UNIVERSITY OF
EASTERN FINLAND

22.1.2018

Thesis topics

Pasi Fränti

Machine Learning Group
School of Computing
University of Eastern Finland
Joensuu, FINLAND

Web mining

Automatic creation of web page

Input: Mopsi services

Output: Simple web page

Motive:
- Mopsi data easy to create.
- Automatic. Decent outlook.

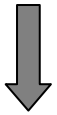
Data:
- Sample photos
- Address
- Map
- Description

Started JS

Closest existing solutions:
- CMS: Drupal, wordpress
- https: //joensuunyt.wordpress.com/
- https: //vintagejoensuu.wordpress.com/

Title : Pizza Master
Keywords : cheap, student, best, pizza
Description : Pizza and kebab restaurant
Address : Niskakatu 2, 80100 Joensuu

Photos :



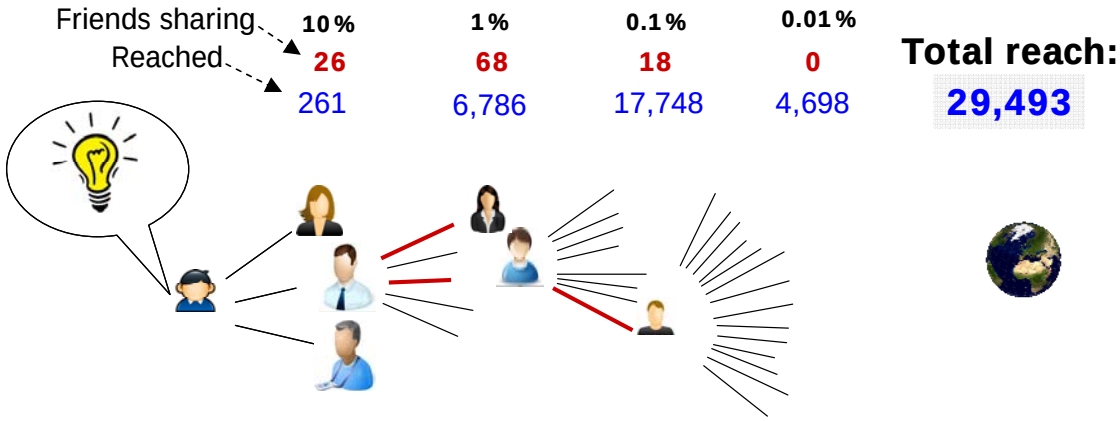
Pizza Master

Pizza and kebab restaurant

- Cheap
- Student
- Best
- Pizza

Niskakatu 2, 80100 Joensuu

Ad hoc and social networks analysis



1. Ah hoc -verkoston luominen eri informaatiosta.

Käyttäjien välisestä kommunikoinnista (on relaatio), tai heidän käyttäytymisestään (ovat usein samaan aikaan samassa paikassa). Pelkästään sijainnista ja aikainformaatiosta voi päätellä jotain jos dataa tarpeeksi.

2. Verkoston hyödyntäminen markkinoinnissa.
Informaatioteoreettisempi näkökulma. Mikä on kustannus että saadaan informaatio henkilöltä A henkilölle B? Voidaan laskea myös hyötyfunktio, jolloin voidaan mallintaa ihmisten saavutettavuutta verkoston kautta todennäköisyysmalleilla.

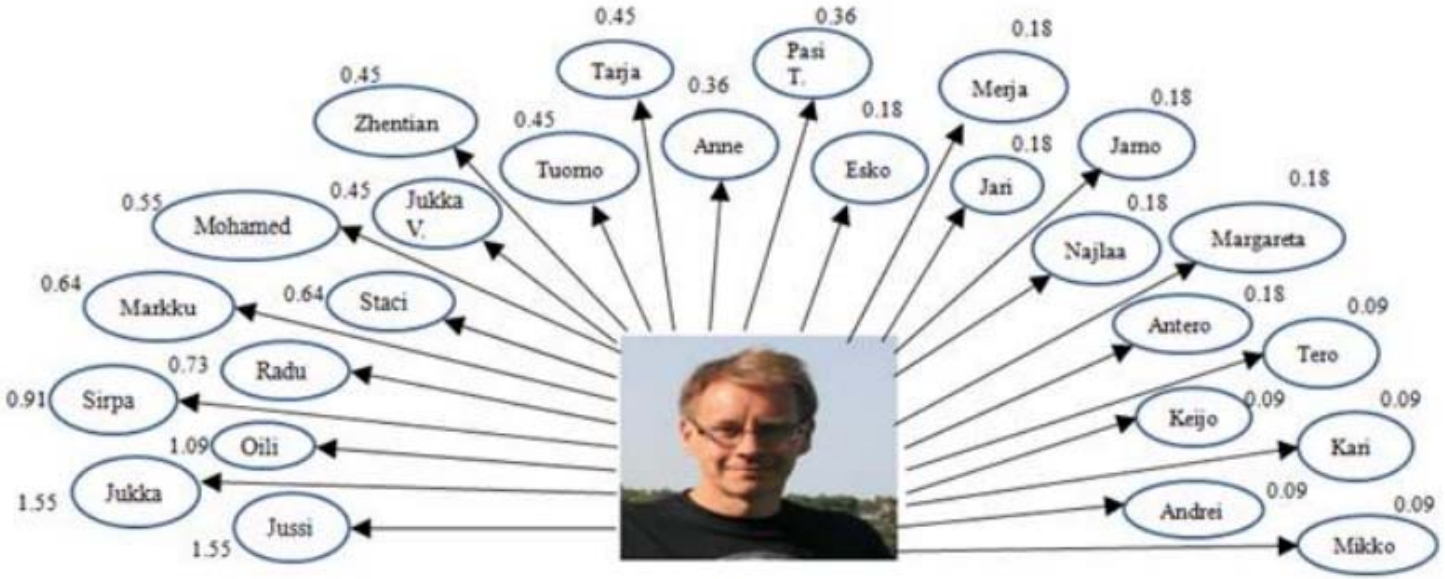
3. Sijainnin hyödyntäminen verkostossa: Sijantitiedon muuttumisen analysointi. Ensin klusteroidaan paikkakeskittymät (joissa ihmiset kulkee). Sitten segmentoidaan henkilön data ajan funktiona. Tarkastellaan muutoksia. Päätellään milloin henkilö "vaihtaa paikkaa". Informointi kavereille kamujen liikkeistä. Esim. jos Pekka saapuu Joensuuhun (yksi klusteri) sillä on merkitystä Pasille. Mutta jos Joensuussa asuva käy naapurikunnassa ja tulee kohta takaisin, ei välttämättä. Jos Joensuussa asuva saapuu tiedepuistoon (Joensuun sisällä oleva klusteri), niin voi olla jo relevanttia.

4. Verkoston analysointi: linkkien vahvuus, klusterointi, solmujen etäisyydet. Ei sen kummempia sovellustavoitteita. Mutta jos perusanalyysit osataan tehdä, näitä on helppo soveltaa ja hyödyntää monella tavalla joita ei vielä ole osannut edes ajatella.

Kantava ajatus, että täytyy konkreettisesti liittyä tähän sovellukseen. Muuten jää helposti irralliseksi ja lähtee meneen johonkin ehkä mielenkiintoiseen mutta epärelevanttiin suuntaan.

Social network in FB and Twitter

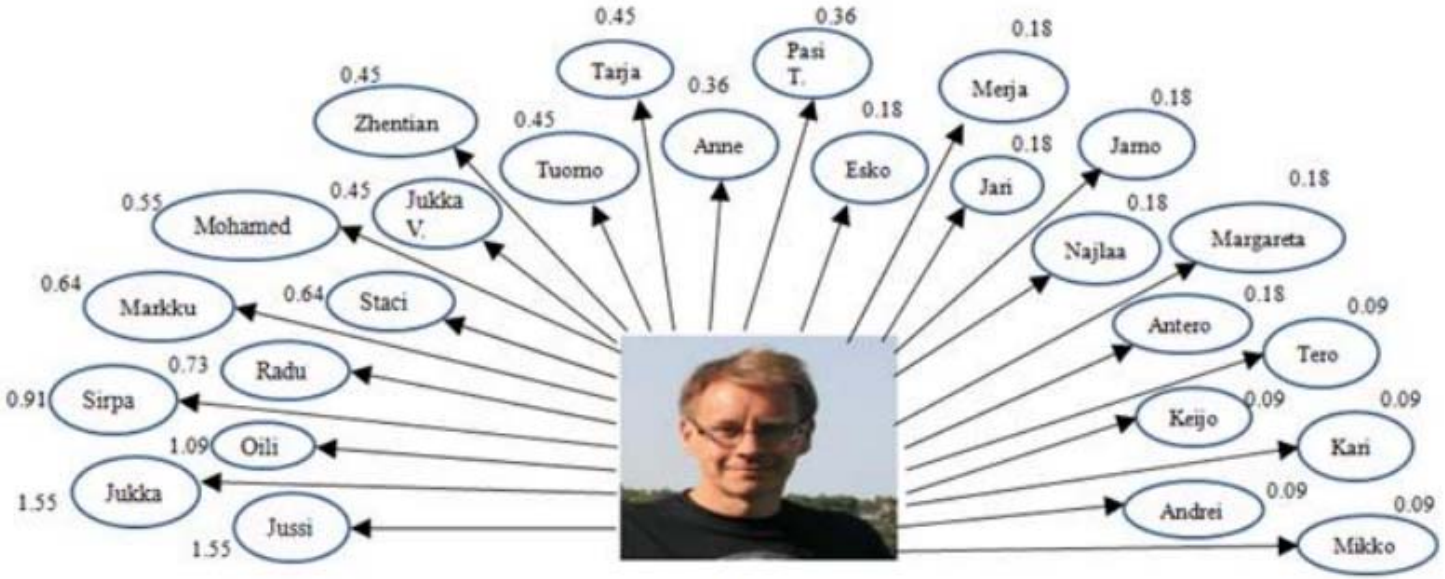
- Build Facebook/Twitter API to fetch data
- Analyze network structure (e.g. community detection)
- Analysis of user behavior, similarity
- Alternative focus on sociology theme combining user self-image and user influence.



