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ORCHID

Intelligent Agents for Mobile Location Services

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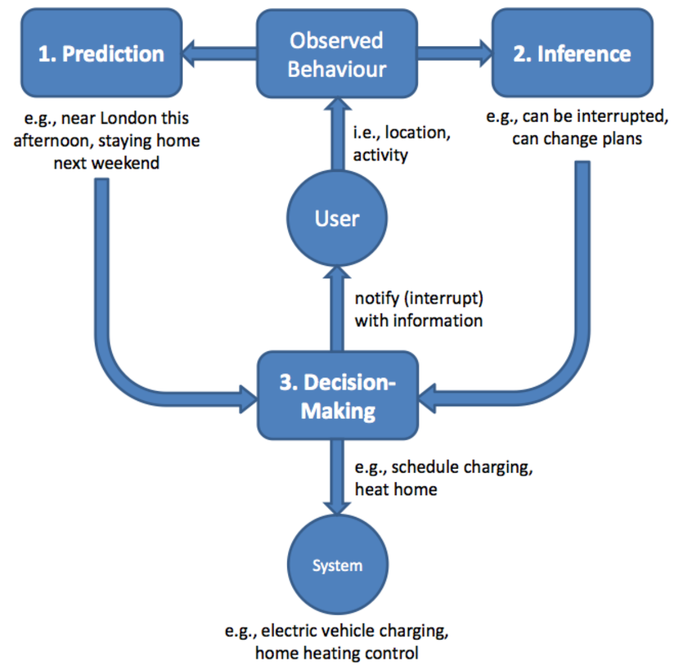
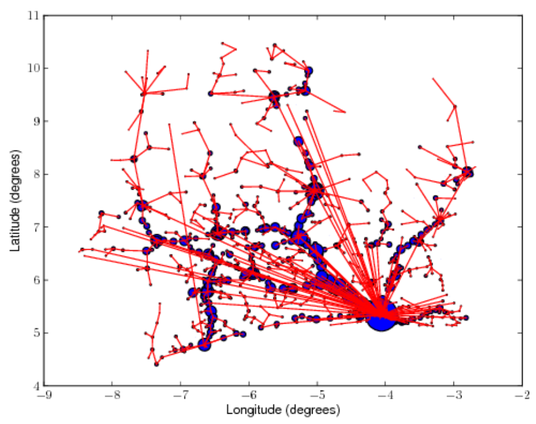
Workflow for Intelligent Assistance

To provide background services to users of mobile devices in daily life



Validated with Orange and Nokia Datasets



Orange Dataset
- 500,000 mobile phone users in Ivory Coast for 1 year
- Sparse cell tower data

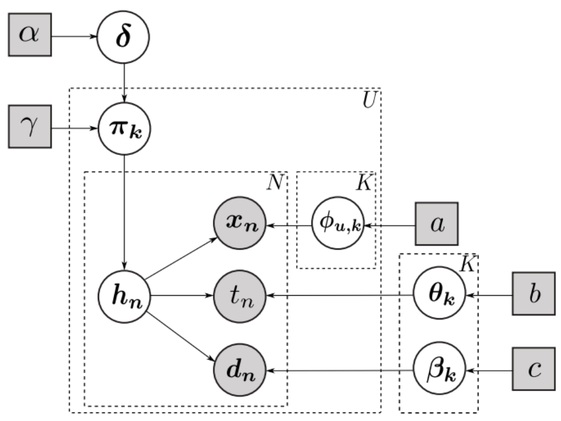
Nokia Dataset
- 38 people over 1 year [1]
- GPS, app use, bluetooth proximity, calls, and text messages

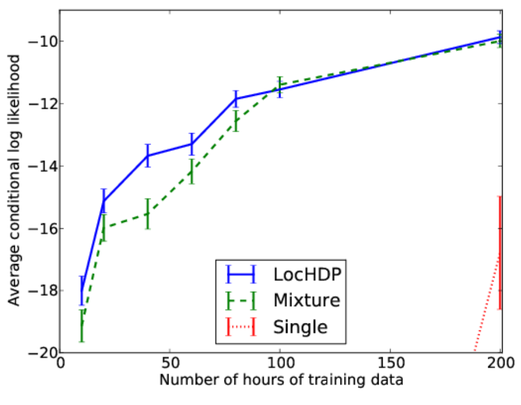
1. Realistic Location Prediction

Goal: generate accurate predictions for **new users** of location prediction services

- Extension to the hierarchical Dirichlet process (HDP) usually applied to topic modelling [2]
- Models location behaviour ***x***, ***t***, ***d*** of set of *U* users, who may behave very differently
- Nonetheless, we can discover commonalities in temporal structure of behaviour in parameters ***Θ*** and ***ß***
- This common structure allows us to transfer knowledge from existing to new users
- Spatial parameters ***Ø*** are personal to individuals, allowing us to relax the requirement that users must live in the same area

