University of Athens,
Department of Informatics & Telecommunications,
Communications Network Laboratory,
Greece.

Pervasive Computing Research Group

An Online Adaptive Model for Location Prediction

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Theodoros Anagnostopoulos, Christos Anagnostopoulos,

Stathes Hadjiefthymiades

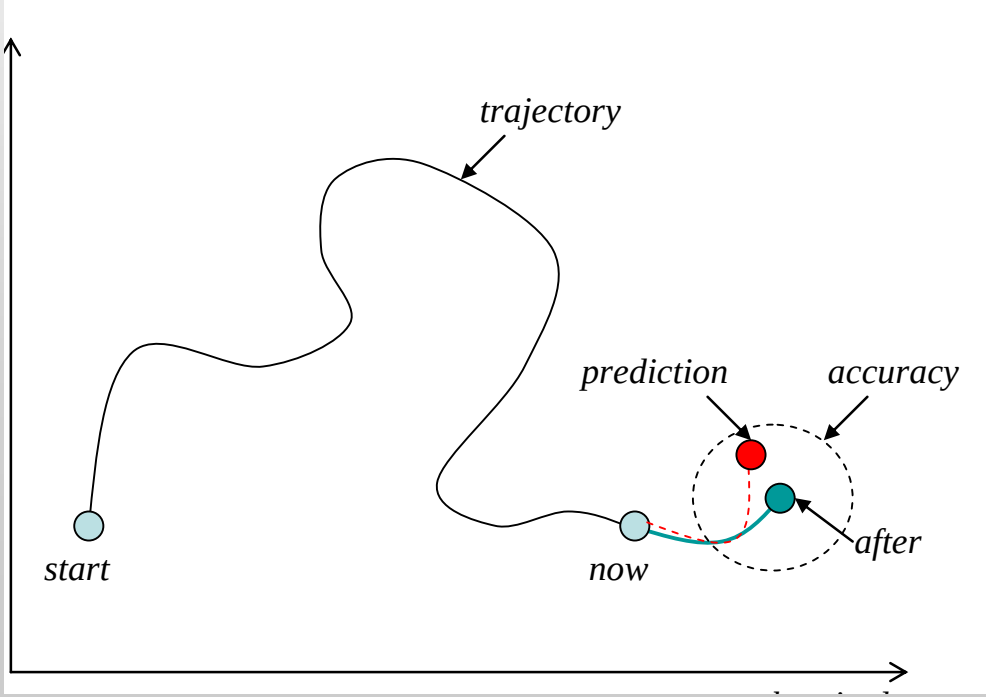
Autonomics - 2009

Limassol, Cyprus

September 2009

Location Prediction Problem

- The mobile user starts his/her movement from the start point.
- After certain time he/she walked a trajectory in the movement space (e.g., GPS coordinates).
- The predictor is used for predicting a point (the prediction point) as close as to the actual future point having certain accuracy of that prediction.



Machine Learning Models

- **Machine Learning**: the study of algorithms that *improve* automatically through *experience.*
  - **Offline *k*Means**,
  - **Online *k*Means** and
  - **Adaptive Resonance Theory (ART)**.

Adaptive Resonance Theory (ART)

- An online learning scheme in which the set of patterns is not available during training.
- Patterns are received one by one and the model is updated progressively.
- It is a competitive learning model (*winner-takes-all*).
- The ART approach is *incremental*, meaning that one starts with one cluster and adds a new one, if needed.