Pasi's influence = **11.9**

Data exchange Web ↔ Facebook

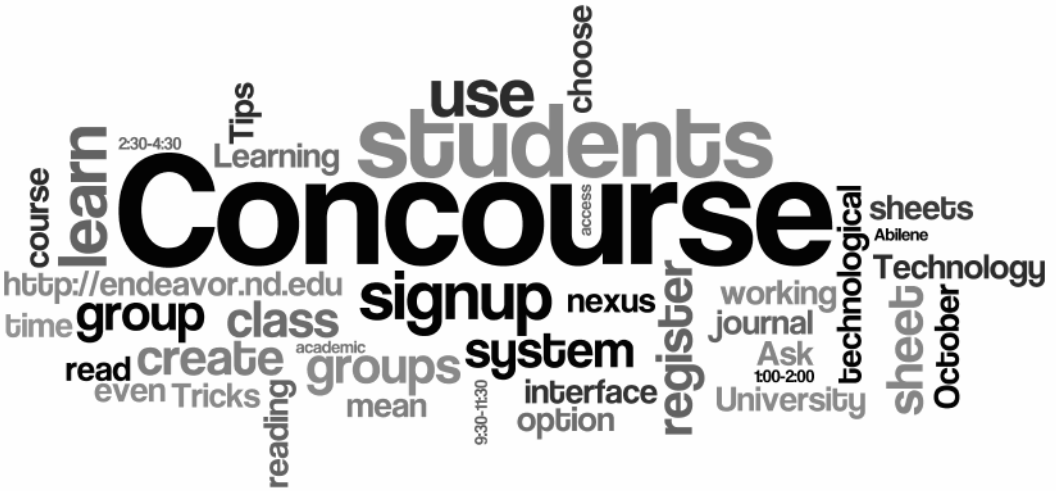
- Convert Web page to FB publications
- Convert FB content to Web page (photo albums, notes)
- Requires web mining (DOM tree, data extraction, NLP)
- Web programming and FB API skills required
- Data analysis



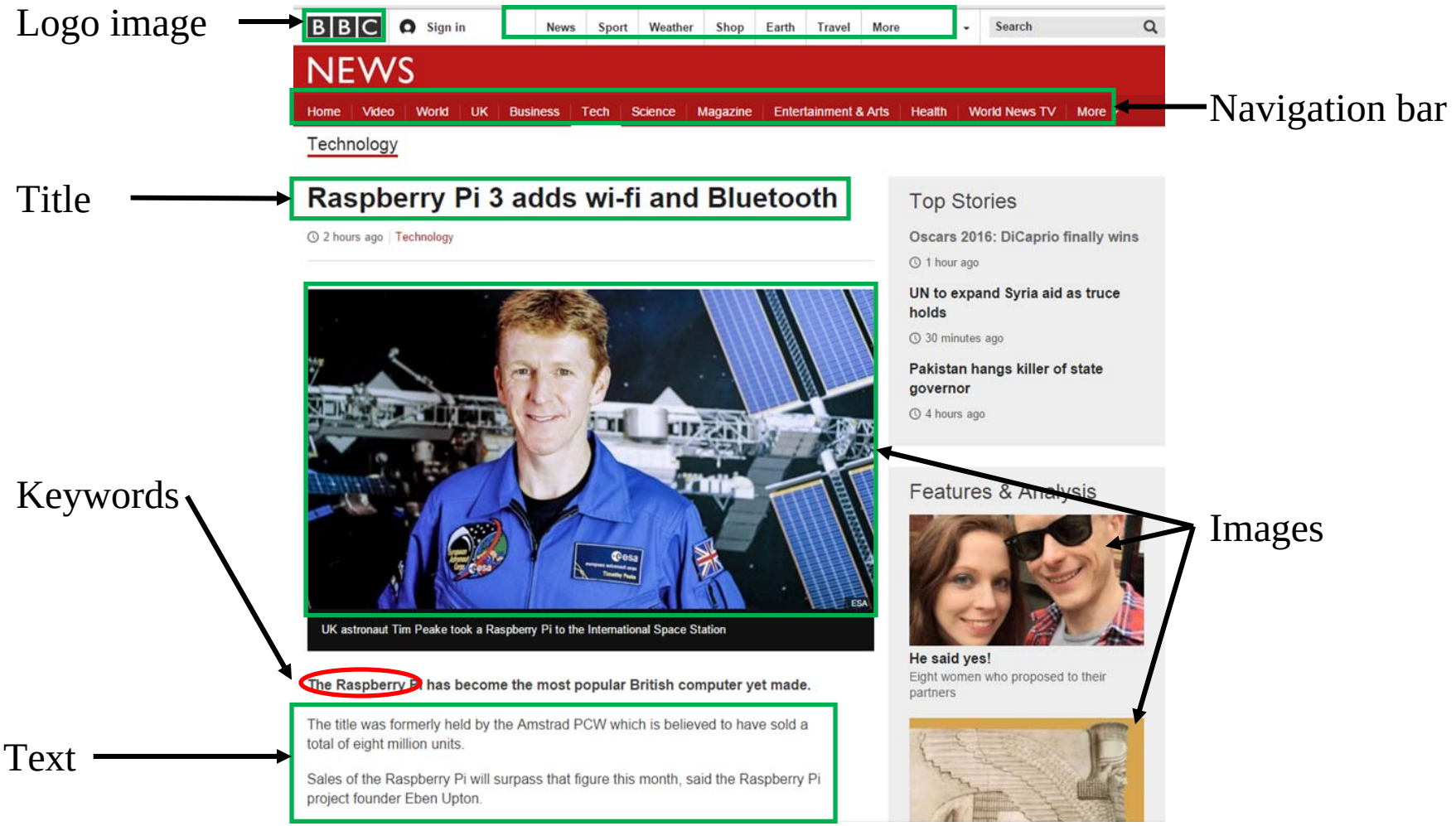
Pasi's influence = **11.9**

Word cloud from web page

- Analyze given web page
- Extract relevant keywords
- Build word cloud from the keywords
- Optional: clustering of the keywords
- Possible applications:
  - Person homepage
  - Facebook publications



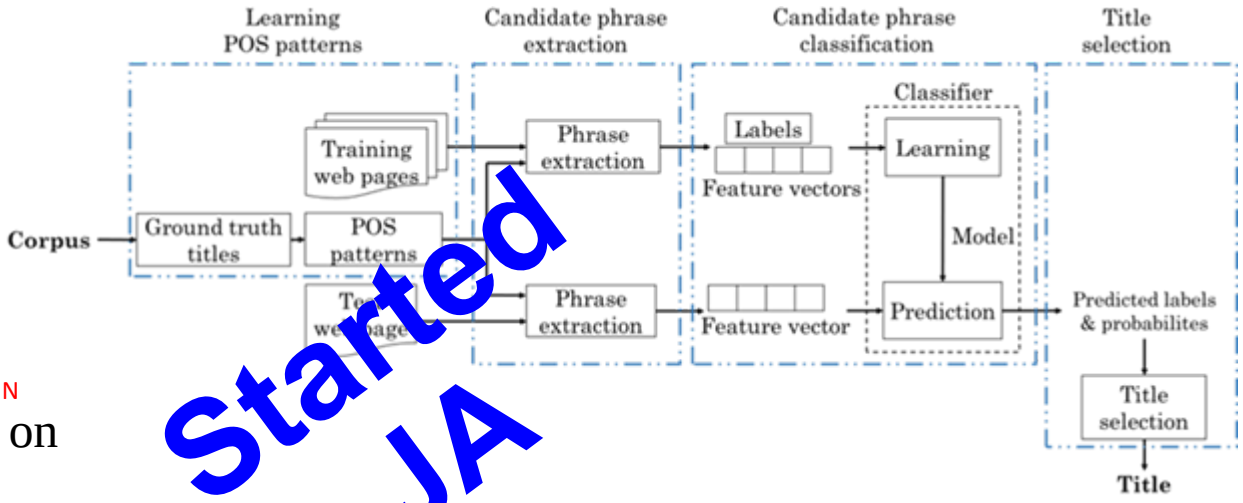
Language-independent content extraction



NLP tools for detecting tweeting Bots

4-month project available!

http://cs.uef.fi/sipu/OpenPositions-2.pdf



Started JA

NNP
Navigation

VBG NNP VB PRP IN
Feeling Social? Find us on

NNP
Facebook

NNP NNP NNP NNP NNPS NN
Sydney Waterfront Restaurant Restaurant Milsons Point

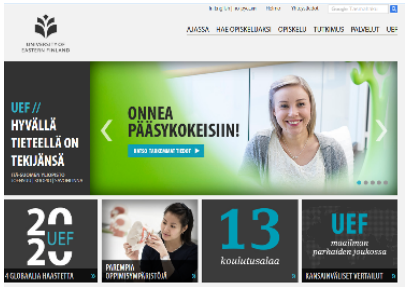
NNP NNP VBZ DT JJ NNP NN NN
Aqua Dining offers a quintessential Sydney dining experience
IN JJ NN NNS WDT NN IN NNP NNP IN DT
with unrivalled harbour views that sweep from Luna Park to the
NN JJ NNP NNP NNP CC DT NNP NNP
world famous Sydney Harbour Bridge and the Sydney Opera
NNP
House.

