Pythia: A Privacy-enhanced Personalized Contextual Suggestion System for Tourism

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Summary

Summary of this work

- We present Pythia, a privacy-enhanced non-invasive contextual suggestion system for tourists
  - high quality personalized recommendations
  - non-invasive operation
  - protection of user privacy
- Make contextual suggestions (POIs) based on automatically built user profiles
- The user profile is POI-based using as personal data from user's Smartphone:
  - Location traces
  - Browsing history
  - Web searches
- Strong privacy guarantees are achieved by placing both mechanisms at the user-side
- Proof of concept: a prototype implementation of Pythia
  - as an Android application, as well as a web application

- Background
  - *Privacy*
  - *Tourism recommendations*

Privacy & Legislation

- **What is privacy?**
  - "The right to be let alone" [Warren and Brandeis, 1890]
  - "The right of the individual to decide what information about himself should be communicated to others and under what circumstances" [Westin, 1970]
  - The right to informational self-determination [1983]

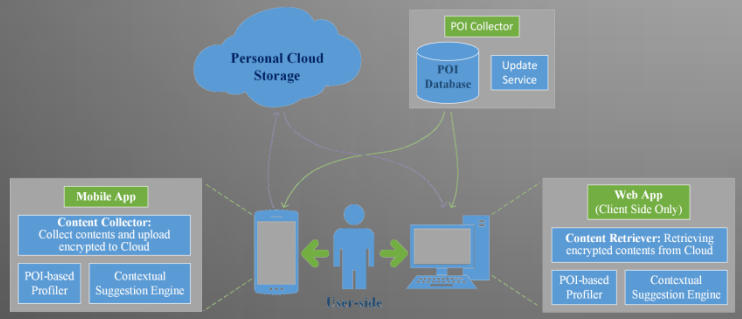
- **Personal Data**: Any information that refers to a person

- **Related Legislation**: e.g. EU Data Protection Directive 95/46/EC
  - Indicative principles:
    - Reported and transparent processing
    - Finality & Purpose Limitation
    - Personal data quality
    - Security
    - Personal data traffic outside EU

