Automatic Analysis of Large Volume Eye-tracking Data

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Our background

• PhDs in software engineering

• Focusing on analyzing human behavior in digital environments

• Personalized web group
  • http://pewe.fiit.stuba.sk
User knowledge modeling

**Funkcia CONS**

Oprácia CONS na základe dvoch argumentov: s-výrazu a zoznamu, vytvára nový zoznam, ktorého prvý prvok je s-výraz a ostávajúce prvky tvoria prvky pôvodného zoznamu.

Argumenty funkcie CONS možno opiáť tuto schémou:

\[
CONS \text{ nový-prvok zoznam}
\]

Napríklad:

\[
\begin{align*}
    & (CONS \ 7 \ (2 \ 14)) \\
    & (CONS \ (1 \ 2) \ (3 \ |4))) \\
    & (CONS \ 14 \ NIL) \\
    & (CONS \\
\end{align*}
\]

Druhý argument \(CONS\) je v tomto prípade inverzný k operáciam FIRST a REST. Môžeme to sledovať na príkladoch:

\[
\begin{align*}
    & (FIRST \ (7 \ 2 \ 14)) \\
\end{align*}
\]
User interest modeling

Google

umap

About 357,000 results (0.29 seconds)

Results provided by peweproxy:

UMAP 2010 , UMAP 2011 , umap conference

UMAP 2010 - User Modeling, Adaptation and Personalization
UMAP 2010 - 18th Intl. Conference on User Modeling, Adaptation and Personalization. ... Plan your conference schedule and share your thoughts using the UMAP ... http://www.hawaii.edu/UMAP2010/ - Cached

UMAP 2010 - Workshops and Tutorials

Homo | UMAP2009
UMAP is the most important conference for those interested in any aspect of ... The UMAP 2009 conference was held in the week of June 22nd, 2009. ... http://umap09.fbk.eu/ - Cached

UMAP Thailand Short Course 2010 | Office of International Affairs
Ian Hoskins on UMAP Thailand Short Course 2010; dizz on UMAP Thailand Short Course 2010; Elitia on Kokushikan University Exchange Program 2011 ... http://oia.ugm.ac.id/interface/?p=407 - Cached

Results for: umap

UMAP - University Mobility in Asia and the Pacific
Invitation to UMAP Participating Universities to Join the UMAP Student Connection Online [USCO] Full Features 2/2010, for student exchanges & credit ... www.umap.org - 11 hours ago - Cached - Similar

UMAP 2010 - User Modeling, Adaptation and Personalization

UMap (AS 3.0) - Advanced Flash Components
UMap API has moved. Visit UMapper to download the latest version of UMap. ... One of the
Question routing in CQAs
Deception/focus detection

• Automatically decide upon nature of human-computer interaction
  • Filling of web-based questionnaires

• How reliable are the answers?
  • Did our user pay attention to questions?
  • Did she tried to deceive us?
User interaction analysis

• Focus beyond user interface
• Analyzing all kinds of digital footprints on the Web

• Social Web
• Adaptive Web
  • Predictive Web

• We need to model our users
Machine Learning

• Where explicit rules are not applicable

• Let a program to learn dependencies/connections within data

• train/test model on available data

• use model to predict/classify new data
Machine Learning

• Supervised
  • data with labels
    • user logs + “deceiving” or “telling the truth” label
  • task: find mapping of input to output
  • classification, regression

• Unsupervised
  • task: find a structure within data itself
Supervised learning

• Describe individual observations through a set of features
  • time spent on a task / between clicks
  • average length of a visit
  • number of rated items
  • …

• Find such a combination of these features (using a learning algorithm) that would produce minimal error in classification/prediction
Supervised learning – features and labels

• Which features to choose?

• How many of them?

• How many labeled observations do we need?
  • Acquiring them requires human effort
Unsupervised learning

• We do not need labelled data
  • that means we can use tons of them for our model

• We are looking for an implicit structure/connections present within data
  • cluster, groups
Unsupervised learning

• We do not need labelled data
  • that means we can use tons of them for our model
• We are looking for an implicit structure/connections present within data
  • cluster, groups
• We can “learn” features which are suitable for supervised learning
  • This is how humans are learning things!
How do we know that all these are chairs?
Low level features of an object
Artificial Neural Networks
GoogLeNet
Deep Learning learns layers of features
User interaction data analysis

• gaze data – which features?
  • AOIs, sequences

• how to evaluate gaze data of several users?
  • identify outliers - users or interaction segments
  • compare/cluster interactions data

• provide efficient representation to supervised learning algorithms
  • higher level features
Our approach

• Stochastic generative model
  • Restricted Boltzmann machine
  • Input: gaze data (sliding window)
  • Output: binary vector (dimension 200)

• Clustering of resulting binary vectors
  • Hamming distance
Input to the network – a heatmap
Patterns of user interaction

8 participants

12 most frequent clusters
User eXperience @ FIIT STU

**UX Lab**
- Emotion detection
- 300 Hz Tobii eye-tracking
- 3D depth camera
- ECG, GSR, FSR, °C
- EEG Emotiv

**UX Class**
- 20x
- 60 Hz Tobii eye-tracking
- 3D depth camera
- Emotion detection

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PeWe@FIIT
personalized web group
UX Lab

• Observing emotions on multiple levels:
  1. Sensors on the neuro-level (brain) (EEG)
  2. Sensors on the physiological level
     ECG, GSR, FSR, °C
  3. Visually, using software
     analysis of facial features
     from HD and depth camera streams

Happy, Sad, Angry, Surprised, Scared, Disgusted

Creative Senz3D
UX Class

• Run experiment with 20 participants in parallel
  • stable conditions

• Computer class with technology of future
  • Support of learning using personalized web-based educational systems

• 20x PC with sensors (eye-gaze, cameras, ...)
  • Observing and adapting to the way how students work/use: keyboard, mouse, eye-gaze, emotions
Observation in dynamic web applications
Specifying AOI (area-of-interest)
Our gaze-data related projects

• Analyzing User Gaze on the Web
  • which parts of a web page were really read

• Deception detection
  • web-based questionnaires

• Enhancing crowdsourcing precision by taking into account gaze data
  • which other options were considered
Conclusions

• Unsupervised machine learning for modeling user interaction data (including gaze data)
  • get a higher-level representation of an interaction
  • build a prediction/classification on top of that
  • quickly filter-out interesting data

• Infrastructure
  • Detailed observations in UX lab
  • Parallel experiments in UX class