Context Representation (1/2)

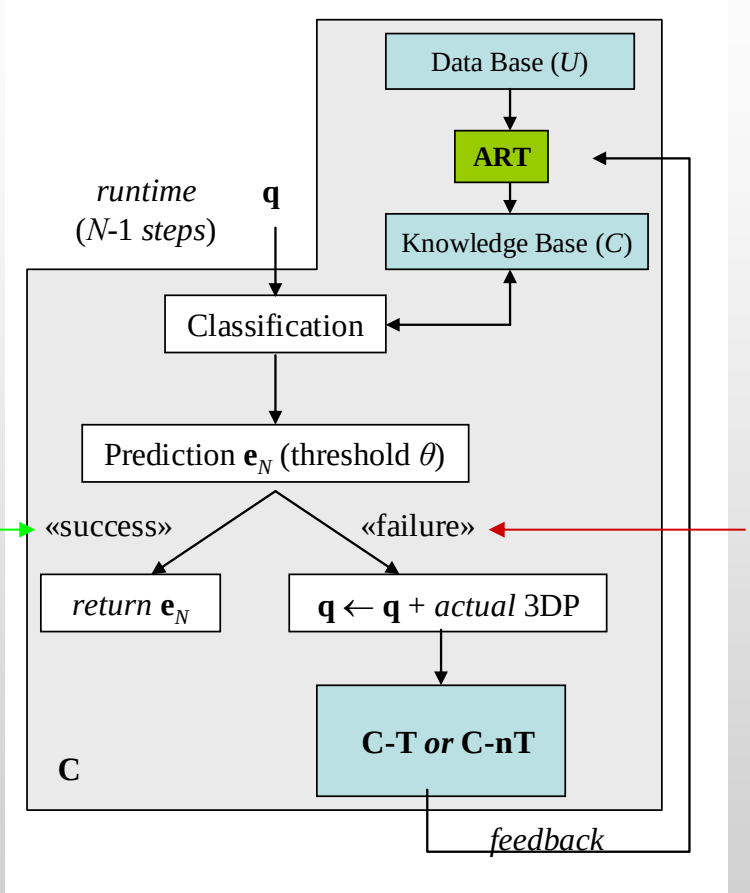
- The current user **location** is represented as GPS coordinate,
- The **history** of user movements is *transitions* between GPS coordinates.
- Let **e** = (*x, y, t*) be a 3D point (3DP).
- The *user trajectory* **u** consists of several time-ordered 3DPs.
  - $\mathbf{u} = [\mathbf{e}_i] = [\mathbf{e}_1, \ldots, \mathbf{e}_N]$, $i = 1, \ldots, N$
  - The **u** is stored in the system's database.
- It holds true that $t(\mathbf{e}_1) < t(\mathbf{e}_2) < \ldots < t(\mathbf{e}_N)$, i.e., time-stamped coordinates.

Context Representation (2/2)

- A *cluster trajectory* **c** consists of a finite number of 3DPs.
  - $\mathbf{c} = [\mathbf{e}_i]$, $i = 1, \ldots, N$
  - It is stored in the knowledge base,
  - It is created from ART based on unseen *user trajectories*, is a representative itinerary of the user movements.
- A *query trajectory* **q** consists of a number of 3DPs.
  - $\mathbf{q} = [\mathbf{e}_i]$, $j = 1, \ldots, N-1$.

- Given a **q** with a N-1 history of 3DPs we predict the $\mathbf{e}_N$ of the closest **c** as the next user movement.

Mobility Prediction Model (1/2)