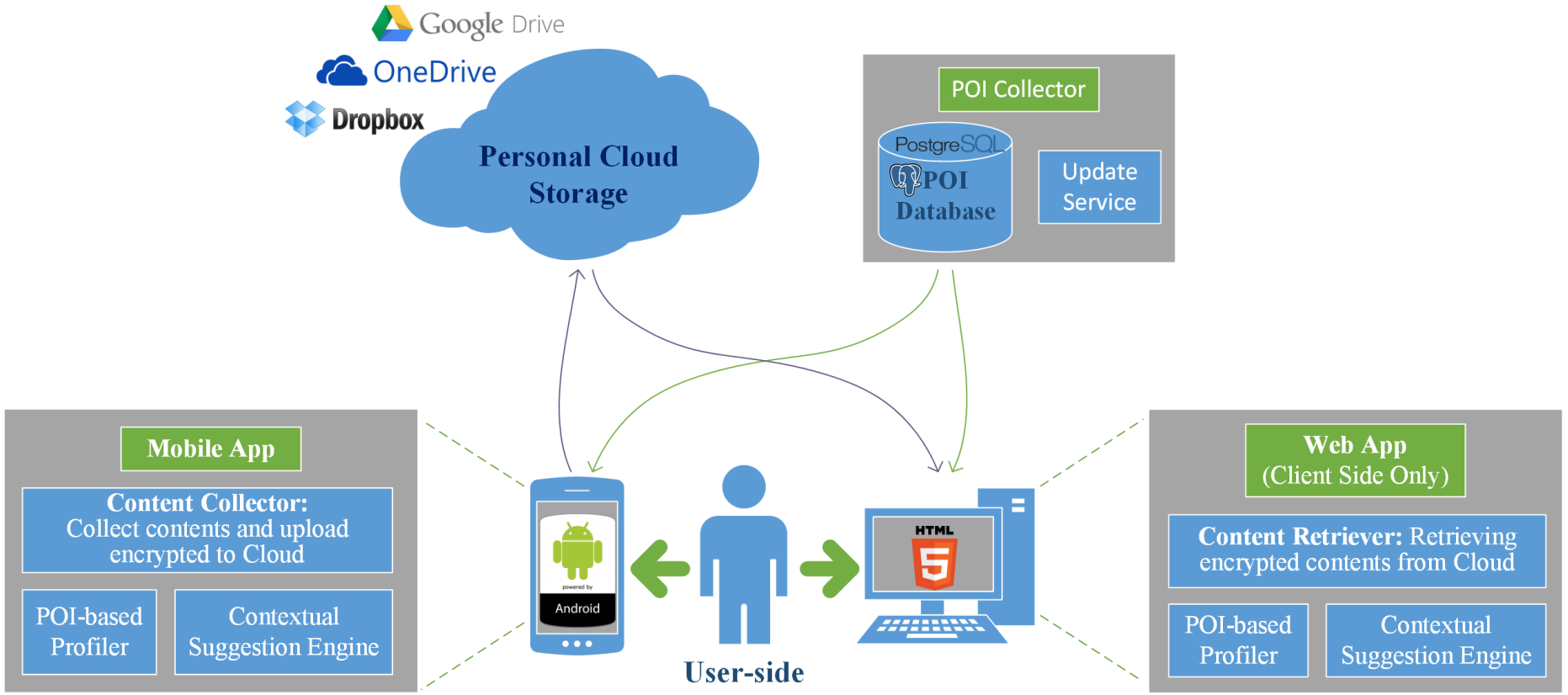
Recommender Systems in Tourism

- A recommender system requires some input data in order to make appropriate suggestions
  - Simple preferences: needs, interests and constraints
  - Evaluations and ratings of other tourists (collaborative filtering)
  - Travelers who are in close spatial and temporal proximity often share common travel interests
- Common practice of such systems
  - Users have to enter their personal information into some system
  - User profiles have to be stored and managed by the recommender service
  - The recommendations are performed in server-side
- The usage of personal data concerns privacy issues
- Pythia system combines a set of unique features in the field of mobile recommendation systems
  - User-centric architecture
  - Privacy-preserving
  - Rich user profiles
  - Non-invasive creation of user's profile