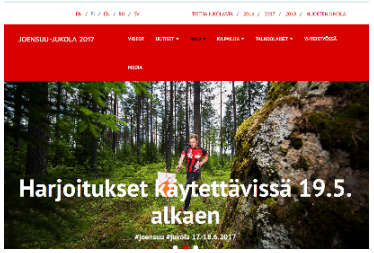
NNP=Proper noun, singular
NNPS=Proper noun, plural
NN=Noun, singular or mass
VBG=Verb, gerund
VB=Verb, base form
PRP=Personal pronoun
DT=Determiner
CC=Coordinating conjunction
JJ=Adjective

Correlation-based word similarity

Input: Two words
Output: Similarity in range 0..1

Method: use web searches to find out co-occurences of the words. Estimate similarity based on this and their total frequence w/o any language information.





Example: **Uutinen**, **news**
High similarity because same meaning despuite different language.

Detecting clusters from text phrases

Input: Given a set of geo-tagged user photos in (1) Mopsi, (2) web search.
Goal: Detect potential cluster.
Approach: Cluster first by location. Then find out whether there is dominant cluster based on their descriptions. For example, can we conclude what is in the following location?

Descriptions:

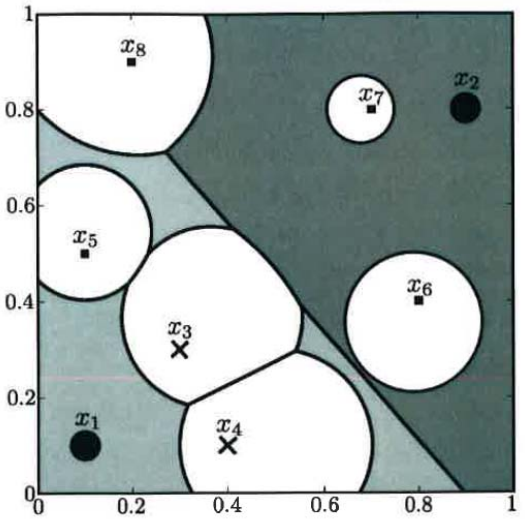
Kauppa valintatalo
Kahvila heinosen leipomo
Valintatalo kauppa
Kauppa
Kahvila Heinosen leipomo
Äijähetki salaatti - box fit!!!
Valintatalo ruokakauppa
Valintatalo
Nyt välähti
Market
Scientific Writing w 10l milk.. :)
Keltainen talo
Valintatalo

Clustering

Density-based clustering

Clustering with weighted centroids:

- Each centroid has weight [0..1]
- Cost is weighted distance
- Valuable centroids attract points far away
- All weights sum=1 (or some constant)
- Resource allocation problem



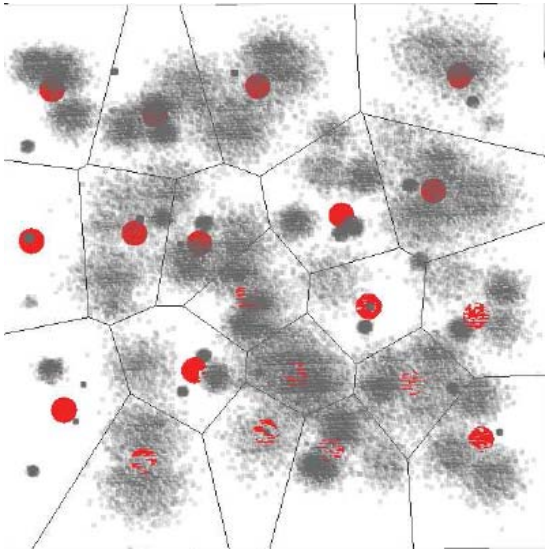
Algorithm:

- K-means / RS algorithm
- Open question: how to optimize weights?

Started JP

Experimenting:

- CS-software with modules (c-lang)
- Aim at solving Birch3 dataset and such



Alternative:

- Graph-based density estimation

K-means properties

- Systematic study on K-means with artificial datasets varying
  - Size
  - Number of clusters
  - Dimensionality
- Properties of the datasets (A, G2, DIM,...)
  - Neighborhood size
  - Clusterness
- Systematic study when K-means work and when not
- Number of iterations
- Stability
- Dimensionality properties of G2
- Extension to other cost functions beyond TSE

Completed

Balance k-means clustering

M.I. Malinen and P. Fränti, "Balanced K-means for clustering", *Joint Int. Workshop on Structural, Syntactic, and Statistical Pattern Recognition (S+SSPR 2014)*, LNCS 8621, 35-44, Joensuu, Finland, August 2014.

Mikko's S+SSPR paper as starting point

Alternatives for partition step:

- As pairing problem using Hungarian algorithm: $O(n^3)$
- Network flow problem (for balancing)
- Any heuristics where centroids have size constraint

Balance-driven cost function

- $\lambda=0$ is k-means; $\lambda=\infty$ is balance
- λ is increasing until converged to balance solution

$$\sum \left\| x_i - c_j \right\|^2 + n_j \cdot \lambda$$

Stability of clustering algorithms

- How much results of clustering changes if randomness is added to data
- How much if added to the clustering process
- For example comparing result of full set and random subsets (20%):
    - Stable algorithm provides same result, unstable different.
    - Such experiments are probably done for K-means only.
- Requires systematic testing, re-compiling software, and extensive testing

Dynamic Random Swap

- Variant that solves also number of clusters
- Three centroid operations:
  - Swap
  - Removal
  - Addition (instead of split)
- Proper stopping criterion
- Cost function should also solve k. Possibilities:

  Q. Zhao and P. Fränti, "WB-index: a sum-of-squares based index for cluster validity", *Data & Knowledge Engineering*, 92, 77-89, July 2014

- Start variant is reported here:

  I. Kärkkäinen and P. Fränti, "Dynamic local search for clustering with unknown number of clusters", Int. Conf. on Pattern Recognition (ICPR'02), Québec, Canada, vol. 2, 240-243, August 2002.

  http://cs.uef.fi/sipu/pub/DynamicLocalSearch-ICPR2002.pdf

Clustering users for recommendation

Clustering users

- Based on social network (common neighbors)
- Based on similar interests (likes in FB)

Recommendation:

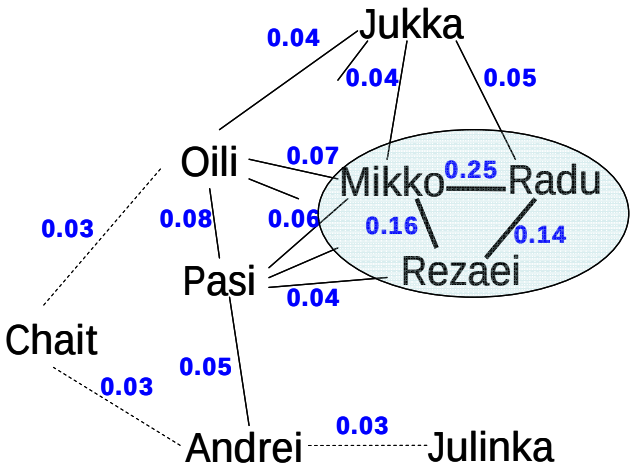
- Relevance = Influence of user * Relevance of POI
- Influence = Activity + dominance

Approach A:

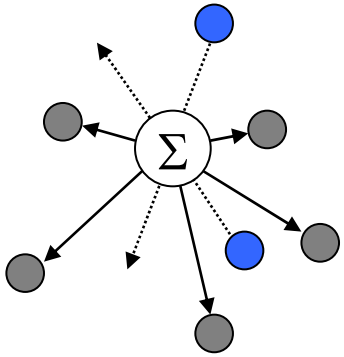
- Group users together
- Same recommendation for all users

Approach B:

- Individual recommendations
- Merge recommendations



Clustering-based classifier

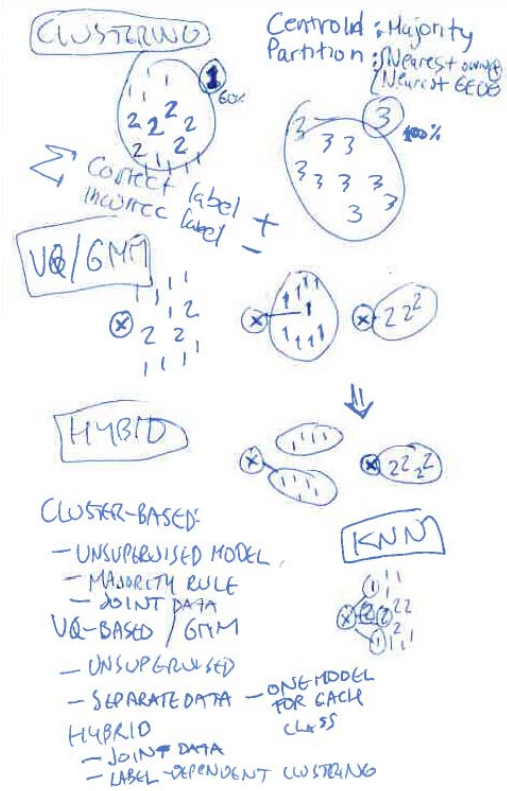


Traditional centroid-based models

- Optimize separate model for each class
- Adopt from universal background model
- Vector quantization (clustering-based) or GMM
- New: generate joint model

