

# Development of Mobile Search Applications over Structured Web Data through Domain-Specific Modeling Languages

M.Sc. Thesis  
Atakan ARAL  
June 2012



# Acknowledgements

- Joint agreement for T.I.M.E. Double Degree Program between:
  - Istanbul Technical University
  - Politecnico di Milano
- Article 2.1
  - (...) They shall produce a final thesis in English with summaries in Italian or Turkish, which shall be presented at both Institutions. Thereafter they shall be awarded the titles of "Laurea Magistrale in Ingegneria" at PM and "Master of Science" at ITU. (...)

# Acknowledgements

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Research and development for this thesis was carried out

- in collaboration with **M. Sc. Ilker Zafer AKIN**
- under supervision of **Asst. Prof. Marco BRAMBILLA**
- within the scope of the **Search Computing Project (SeCo)**

# Acknowledgements

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- SeCo aims to build the answers to complex search queries
  - by interacting with a constellation of **cooperating search services**
  - using **ranking** and **joining** of results as the dominant factors for service composition
- DataBase Group in Politecnico di Milano
- Funded by the European Research Council
- November 2008 - November 2013

1. Problem Definition
2. Thesis
3. Background Information
4. Proposed Solution
5. Implementation
6. An Example Scenario
7. Conclusion



- Web search applications are primarily designed for access through PC's
  - Most widespread usage scenario
- Adoption of web-enabled smartphones, tablets and embedded devices
  - Different **application goals** and **user expectations**
  - Limitations and opportunities
  - Different **interaction methods**



- Basic text-based search had been acceptable until recently, but...
- Technological advances
  - Broadband internet connectivity
  - Device mobility
- New trends
  - Web 2.0
  - Semantic web
- **Higher expectations**



- We aim to propose a novel search paradigm focussing:
  - Mobile devices
    - Utility information on **concepts** and on **geo-located entities**, rather than web pages
    - Less complicated interaction and minimal **textual input**
  - Multi-Domain search
  - Exploratory search
  - Enhanced presentation of results





Our claim is that:

‘New search paradigms may let users conduct the search on small devices without being hampered by the limitations of the devices themselves.’

‘Appropriate solutions may also exploit the advantages of such devices for further improving the overall search experience.’



- Multi-Domain Search
  - ‘Queries that are over more than one **semantic field of interest**’
  - Automatically combine the results of **domain-specific searches**
  - Provide **answers** originating from various domains
  - Exhausting and time-consuming job without multi-domain search



# Background Information

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‘Find a good **database conference** in October 2012 in Milan, Italy, with accommodation in a 5-star **hotel** with reasonable price’

‘Find a **Cinema** in Paris that has Titanic **movie** on display with a good, nearby **Chinese restaurant**’



- A multi-domain search application may include:
  - Identifying semantic fields
  - Identifying input parameters
  - Invoking domain-specific search services
  - Associating and combining results
  - Ranking and sorting combinations
  - Presenting combinations