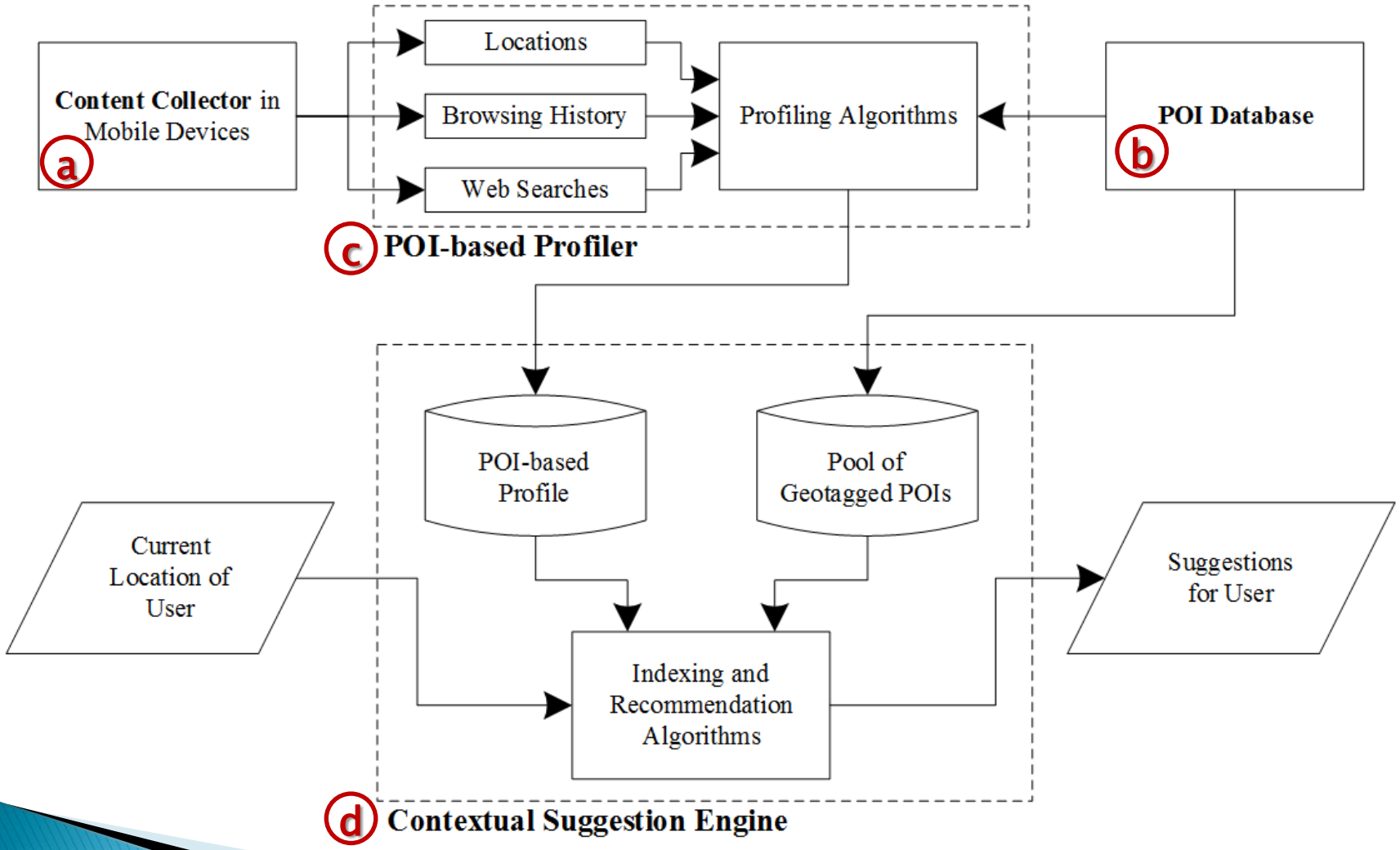
The Pythia System



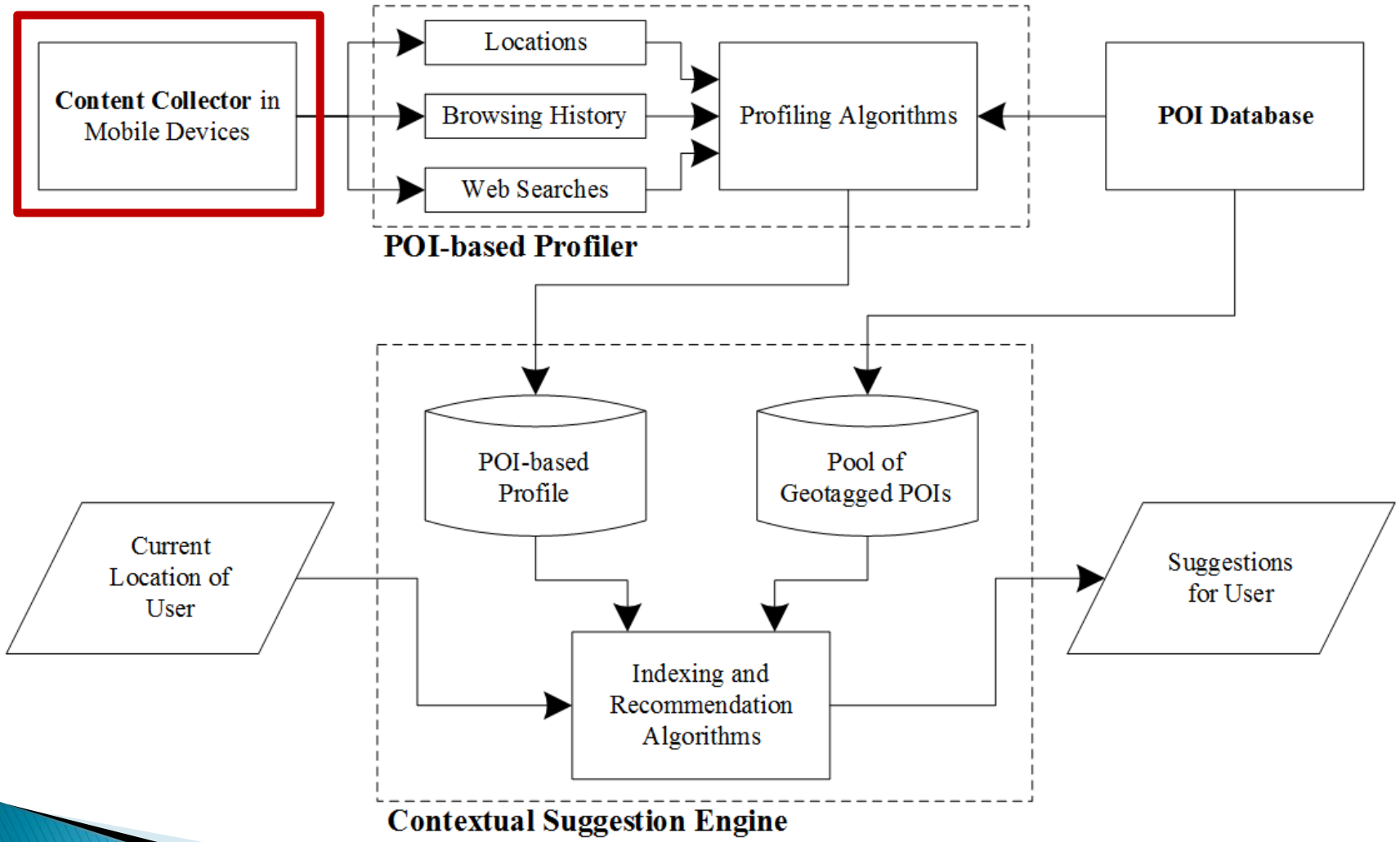
The architecture of the Pythia system



Interaction of Pythia components



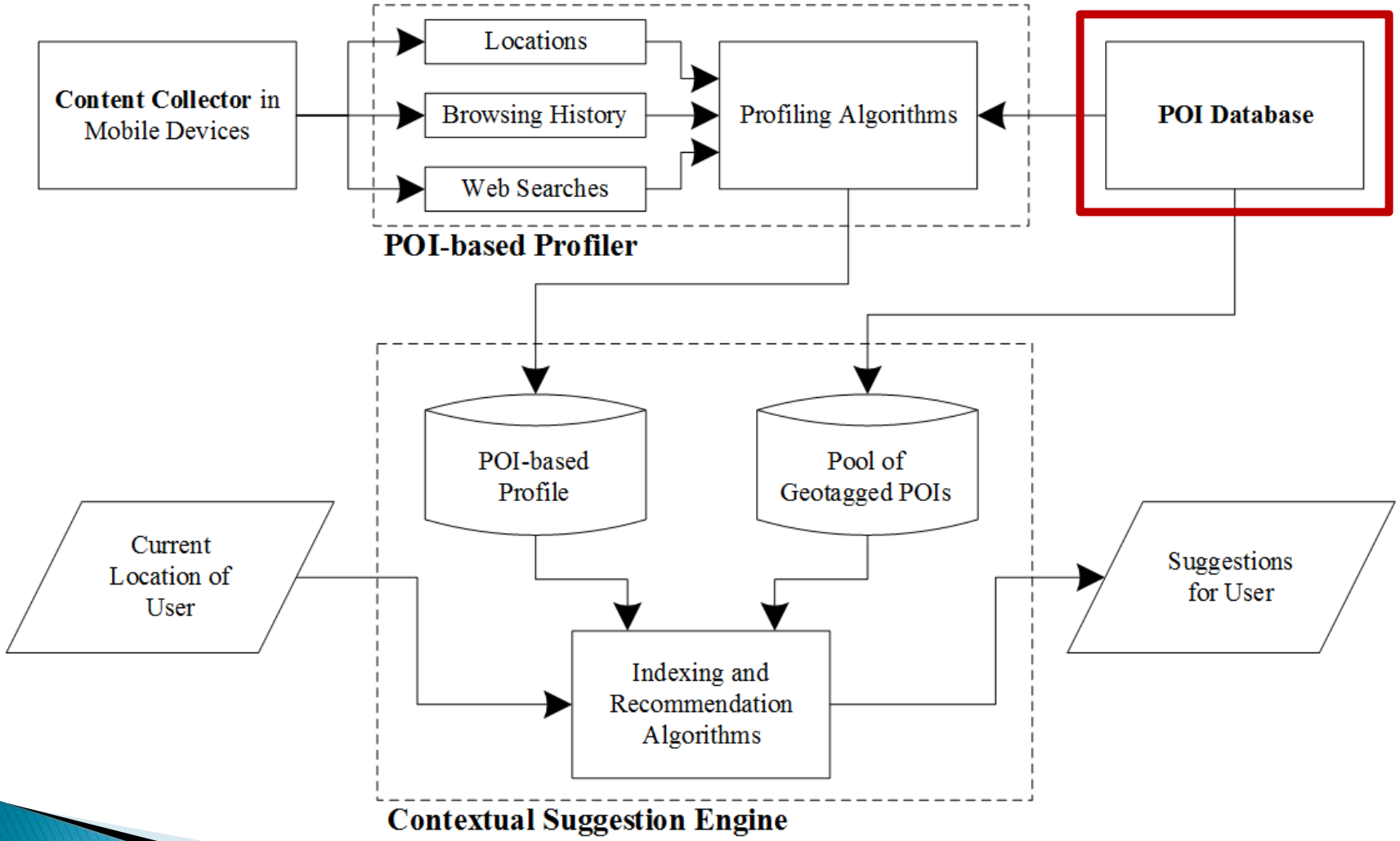
ⓐ Personal Data Collection



ⓐ Personal Data Collection

- Content Collector collects personal data of the digital trace generated by the everyday usage of the smart devices
- This data is stored locally on each device
- Focus on the following types of personal data:
  - **Location traces:** Records of locations in a particular time frequency
    - [Latitude, Longitude]: GPS or Network provider
    - Speed, Altitude, Bearing
    - Accuracy
    - Time
  - **Browsing history:** Records of browsing history
    - Title
    - URL
    - # of visits
    - Time of last visit
  - **Web searches:** Query logs
    - Query
    - Submission time