Joint optimization (new)

- Shared prototypes
- Training vectors join to nearest cluster
- Label of cluster prototype by:
  (a) Predefined label
  (b) Adaptively by majority rule
- Vectors with same label attract prototype
- Vectors with different label resist prototype



Optimizing classifier weights by GA

- Good understanding of basic classifiers
- Interest in machine learning
- C/Java programming

Clustering categorical data

	VSC-896	ABC-123	TDK-111
Model	VW	Opel	Hyundai
Color	Silver	Red	Blue
Country	Germany	Germany	Korea
Owner	Pasi	Aku	Pasi

- Connection via sharing attribute:
  - VSC-896 and TDK-111 have same owner
  - VSC-896 and ABC-123 made in same country
- Connection can be exact (=same) or inexact (European, Asian)
- Correlation of attributes connections correlate
- Euclidean:
  - Only nearby distances (KNN or XNN)
  - Connection with strength 1/d
- Clustering:
  - Cluster goodness = maximal (average) similarity: SUM(1/d) = max!
  - MSE = SUM_ij(d^2)/n = min!
  - MSE = SUM_ij(1/d^2)/n = max!

TSP

TSP algorithms

Suitable also for DAA projects

1. **Christofides** **Started: YL**
- Complete implementation using existing components
2. **Pre-Christofides**
- The simple 1-approximation variant using tree traversal
3. **Kruskal TSP** **Completed: AK**
- Build TSP similar to Kruskal
- Allow only adding links to the end of chains
4. **MST → TSP** **Completed: FD**
- Follows the spirit of Christofides
- Instead of adding more links, detect knots and leafs
- Re-connect leafs and knots to remove branches
5. **Local search**
- Use 2-opt, node swap, link swap operations
- Allow branches in the intermediate solutions

O-Mopsi and games

O-Mopsi Android

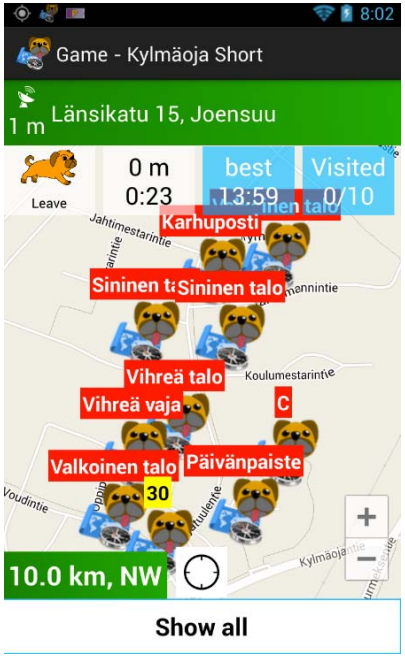
Goal:

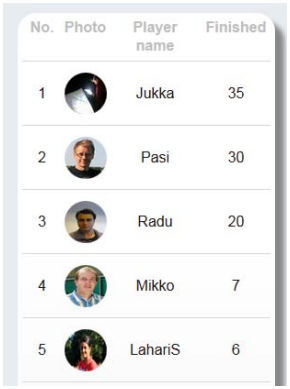
- New features for O-Mopsi game
- Chat, feedback, top score
- Content creation tools

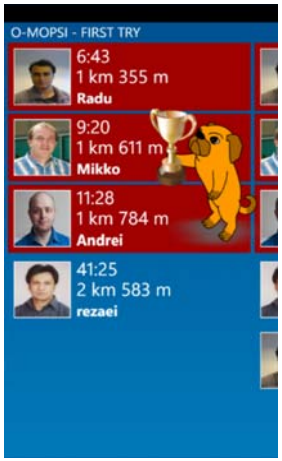
Requirements:

- Strong programming experience
- Ready to learn Android
- Might require web-programming

Started
AJ



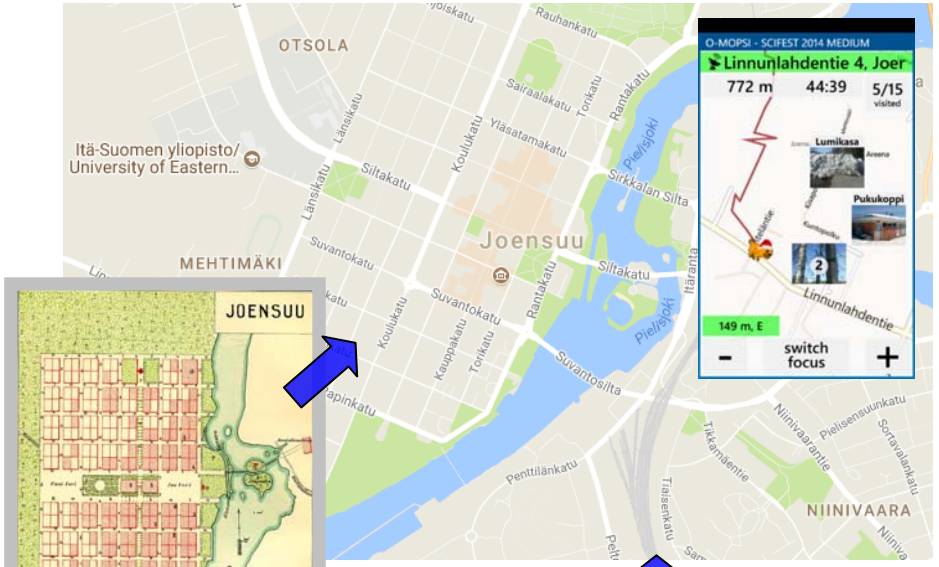




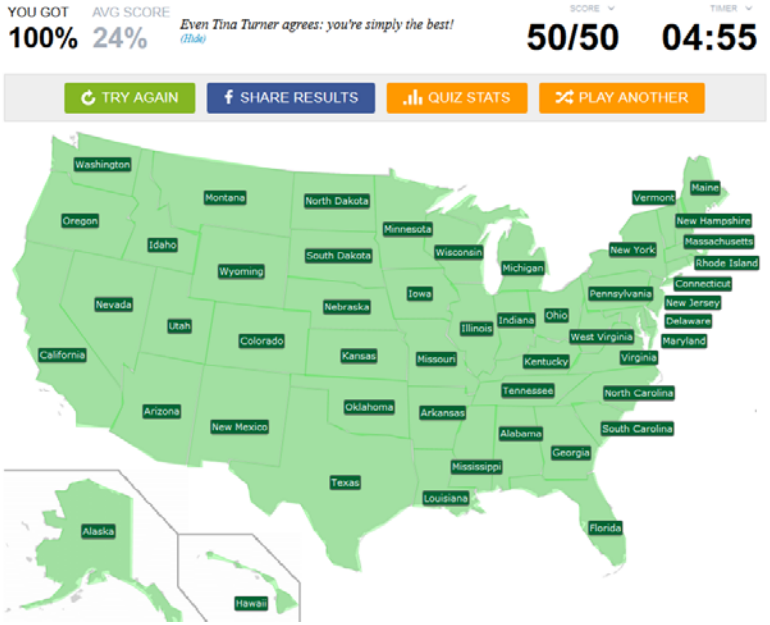
Educational applications

Tools for adding material:

- Additional map layers
- Questions & answers
- More info about target



Educational games?



Educational content

- Name of object (trees, flowers)
- Background story

Outdoor museums

Botanical gardens

Geography

Architecture

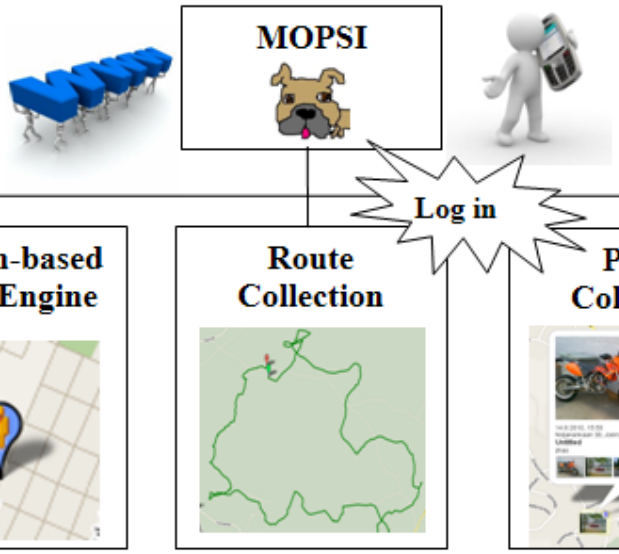
Biology

City history

Exhibitions

Mopsi

Mopsi overview



Recommendation System

- Service (bus, friend)
- Text (search query, photo description)

