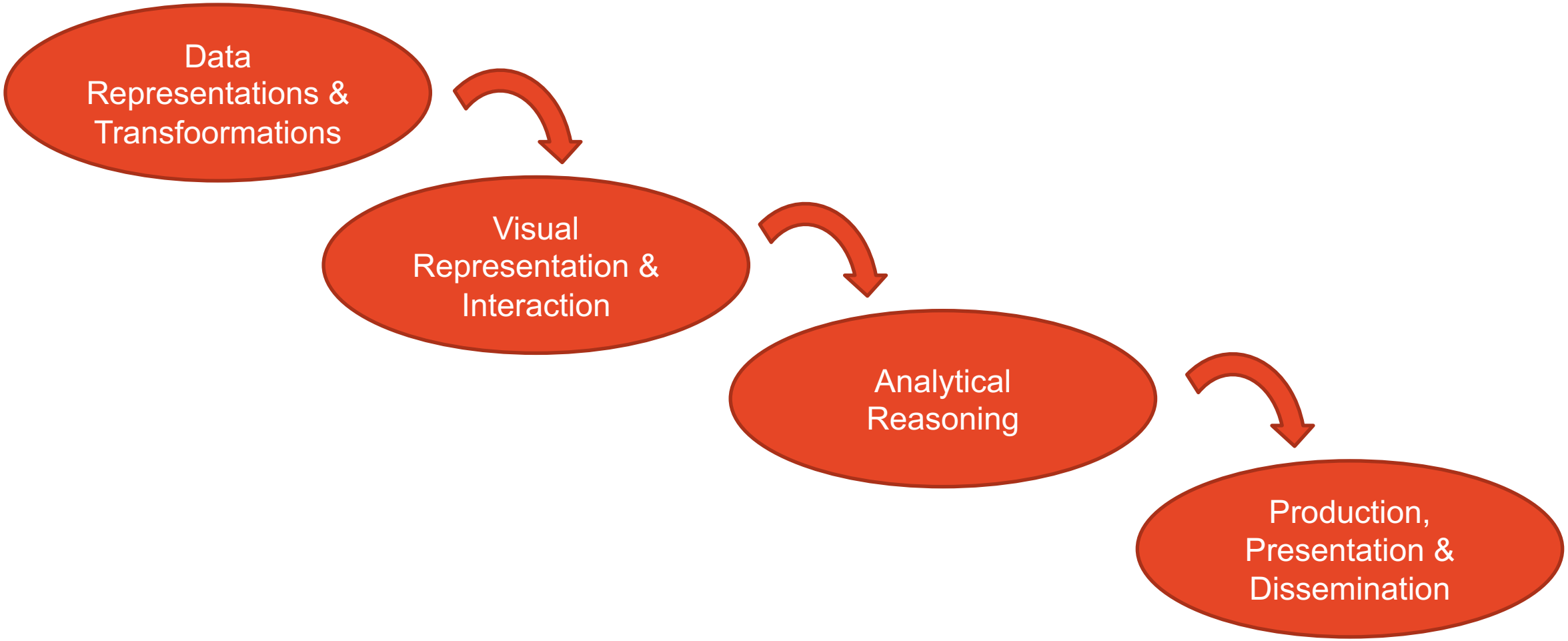
Both need to be

- driven by theory-based computational tools :
  - Data Types, Semiology of Graphics
- based on cognitive, design and perceptual principles
  - Human Visual Systems, Human-Computer Interaction, Gestalt Theory

Elements of Visual Analytics

- Analytical Reasoning
- Visual Representation & Interaction
- Data Representations & Transformations
- Production, Presentation & Dissemination

Visual Analytics Pipeline



Conclusion

- Visual Analytics
  - Interactive visual interfaces guides analytical reasoning process
  - Encompasses:
    - Analytical reasoning process
    - Visual Representations and Interactions
    - Data Representations and Transformations
    - Production, Presentation and Dissemination

Analytical Reasoning

Methods to obtain deep insights

Analytical tasks

- Understand past and present situation (including trends/events lead to the current situation) ***quickly***
- Ascertain the sign of **alternative** futures and warning signs
- Monitoring of emerging events (including **unexpected** events)
- Etc. (other tasks which influence the decision making process)