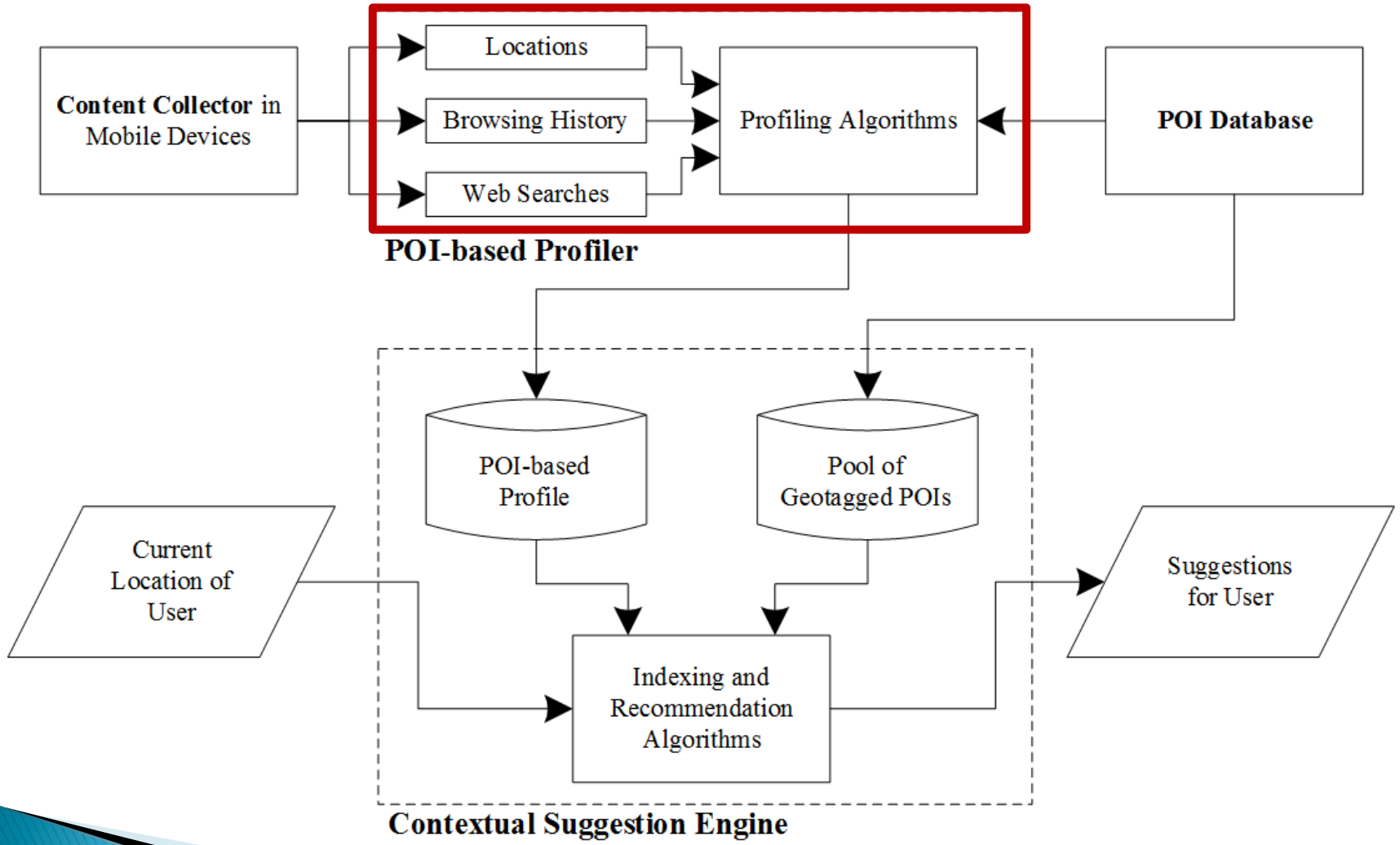
ⓑ POI Collection Framework



ⓑ POI Collection Framework

- This framework implements a Web API which is used by other Pythia components to access the POI database
- The POIs can be retrieved via API:
  - one by one
  - as chunks corresponding to a specific county or area
- The data available for each POI are:
  - title
  - geo-location
  - address
  - phone number
  - categories
  - several URLs
  - rating
  - total unique visitors and total visits
  - a collection of terms describing the POI
- An update service continuously updates and extends the database with new information about POIs from Foursquare and Google Places