Web Content Mining

- Meta searching
- Service title detection
- Document processing

Route Pattern

- Route reduction
- Route segmentation
- Activity area

Social network

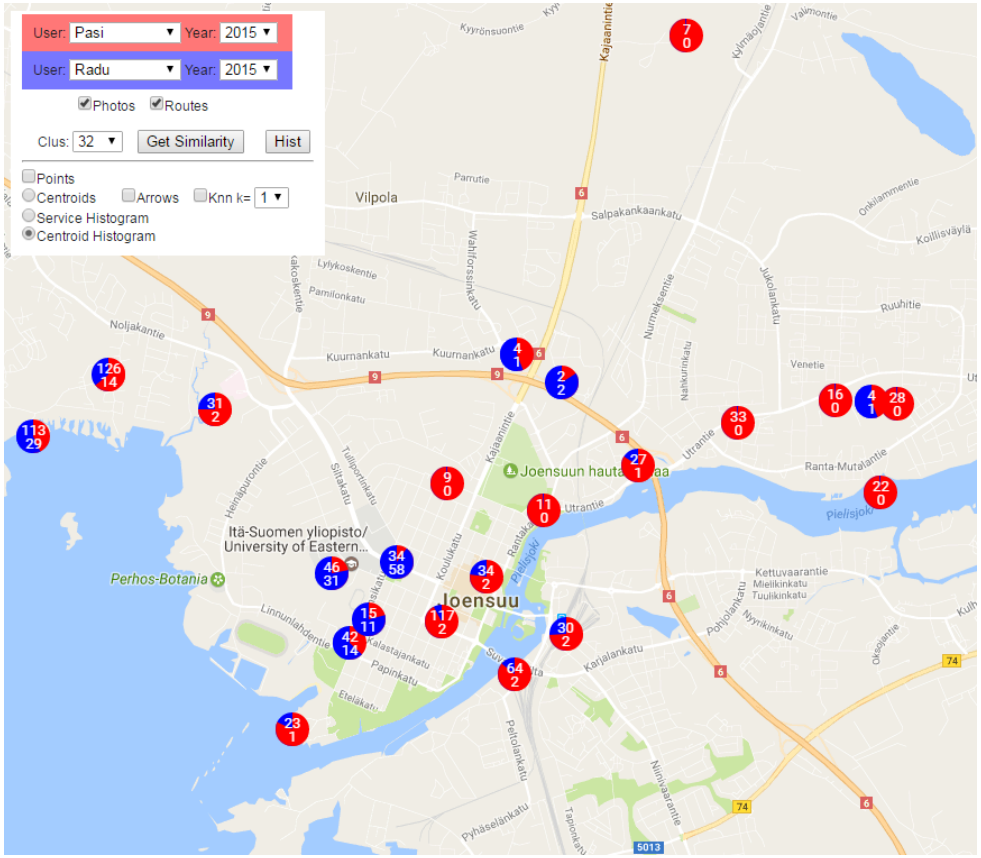
- Facebook

Location-based Game

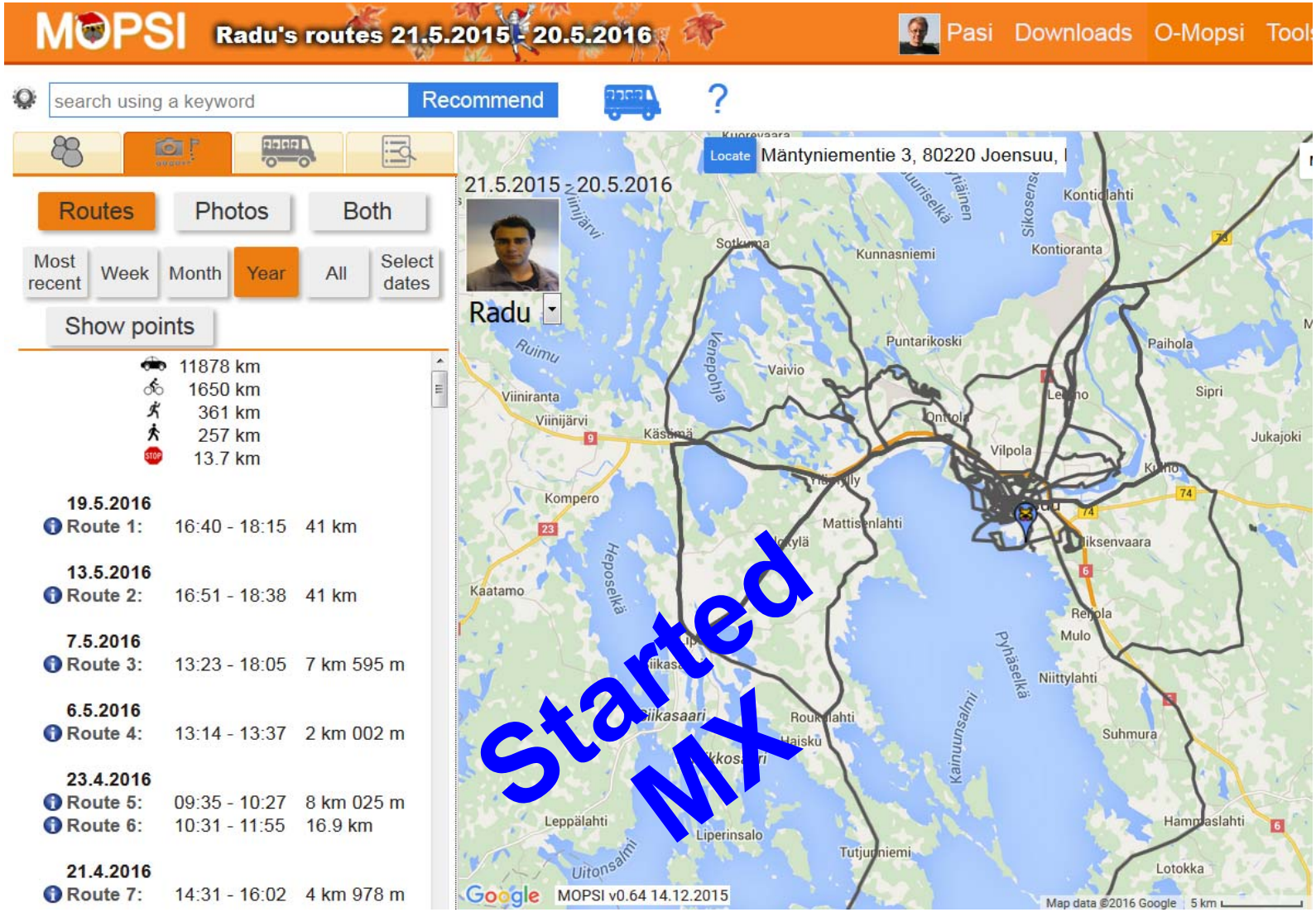
- Orienteering
- Killer-game

User similarity

- Studying different methods based on user data
- Profile, activity, location history, photo descriptions
- Requires machine learning skills such as
  - histogram comparison
  - clustering
  - model adaptation