Role of Visualization in Analytical Reasoning

- Increased resources
- Reduced search
- Enhanced recognition of patterns
- Perceptual inference
- Perceptual monitoring
- Manipulable medium

Conclusion

- Analytical Reasoning
  - Assessment
  - Forecast
  - Develop hypotheses / options

- Visualization facilitate the analytical reasoning process

Visual Representation & Interaction

Allows to see/explore/understand a lot at once

Principles for depicting information

- Appropriateness Principle
  - *The visual representation should provide neither more nor less information than that needed for the task at hand*
- Naturalness Principle
  - *Experiential cognition is most effective when the properties of the visual representation most closely match the information being represented*
- Matching Principle
  - *Effective visual representations should present affordances suggestive of the appropriate action*
- Principle of Congruence
  - *the visual representation should represent the important concepts in the domain of interest.*
- Principle of Apprehension
  - *The structure and content of a visualization should be readily and accurately perceived and comprehended*

Designing Visualization

- Bertin (French cartographer) developed a system for characterizing visual representations (Semiology of Graphics)

- Semiology of Graphics has been used to define various design space
  - Mackinlay (1986), MacEachren (1995), etc.

- Taxonomies of visual techniques
  - Shneiderman (1996), Spence (2000), Ware (2000)

Interaction in Visualization

- Filtering : modifying data transformation through interaction
- Visual mapping: modifying visual representation through interaction
- Navigation: moving through data space through interaction
  - Selection, panning, zooming, etc.
- Human-info discourse: analytical process through interaction
  - Interactions for comparing, categorizing, extracting, recombining data,
  - Creating/testing hypotheses, annotating data

Conclusion

- Theoretically founded visual representation and Interaction design leads to the effective analysis.

Data Representations & Transformations

Convert data into forms that facilitate analytical process

Data Representations

- Structured forms suitable for computer-based transformations
- Original structures might not be easily mapped to visual representations
  - May require transformation
- Data representation may influence the design of interactive visualization

Characteristics of Data Representations

- Data type :
  - numeric (numbers) vs non-numeric (text/language)
- Levels of structure:
  - structured (easy to computationally represent) vs unstructured (human usually interpret)
  - Text, image, video
- Geospatial:
  - georeferenced numeric (physical measurement) vs non-numeric data (e.g. political boundaries)
- Temporal: data may change over time

Data Transformations

- When the original data representation is not appropriate for visualization
- Data may need to be converted into different representations
  - To Structured
  - So that they are easily mapped to visual representations
  - Based on a mathematically defined conversion process

- Examples:
  - High-dimensional data to Low-dimensional data (easy to display on the screen/paper)
  - Derive statistical characteristics of the data
  - Applying computational linguistic analysis, etc.

Conclusion

- If it’s necessary, the original data should be transformed into different representations so that:
  - Easily mapped to better visual representations,
  - Suitable to be manipulated through interactive interfaces.

Production, Presentation & Dissemination

Present and consume Visual Analytic results

Production

- Is the process of summarizing the results obtained through the analytical processes.

- All the processes and configuration of tools/applications are finalized
  - You can repeatedly produce the same result by applying the same process.

Presentation

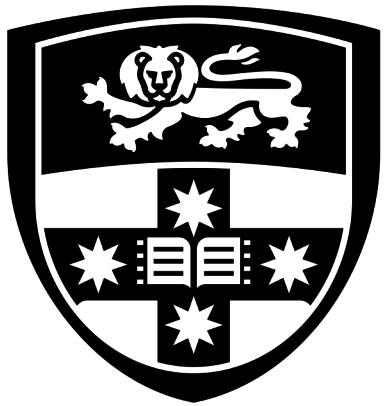
- All the results produced by the “Production” process are packaged together to form an contextualized artifact meaningful to the target audience

Dissemination

- Packaged presentation needs to be efficiently shared and circulated among all the relevant parties.

Conclusion

- Production, Presentation and Dissemination aim to inform a wide variety of audiences (including decision makers and even public) the analytical results in efficient manner.



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