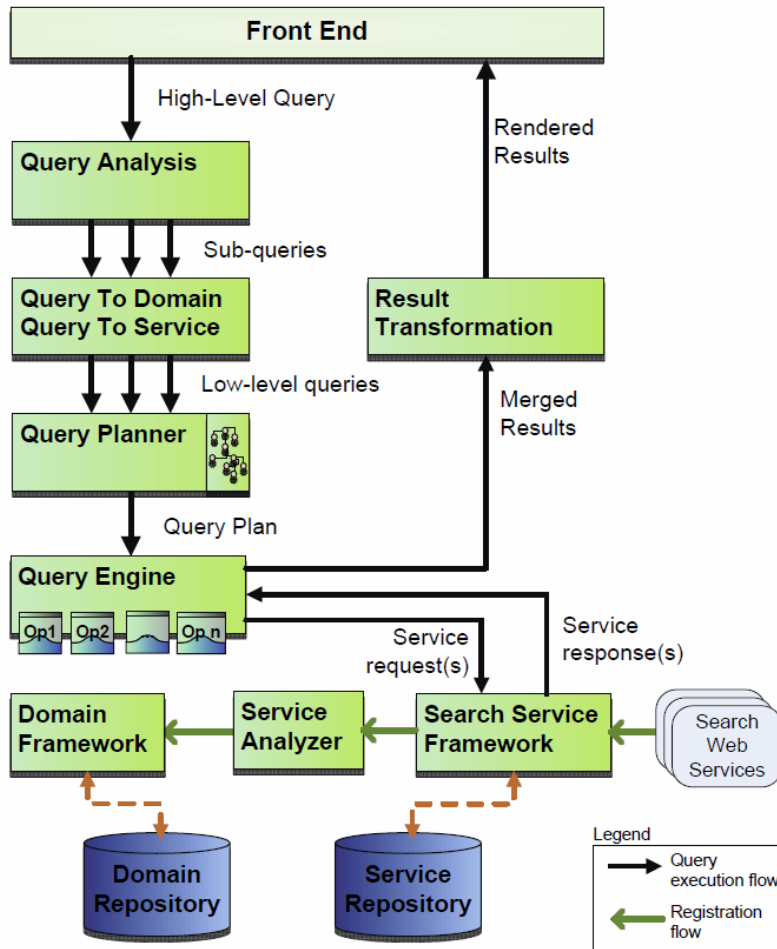


- Exploratory Search
  - ‘Blends **querying** and **browsing** strategies from retrieval that is best served by analytical strategies.’
- Motivation
  - User may not be an expert in the area
  - User may be unsure on how to conduct the search due to technology or process
  - User may be unsure about the goal of the search

- Increasing human interaction in search
- Supporting the user in every step of the search process
  - Identification and formulation of the query
  - Exploration of most relevant and credited information sources
  - Presentation of results
  - Possible improvement of the query
    - Specify
    - Broaden



- Search Computing Framework

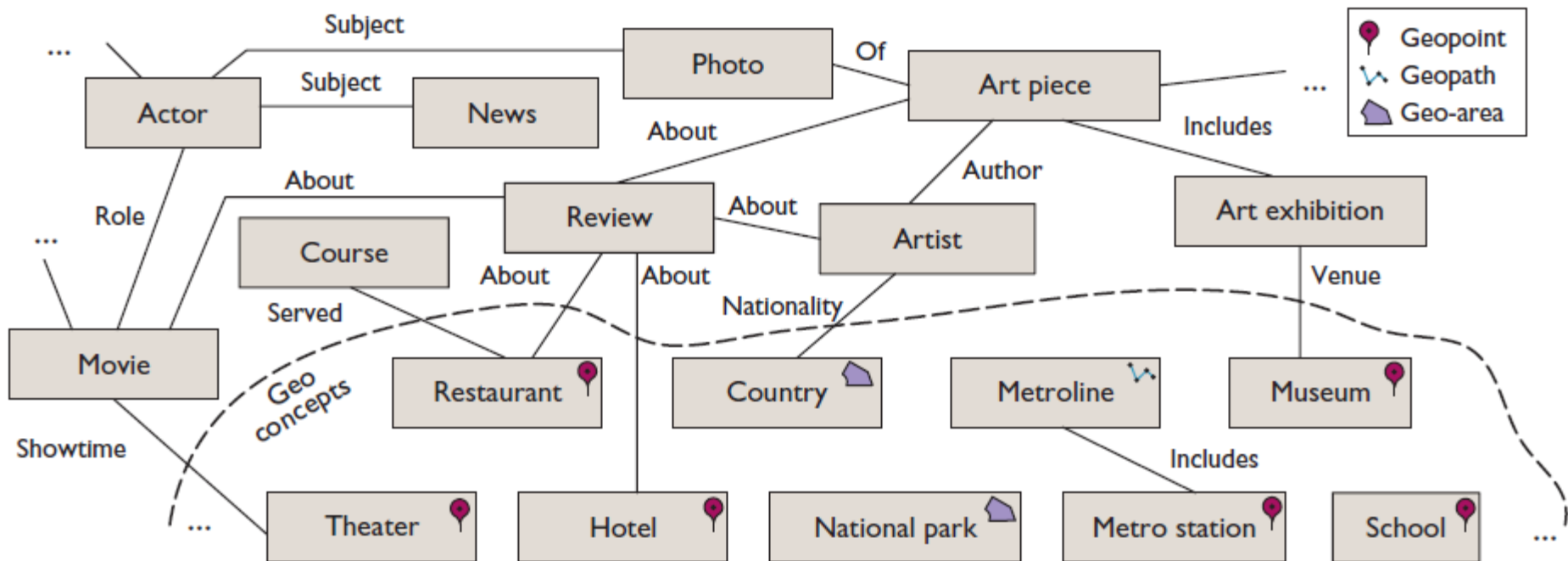


- Mart Repository  
ReST API

- Query Processor  
ReST API

# Background Information

- Connection Patterns in SeCo





- Mobile Search Interfaces
  - Smaller **screen size** and **resolution**
  - Ability to use in different **orientations** like landscape and portrait
  - Responds to **hand gestures** instead of clicks
  - User can interact with a single application and a **single screen** of it at the same time
  - Less computational capacity