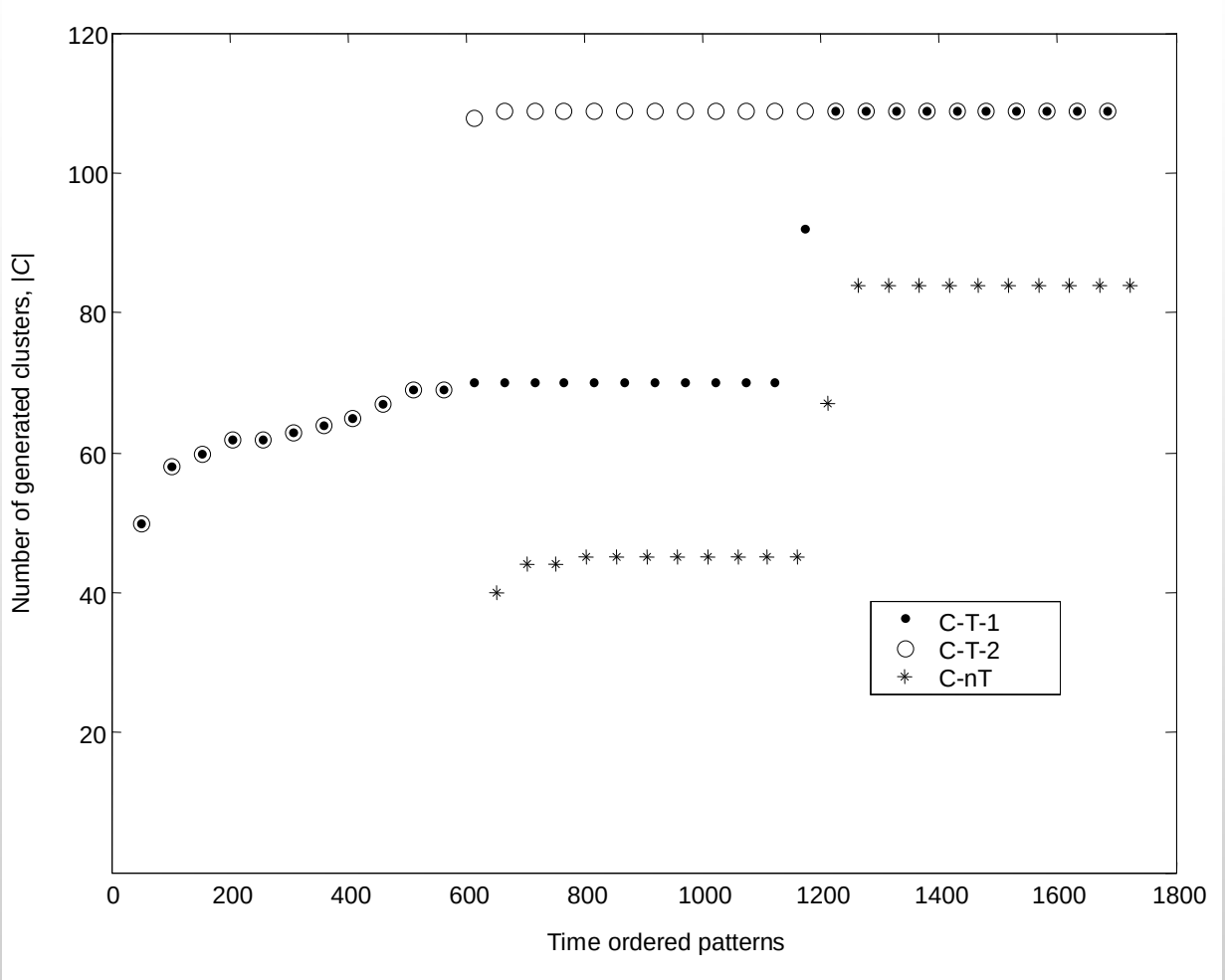


- The adaptive classifier for location prediction.

Mobility Prediction Model (2/2)