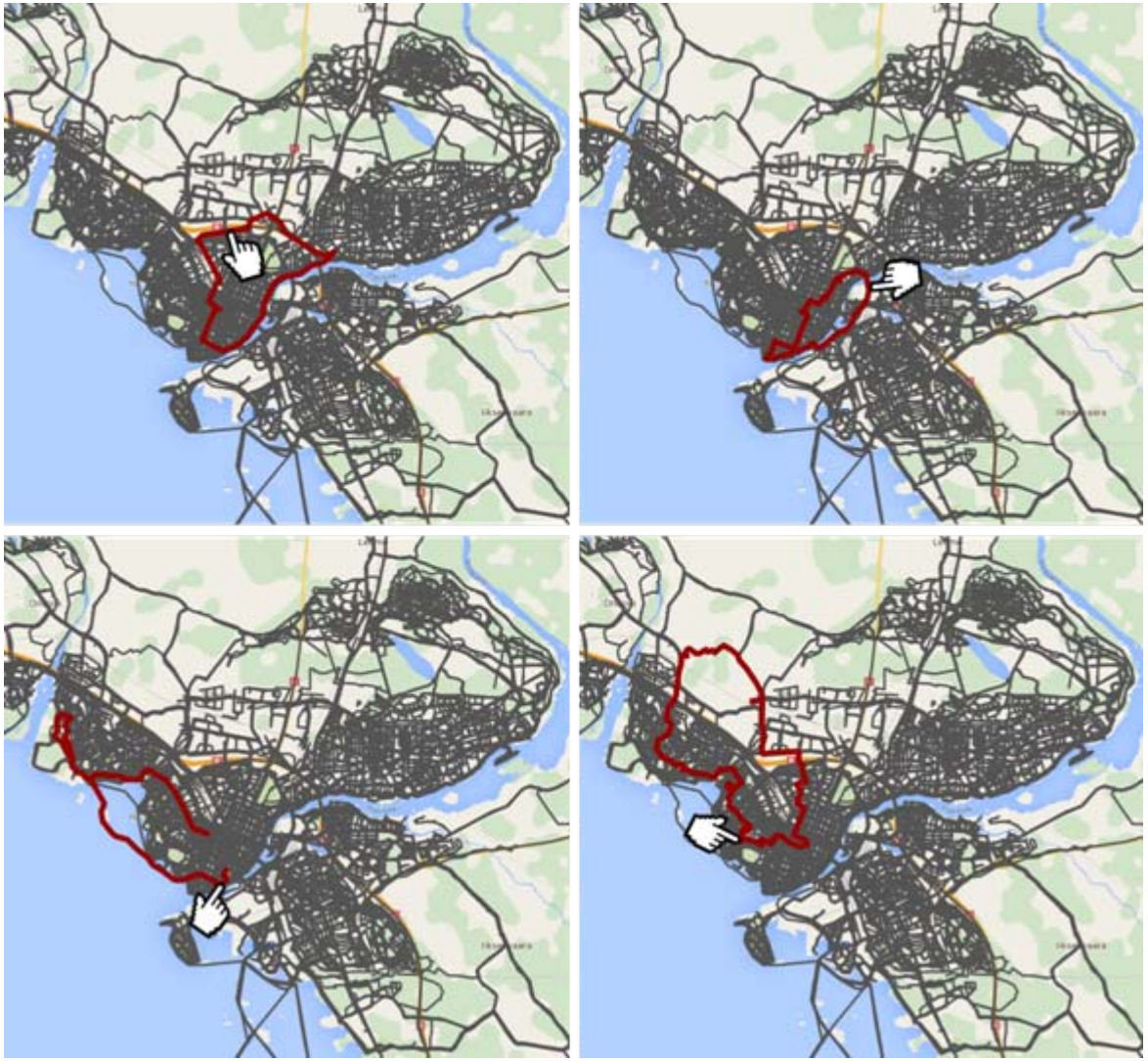
Clustering routes



Route prediction

Organizing route collection for efficient retrieval

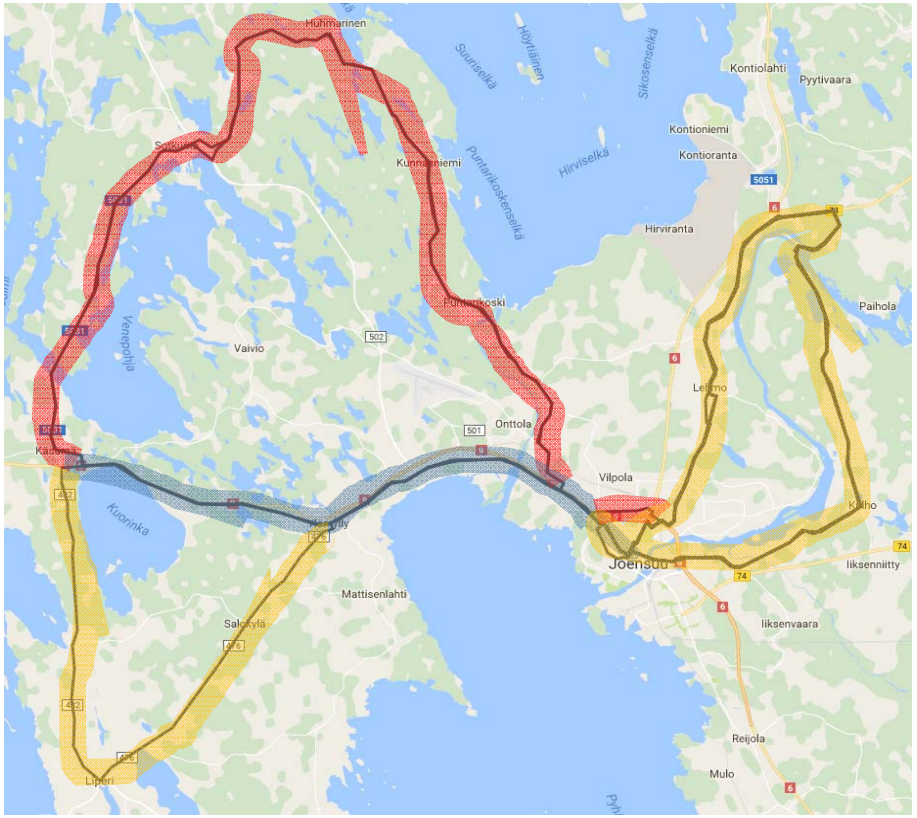
http://cs.uef.fi/sipu/pub/Gsearch.ppt



R. Mariescu-Istodor and P. Fränti, "Gesture input for GPS route search", *Joint Int. Workshop on Structural, Syntactic, and Statistical Pattern Recognition (S+SSPR 2016)*, Merida, Mexico, LNCS 10029, 439-449, November 2016.

GPS route search via segmentation

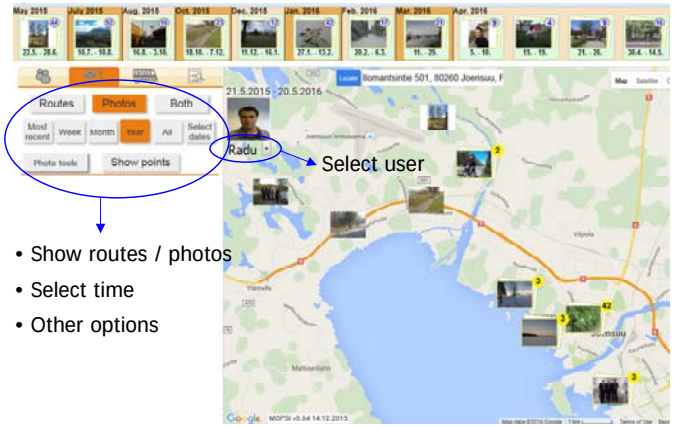
- Segment the on-screen routes using Road Network
- Clicking a segment limits to routes passing through the segment
- Clicking a second segment continues to limit the screen, etc.

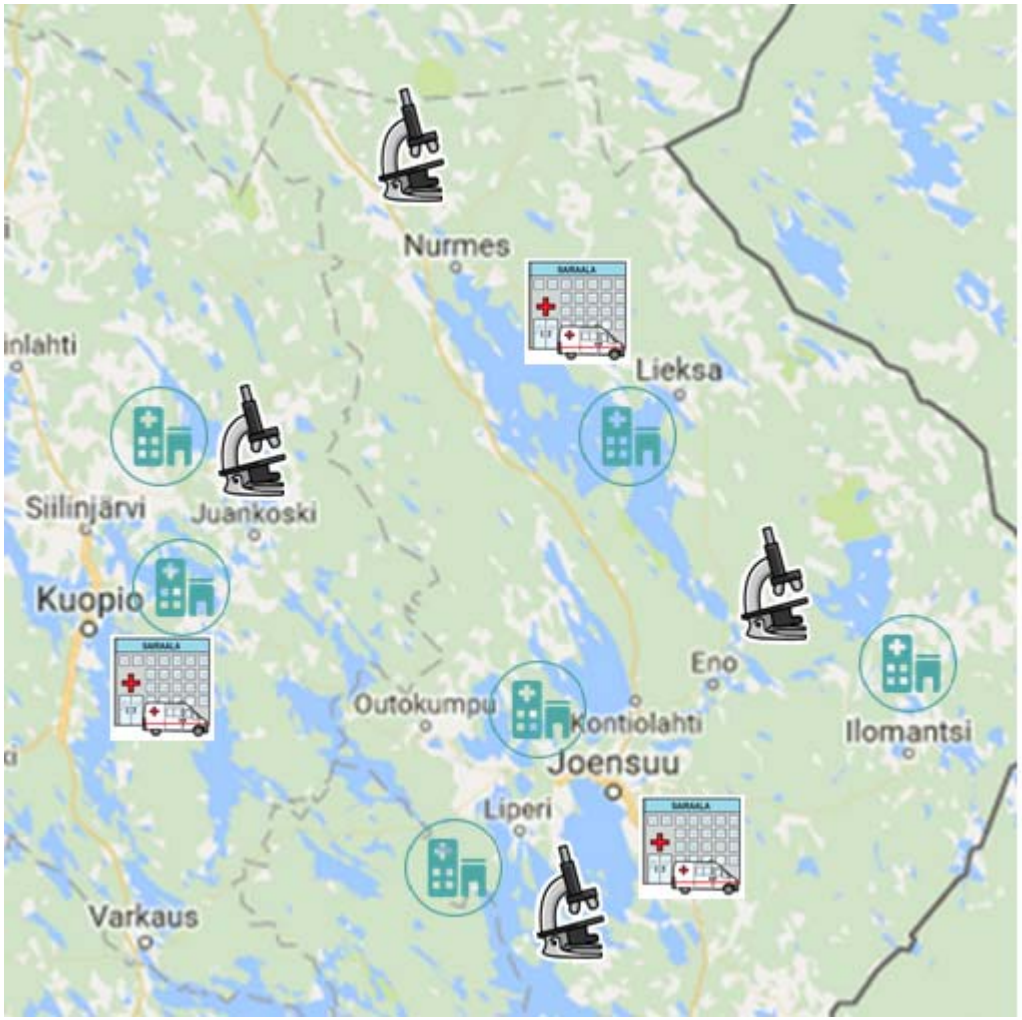


Optimizing health care services

3-years project starting 1.1.2018

http://cs.uef.fi/sipu/OpenPositions-1.pdf





Main goals:

- Developing methods for location-based applications
- Apply the methods for multi-objective optimization (cost, location, travel time)
- Interactive user-interface on maps