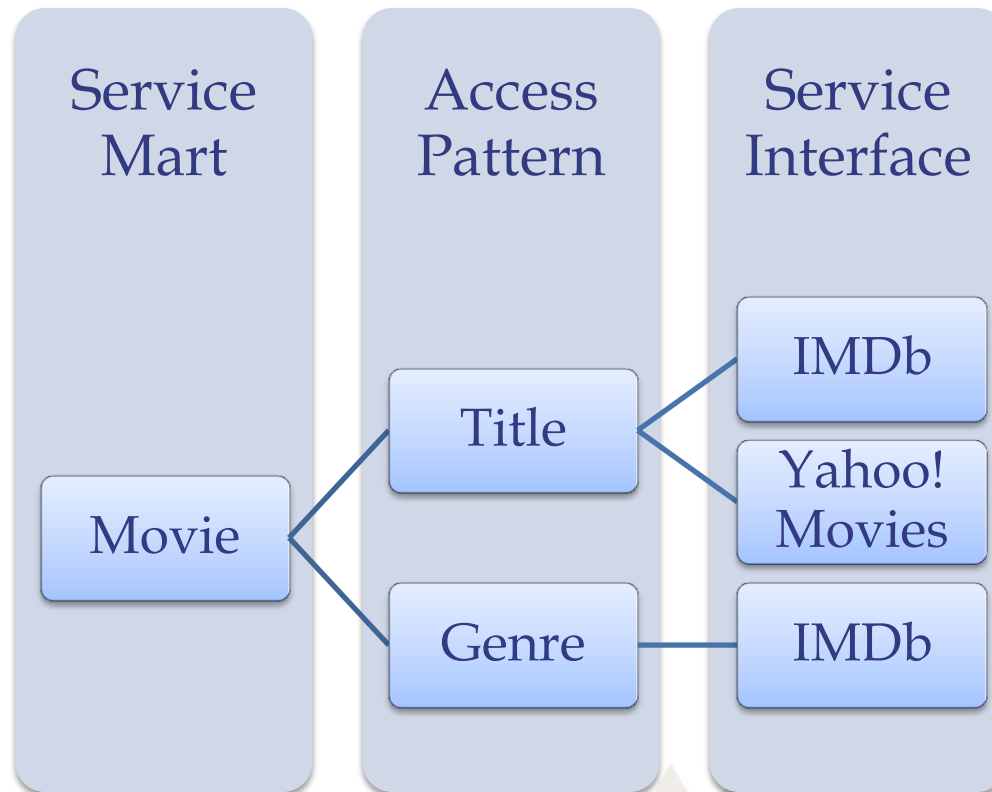


- Presentation of Results
  - Result set for multi-domain query can be highly dimensional
  - Multiple visualization methods should be provided
    - map view for geo-referenced objects
    - timeline view for time-located objects
    - other methods when suitable interval dimensions are not available



# Proposed Solution

- Initial formulation of the the query
  - Top-down approach, predefined items



# Proposed Solution

- Collection of input parameters
  - Predefined input list
  - Specialized form elements for different data types
    - Coordinates, date, time etc.

Sat Feb 2	11	50	
Sun Feb 3	12	55	AM
<b>Today</b>	1	00	PM
Tue Feb 5	2	05	
Wed Feb 6	3	10	

October	23	2005
November	24	2006
December	25	2007
January	26	<b>2008</b>
February	27	2009

# Proposed Solution

- Presentation of results

« Back Map Compare

▶ 167 Hoyt St (0.0)  
▶ 82 Vanderbilt Ave (0.0)  
▼ 210 Congress St APT ... (0.48)

state: NY  
zipcode: 11201  
city: Brooklyn  
street: 210 Congress St APT 6F  
longitude: -73.99478149414062  
latitude: 40.68775939941406  
type: makeMeMove  
useCode: Cooperative  
details:  
<http://www.zillow.com/homedetails/210-Congress-St-APT-6F-Brooklyn-NY-11201/7079468...>

Search History

« Back compare Map

JOBTITLE	STATE	
Help Desk - I.T. Support	VA	Choose
IT Manager	TX	Choose
IT Manager - Oracle R12 Enterprise Services	GA	Choose

« Back



Harita

New York

Map showing a cluster of red location pins in the New York City area, specifically around the Hudson River and Manhattan. The map includes street names like Broadway, Bowery, and Grand St, and a search bar with the word 'Harita'.