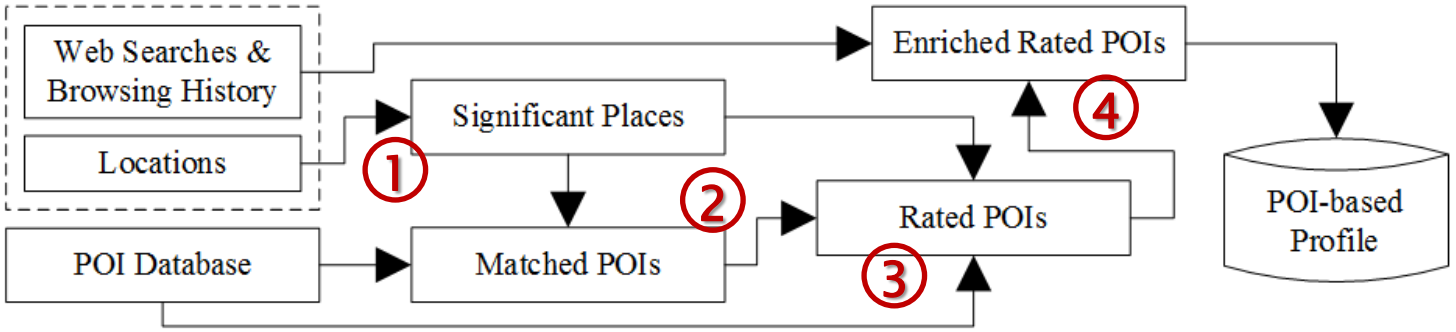
© POI-based Profiling Process



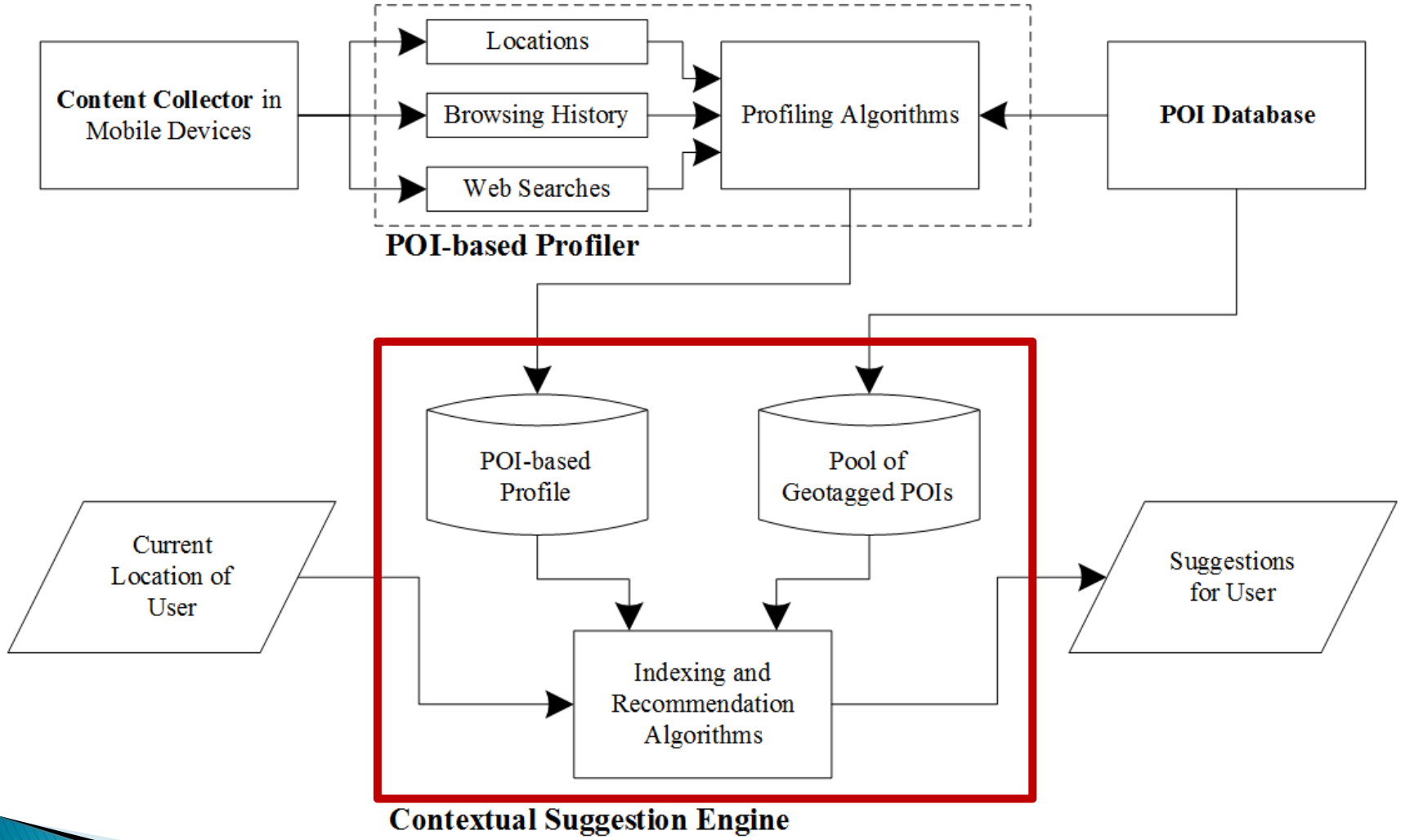
ⓒ POI-based Profiling Process

- Data processing steps:

1. **Significant places extraction**: Apply time-based clustering on location traces
2. **POI matching**: Match significant places with POIs from the POI database
3. **POI rating**: Estimate the user's interest for the POI based on the user's number of visits and the average number of visits per user to this POI
4. **Enrichment of Rated POI**: Adjust the POI ratings based on the web searches and titles of browsing history by applying an information retrieval approach



The Rocchio-like Contextual Suggestion model*



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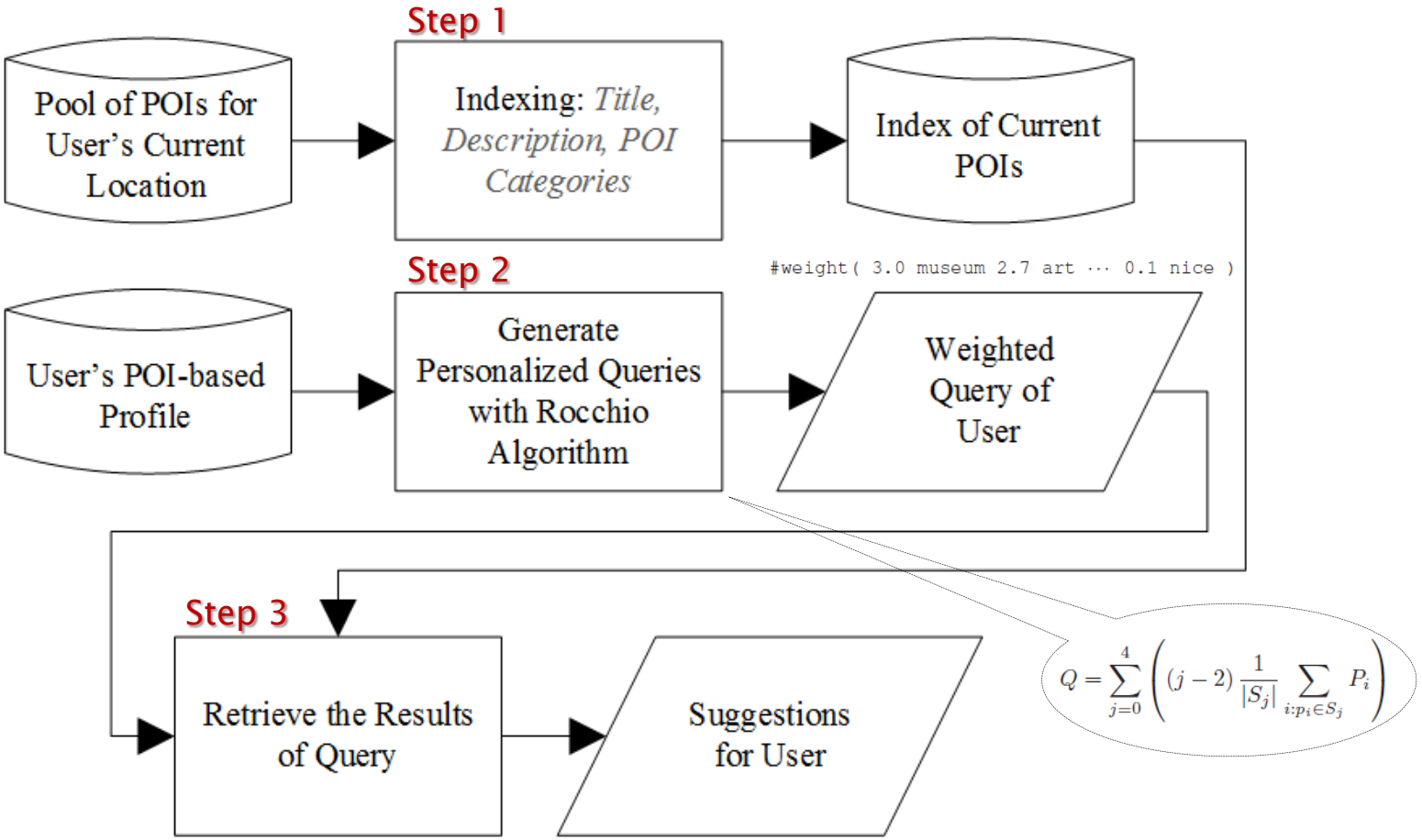