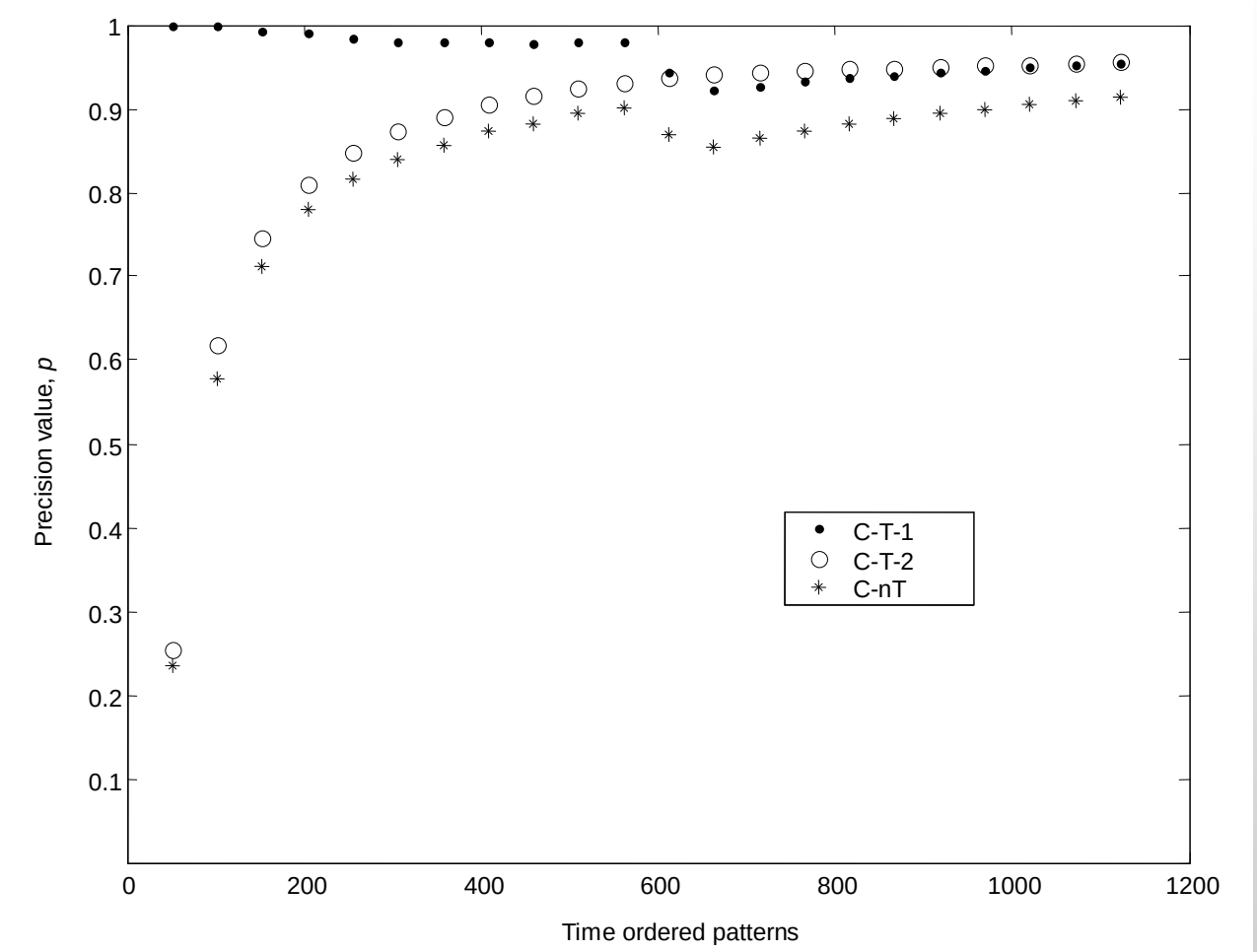
- Two *training* methods.
- **C-T:** in the *supervised method* the model uses training data in order to make classification.
- **C-nT:** in the *zero-knowledge method* the model incrementally learns from unsuccessful predictions.
- **Precision** is defined as the fraction of the correctly predicted locations against the total number of predictions made by the classifier.
- The classifier **converges** once the knowledge base does not expand with unseen patterns.

Prediction Evaluation (1/2)