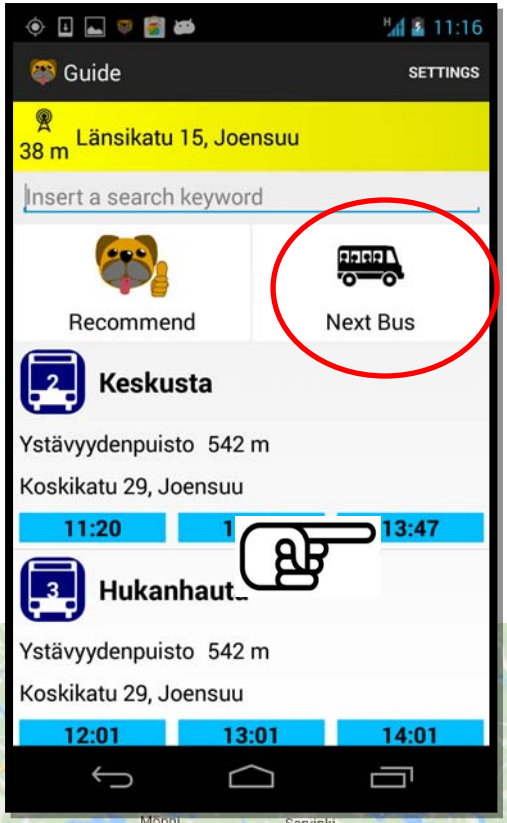
Students on Map

Mobile bus time table systems

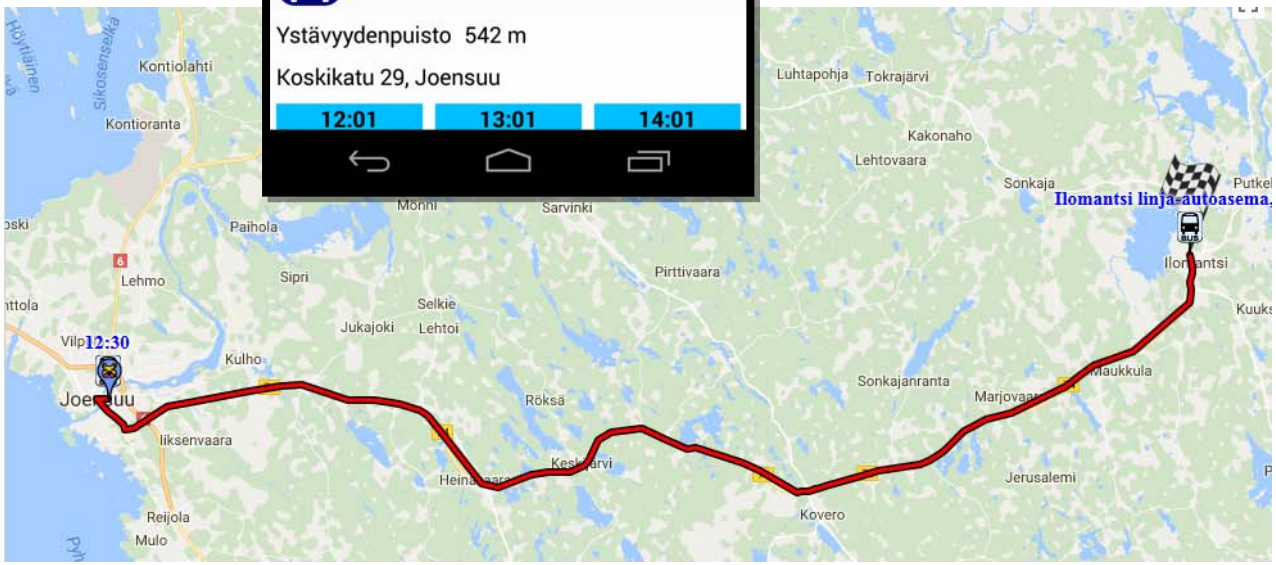
Started GR

Location

One button system



11:36 31	4	Joensuun pääkirjasto I	11:36
11:39 34	9	Siltakatu B L	11:39
11:50 45	9811	Sairaala PKKS E	11:50
12:00 55	9541	Outokumpu linja-autoasema	12:00
12:00 55	null	Kuopio linja-autoasema	12:00
12:05 60	9821	Lieksa linja-autoasema	12:05
12:20	9140	Kiihtelysvaara koulu, P	12:20
12:30	9120	Ilomantsi linja-autoasema	12:30
12:30	9623	Polvijärvi linja-autoasema	12:30



Web crawling for collecting content

Game targets:

- Outdoor landmarks
- Objects in park
- User's own travel pictures

Content-creation:

- Manually maintained (Mopsi database)
- External geo-tagged databases
- Collecting by web crawling

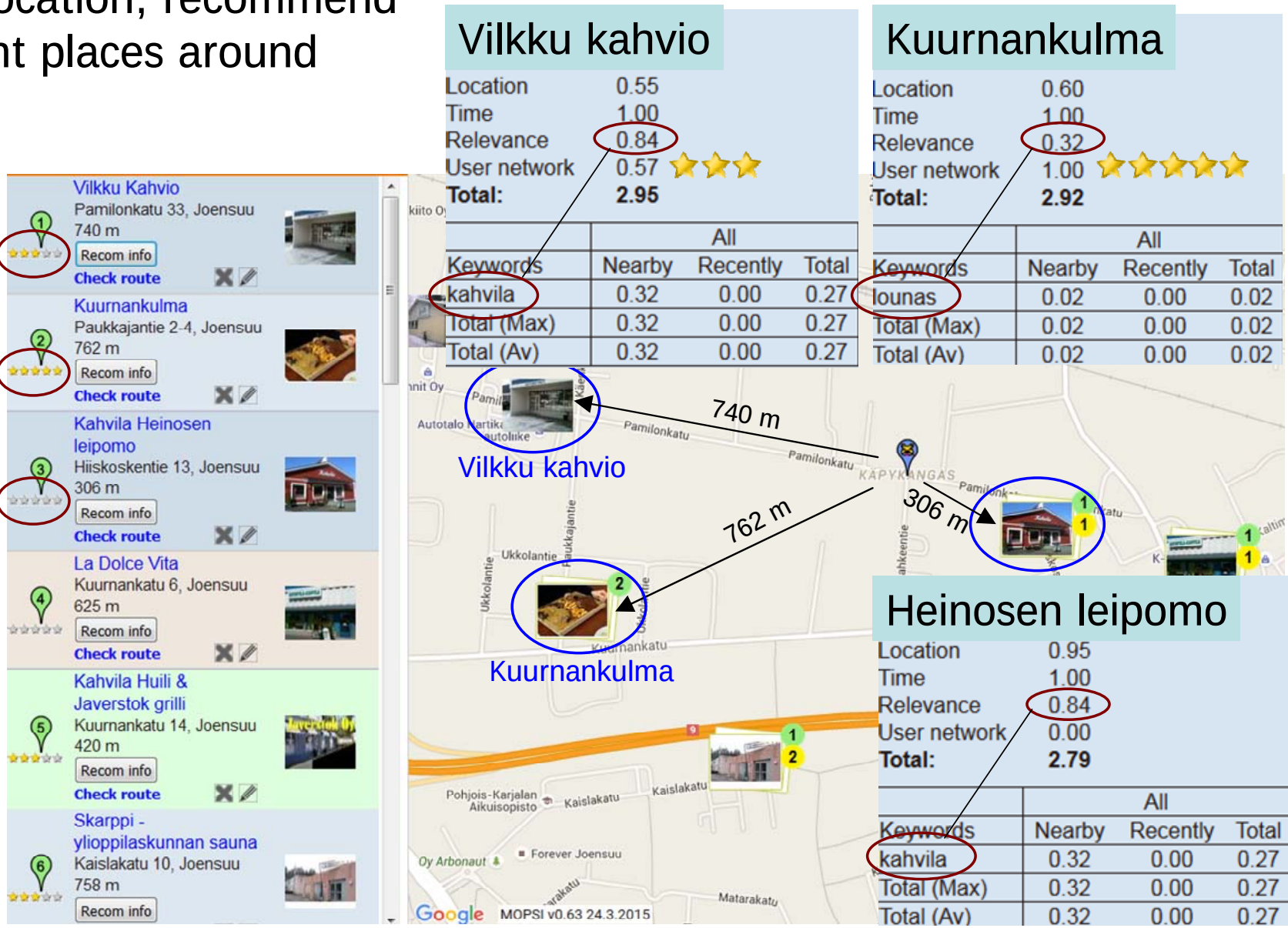
Started KN

Goal:

Creaste tool for systematic collection of material by crawling for geo-tagged pictures

Location-aware recommendation

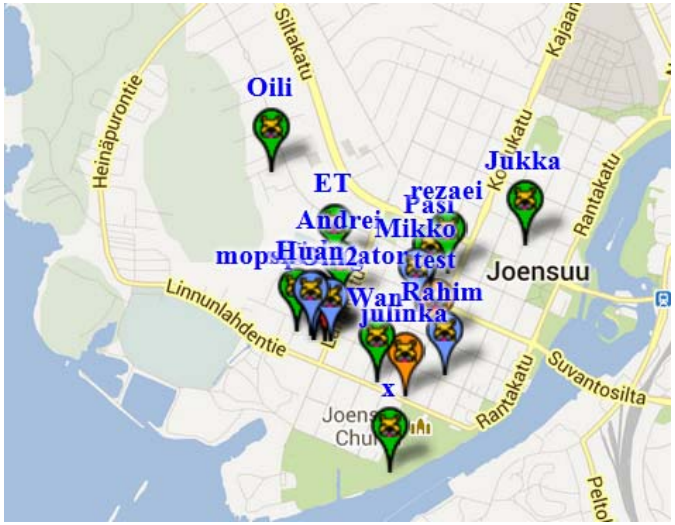
Given location, recommend
Relevant places around



Lenkille.com

Kimppalenkkien (miksei myös kyytien) suunnitteluun ja koordintointiin tarkoitettu työväline. Hyödyntää käyttäjien sijaintia (Mopsi). Käyttäjä voi luoda uuden tapahtuman (event) tai liittyä olemassa olevaan. Järjestelmä tunnistaa osallistumiset automaattisesti ja informoi osallistujia. Piirteitä FB events, nimenhuuto.com ja kimppakyyti-sovelluksista.