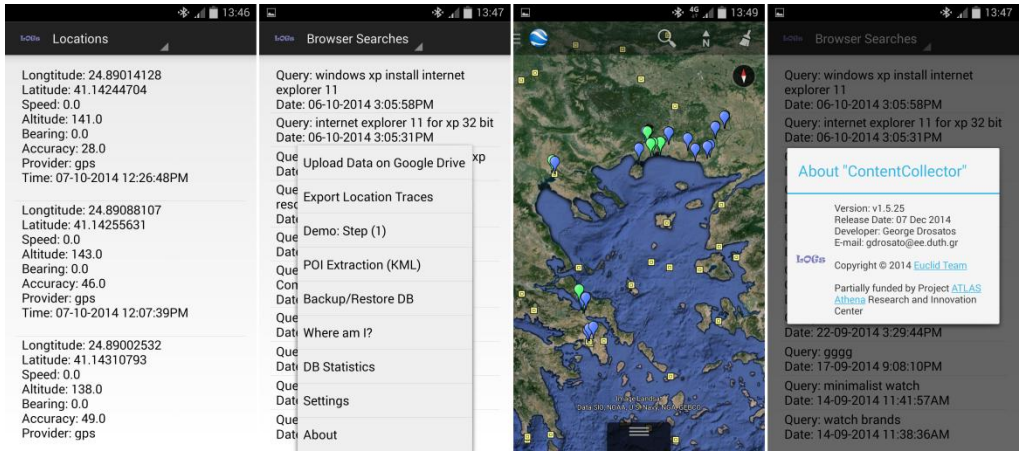
** TREC 2013, Contextual Suggestion Track: We ranked with this algorithm at 2nd place among 15 research groups*

The Pythia Prototype

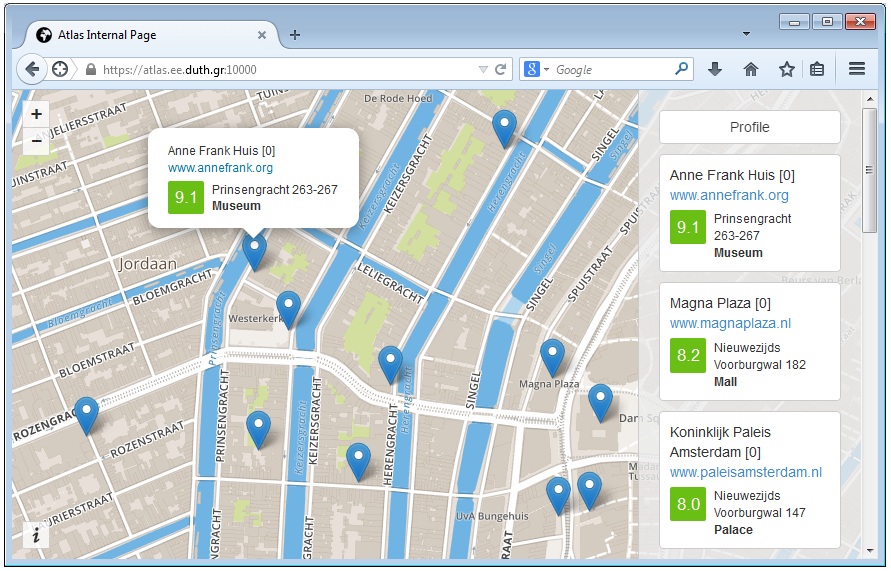
Current status of implementation

- Fully implemented
  - POI Collector (PHP, PostgreSQL)
  - Content Collector (Android platform)
- Only implemented as web application
  - POI-based Profiler (JavaScript)
  - Contextual Suggestion Engine
- The current prototype are implemented as a collection of standalone applications
  - Communicate through the personal Cloud storage of the user

Content Collector



POI-based Profiler & Contextual Suggestion Engine



Conclusions

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- Proposed the Pythia system: a privacy-enhanced non-invasive contextual suggestion system for tourists
- The main system components operate in the background without user interaction
- The personal data of the user are kept on his own device
- Utilize sensitive personal data for personalized suggestions without violating the individuals' privacy
- The protection of user privacy is achieved by placing the profiling and recommendation procedures at the user-side
  - Mobile device OR desktop
- Developed prototype implementation

- Future work
  - Improve the automatic POI matching and POI rating algorithms
  - Upgrade the implementation to a more complete and stable system
  - Perform a more extensive evaluation of the complete system

Thank you,

» any questions ?

Acknowledgement

ATLAS: Advanced Tourism Planning System.
http://atlas.web.auth.gr/

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