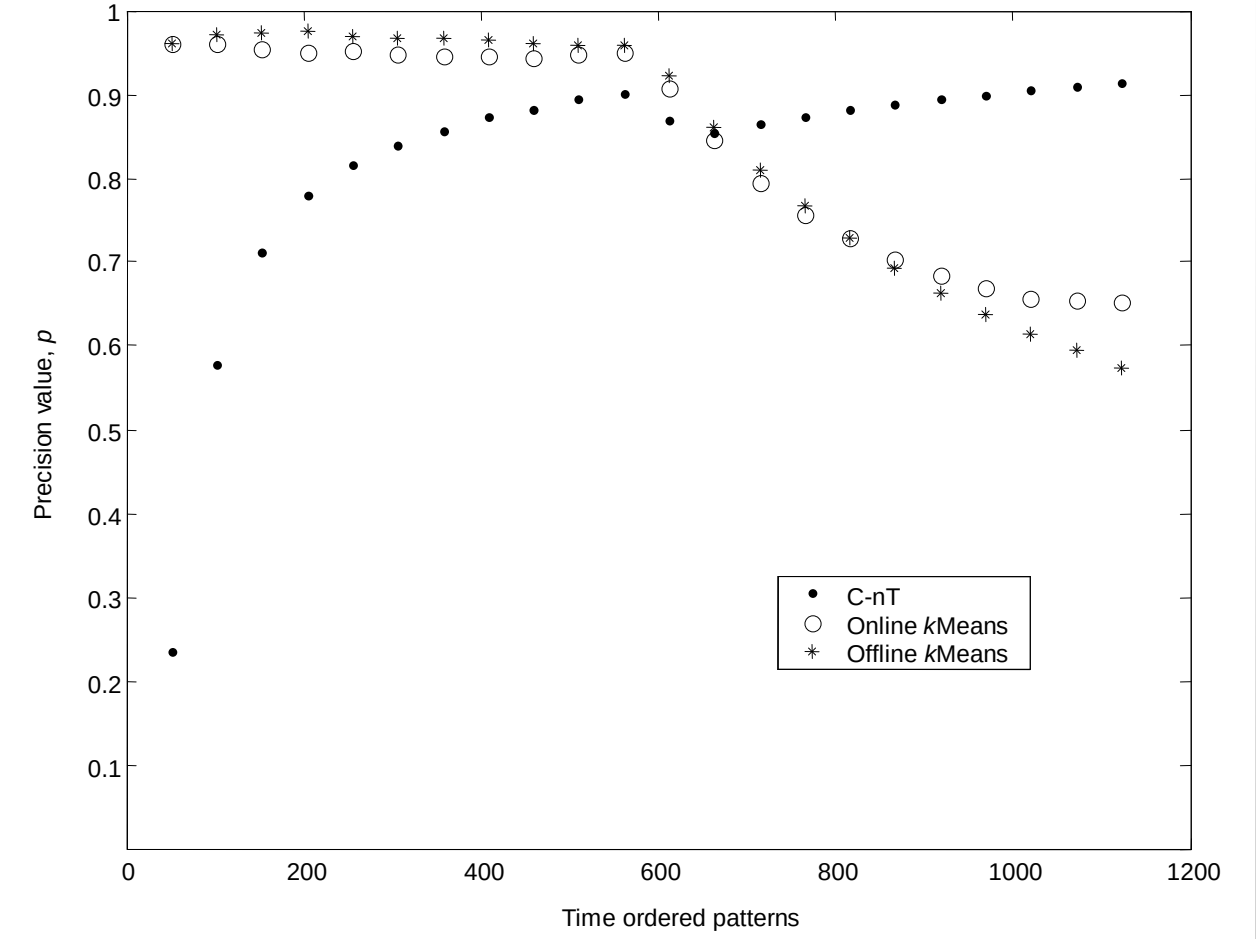
- Convergence of C-T/-nT.

Prediction Evaluation (2/2)



- Precision of C-T/-nT.

Comparison with other Models



- Comparison of C-nT with the Offline/Online kMeans models.

Conclusions

- We use ART (a special Neural Network Local Model).
- We deal with two training methods for each learning method:
  - in the *supervised method* the model uses training data in order to make classification and
  - in the *zero-knowledge method* the model incrementally learns from unsuccessful predictions.
- Our findings indicate that the C-nT model suits better to context-aware systems.

Thank you

Christos Anagnostopoulos

Pervasive Computing Research Group,

Department of Informatics and Telecommunications,

University of Athens, Greece.