Started AS



Planned events:

•	Pekka:	Lauantai 10.00	Areena	Lenkki	18-20 km
•	Olli:	Tiistai 18.00	Tiedepuisto	Juoksu	10 km
•	Radu:	Keskiviikko 16.00	Vesikko	Hiihto	12 km

Publications

Routes

1. R. Mariescu-Istodor and P. Fränti, "Grid-based method for GPS route analysis for retrieval", *ACM Trans. on Spatial Algorithms and Systems*, 3 (3), 8:1-28, September, 2017.
2. R. Mariescu-Istodor and P. Fränti, "Gesture input for GPS route search", *Joint Int. Workshop on Structural, Syntactic, and Statistical Pattern Recognition (S+SSPR 2016)*, Merida, Mexico, LNCS 10029, 439-449, November 2016.
3. S. Sieranoja, T. Kinnunen and P. Fränti, "GPS trajectory biometrics: from where you were to how you move", *Joint Int. Workshop on Structural, Syntactic, and Statistical Pattern Recognition (S+SSPR 2016)*, Merida, Mexico, LNCS 10029, 450-460, November 2016.
4. R. Mariescu-Istodor, A. Tabarcea, R. Saeidi and P. Fränti, "Low complexity spatial similarity of GPS trajectories", *Int. Conf. on Web Information Systems & Technologies (WEBIST'14)*, Barcelona, Spain, April 2014.
5. K. Waga, A. Tabarcea, R. Mariescu-Istodor and P. Fränti, "Real time access to multiple GPS tracks", *Int. Conf. on Web Information Systems & Technologies (WEBIST'13)*, Aachen, Germany, 293-299, May 2013.
6. K. Waga, A. Tabarcea, M. Chen and P. Fränti, "Detecting movement type by route segmentation and classification", *IEEE Int. Conf. on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom'12)*, Pittsburgh, USA, 2012.
7. M. Chen, M. Xu and P. Fränti, "A fast O(N) multi-resolution polygonal approximation algorithm for GPS trajectory simplification", *IEEE Trans. Image Processing*, 21 (5), 2770-2785, May 2012.
8. M. Chen, M. Xu and P. Fränti, "Compression of GPS trajectories using optimized approximation", *IEEE Int. Conf. on Pattern Recognition (ICPR'12)*, Tsukuba City, Japan, 3180-3183, November 2012.
9. K. Waga, A. Tabarcea, R. Mariescu-Istodor and P. Fränti, "System for real time storage, retrieval and visualization of GPS tracks", *Int. Conf. System Theory, Control and Computing (ICSTCC)*, Sinai, Romania, Vol. 2, October 2012.
10. M. Chen, M. Xu and P. Fränti, "Compression of GPS trajectories", *IEEE Int. Conf. on Data Compression Conference (DCC'12)*, Snowbird, Utah, 62-71, April 2012.

Publications
Web Mining

1. N. Gali, R. Mariescu-Istodor and P. Fränti, "Using linguistic features to automatically extract web page title", *Expert Systems with Applications*, 79, 296-312, 2017.
2. N. Gali, R. Mariescu-Istodor and P. Fränti, "Similarity measures for title matching", *IAPR Int. Conf. on Pattern Recognition, (ICPR'16)*, Cancun, Mexico, 1549-1554, December 2016.
3. N. Gali and P. Fränti, "Content-based title extraction from web page" , *Int. Conf. on Web Information Systems and Technologies (WEBIST 2016)*, Rome, Italy, vol. 2, 204-210, April 2016.
4. M. Rezaei, N. Gali, and P. Fränti, "ClRank:a method for keyword extraction from web pages using clustering and distribution of nouns", *IEEE/WIC/ACM Int. Joint Conf. on Web Intelligence and Intelligent Agent Technology (WI-IAT)*, 79-84, December 2015.
5. P. Fränti, K. Waga, and C. Khurana, "Can social network be used for location-aware recommendation", *Int. Conf. on Web Information Systems & Technologies (WEBIST'15),* 558-565, 2015.
6. N. Gali, A. Tabarcea, and P. Fränti, "Extracting representative image from web page", *Int. Conf. on Web Information Systems & Technologies (WEBIST'15),*411-419, 2015

Publications

Clustering + recommendation + games

1. P. Fränti, R. Mariescu-Istodor and L. Sengupta, "O-Mopsi: mobile orienteering game for sightseeing, exercising and education", *ACM Trans. on Multimedia, Computing, Communications, and Applications*, 13 (4), 56:1-25, August 2017.
2. M. Rezaei and P. Fränti, "Set matching measures for external cluster validity", *IEEE Trans. on Knowledge and Data Engineering*, 28 (8), 2173-2186, August 2016.
3. Q. Zhao, Y. Shi, Q. Liu and P. Fränti, "A grid-growing clustering algorithm for geo-spatial data", *Pattern Recognition Letters*, 53 (1),77-84, February 2015.
4. A. Tabarcea, Z. Wan, K. Waga and P. Fränti, "O-Mopsi: mobile orienteering game using geotagged photos", *Int. Conf. on Web Information Systems & Technologies (WEBIST'13)*, Aachen, Germany, 300-303, May 2013.
5. Q. Zhao, M. Rezaei, H. Chen and P. Fränti, "Keyword clustering for automatic categorization", *IEEE Int. Conf. on Pattern Recognition (ICPR'12)*, Tsukuba City, Japan, 2845-2848, November 2012.
6. M. Rezaei and P. Fränti, "Matching similarity for keyword-based clustering", *Joint Int. Workshop on Structural, Syntactic, and Statistical Pattern Recognition (S+SSPR 2014)*, LNCS 8621, 193-202, Joensuu, Finland, August 2014.
7. K. Waga, A. Tabarcea and P. Fränti, "Recommendation of points of interest from user generated data collection", IEEE Int. Conf. on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom'12), Pittsburgh, USA, 2012.

PhD theses

1. Radu Mariescu-Istodor, “Efficient management and search of GPS routes”, PhD thesis, School of computing, Univ. Eastern Finland, August 2017.
2. Najlaa Gali, “Summarinzing the content of web pages“, PhD thesis, School of computing, Univ. Eastern Finland, June 2017.
3. Mohammad Rezaei, "Clustering validation“, PhD thesis, School of computing, Univ. Eastern Finland, June 2016.
4. Karol Waga, "Processing, analysis and recommendation of location data", PhD thesis, School of computing, Univ. Eastern Finland, June 2015.
5. Andrei Tabarcea, “Location-based web search and mobile applications", PhD thesis, School of computing, Univ. Eastern Finland, 2014.
6. Minjie Chen, "Efficient processing and compression of map images and routes", PhD thesis, School of computing, Univ. Eastern Finland, August 2012.
7. Qinpei Zhao, “Cluster validity in clustering methods", PhD thesis, School of computing, Univ. Eastern Finland, June 2012.

MSc Theses

1. Chaitanya Khurana, "Determining User Influence on a Social Network ", MSc thesis, UEF 2015
2. Anton Tsypchenko, "Automatic Game Generation for O-Mopsi Mobile Orienteering Game", MSc thesis, School of computing, UEF 2016.
3. Zhentian Wan, "O-Mopsi: Location-based orienteering mobile game", MSc thesis, School of computing, UEF, 2014
4. Joni Pakarinen, "Optimization of home care services", MSc thesis, School of computing, UEF, 2014.
5. Radu Mariescu-Istodor, "Detecting user actions in MOPSI", MSc thesis, School of computing, UEF, August 2013. (5/5)

Old Topics

(not active at the moment)

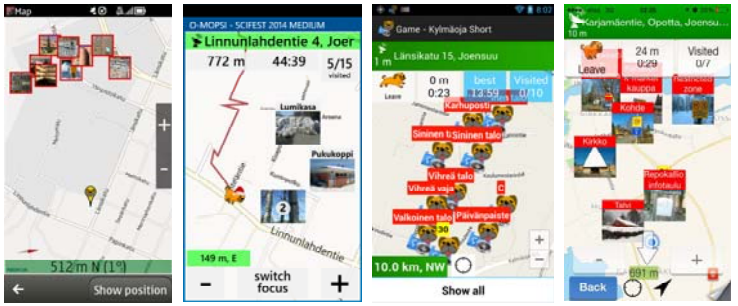
Augmented reality with Mopsi

- Goal would be to integrate this to Mopsi for enhancing UI
- Game in smart phone (with GPS)
- Connect via BT
- Extra interface:

  (1) Mopsi data from phone to device

  (2) User input (gesture, other ways) guiding Mopsi
- Extra output on the lenses can be Mopsi services, user data from database, or other users if happen to met in real life.

Native, Cocos, Unity?



Augmented reality for O-Mopsi

- Same as above but guiding the game playing
- For example showing virtual flag on visor
- Optionally to create new game but requires
  http://www.vastavalo.net/albums/userpics/12793/normal__EK_1566_edited-1.jpg
- Would easily create ideas for new VR/AR gaming

Modeling of distributions based on samples

- Geo-tagged data collected from field
  - Hundreds of samples at each location (GPS)
  - Raw data is spectral measurement of reflections
  - Processed data is intensity of detected elements (alkuaine)
- Device connected to phone (BT) and server (network)
- Interactive data handling on map in server
  - Zooming & panning
  - Choosing elements
  - Modeling distributions based on samples