LocHDP





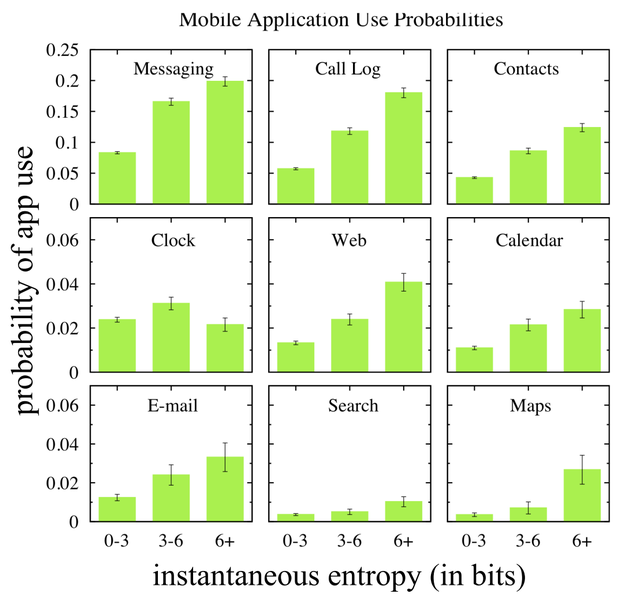
- Tested approach by simulating arrival of new users through truncation of location histories
- Approach demonstrates improvement in prediction for new users when (up to) 2 weeks of history has been gathered, corresponding to 100 hours of non-empty data

2. Inference of Departure from Routine

(Collaboration with Sebastian Stein)

Goal: measure the extent to which user behaviour is currently following routine

- Existing work treats predictability as feature of individual [3]
- But, arguably, *periods* of low predictability are most interesting times for the user, when they are departing from routine

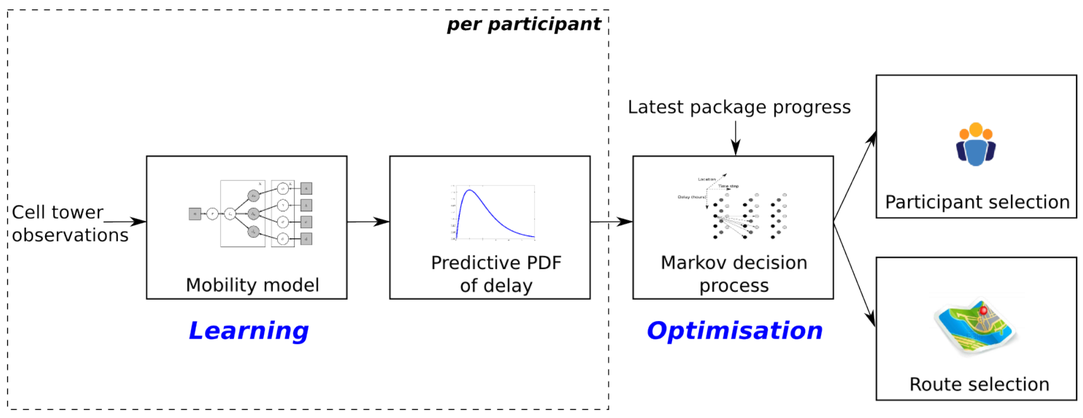


- We propose a novel *latent departure* dynamic Bayesian model of location behaviour
- When user is departing from routine, their habitual sequential and temporal structure no longer apply

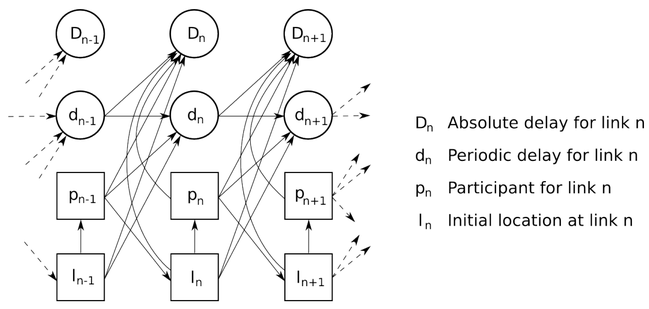
- Result: departure from routine correlates with app use
- Biggest increases occur with maps and search
- Interpretation: the user seeks out information and functionality usually when they are breaking from routine

3. Decision-Making Based on Predicted Human Location Behaviour

Goal: perform opportunistic location-based task assignments (crowdsourced package delivery) using predicted mobility of users



- Validated using Ivory Coast data set using cell tower locations
- Found 83% reduction in simulated delivery time compared with taking the shortest path (i.e., minimising number of participants in each delivery problem)



Future Work

- Prediction: online variational inference of LocHDP
- Decision-making: represent utility of notifications given the current context of the user and the value of information

References

[1] Laurilla et al. The Mobile Data Challenge: Big Data for Mobile Computing Research. *Proc. Mobile Data Challenge by Nokia*, 2012.
[2] Teh et al. Hierarchical Dirichlet Processes. *Journal of the American Statistical Association.*101[476]:1566-1581, 2006.
[3] Song et al. Limits of Predictability in Human Mobility. *Science,* 327(5968):1018-1021, 2010.

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