Detecting Insight and Emotion in Visualization Applications with a Commercial EEG Headset

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• Emotiv EPOC
• EEG-based Detection of Emotions
• Pilot Study
  – Visual Insight Problems
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• Conclusions
• Insight, Aha! moment, epiphany...

  – Isaac Newton - a moment of clarity when he observed an apple falling from a tree ➔ theory of gravity

  – Friedrich August Kekule von Stradonitz - the ring-like structure of benzene
Motivation

- Insight in psychology, cognitive neuroscience...
- “The purpose of visualization is insight, not pictures” - Ben Shneiderman (1999)

- Why? Use insight to evaluate and compare visualization techniques
- How? Defining insight objectively, measuring the number of insights
- Indirect detection of insight through emotions
  - Correlation between emotions and insight?
Motivation

Infosquito, Futurama TV series
Emotiv EPOC Headset
Study

- detect facial expressions and emotional states
- considered emotions: engagement, excitement, satisfaction and frustration
- validation and measuring emotions in spot-the-difference tasks and computer games
Pilot Study

- Six participants
- Four tasks:
  - 2 visual insight problems and 2 information visualizations
- The difference:
  - single solution-single insight; multiple insights possible
Pilot Study

- Comparing the moment of insight with the emotional states prior and during the discovery
  - frustration - 2 min before, excitement - 10 sec before

- Insights confirmation – verbal and post-task questionnaire
Visual Insight Problems

- Eight Coin Problem and Matchstick Arithmetic

- 12 possible insights - 7 solutions
Visual Insight Problems

- **Correlation**
  - 29% error for detection of insight
  - 20% for false detection of insight

- **Post-task questionnaire** – to confirm insight
ManyEyes Visualizations

Population
- 1,000 M .. 1.2 B +
- 800 M .. 1,000 M
- 600 M .. 800 M
- 400 M .. 600 M
- 200 M .. 400 M
- ≤ 0 .. 200 M

Users
- 100 M .. 120 M +
- 80 M .. 100 M
- 60 M .. 80 M
- 40 M .. 60 M
- 20 M .. 40 M
- ≤ 0 .. 20 M
ManyEyes Visualizations

- **Depth of insights:**
  - trivial insights that include direct observations of one data type
  - combination of multiple data types or insights about a process
  - new hypotheses about the underlying information

- **2 visualizations**
  - data about global demographics and social media
  - stacked graph and cartographic visualization
Many Eyes Visualizations

- Time – key factor
- Deep insights are more likely to generate emotions (f+e)
• Questionnaire
  – low complexity and was “easy to find” – keyword *unexpected*
Future Work

- New EEG-based tests for evaluating and comparing different visualization techniques
  + relative value of the insight to the person

- Data tagging and binding based on the interactions the user executed shortly prior and during the moment of insight

- Direct detection of insight
Conclusions

• Insights in visual tasks have the potential of generating emotional responses

• EEG measurements are capable of detecting these emotional states

• Most accurate detection of insight:
  – presence of frustration / effort / deadlock
  – importance to the user – through complexity, domain, direction
  – thinking time
Thank you.

Questions?
Comments?
Suggestions?