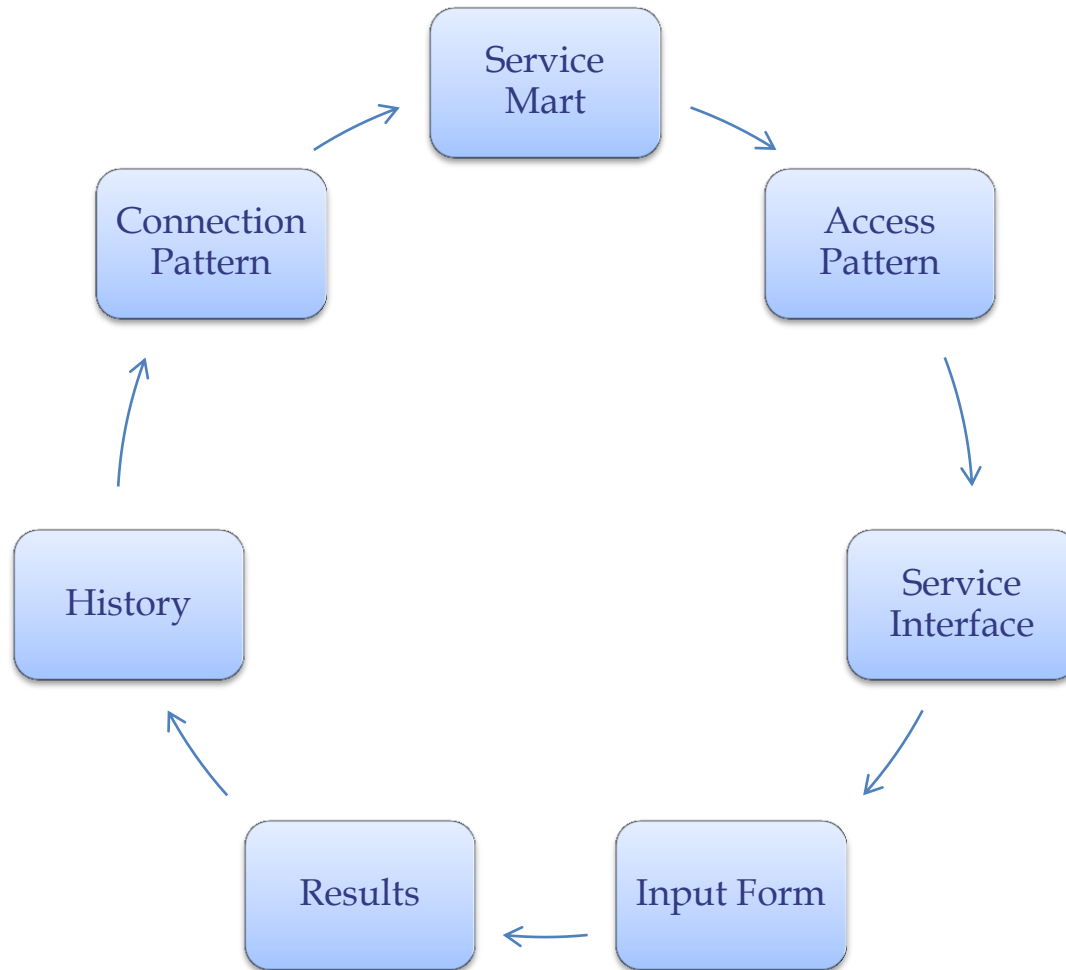
- Improvement of the query
  - Predefined connections
  - Possibility to add another domain after a domain-specific search is complete
  - ‘Potentially unlimited loop of connected domain-specific searches’
  - History list/map to review previous selections and add new domains



A screenshot of a search results list with six items, each followed by a right-pointing chevron. The items are: 'Car rental near Home', 'Walkscore indexes of Neighbourh...', 'School near Home by Zip', 'Events near Home', 'Transit index of Neighbourhood', and 'Job near Home'.

Car rental near Home	>
Walkscore indexes of Neighbourh...	>
School near Home by Zip	>
Events near Home	>
Transit index of Neighbourhood	>
Job near Home	>

# Proposed Solution



- Web search is conventionally carried out in web pages through a browser instead of standalone applications.
- The application is developed as a web application optimized for mobile devices and browsers.
- A domain specific language for developing mobile web applications called **mobl** is used.



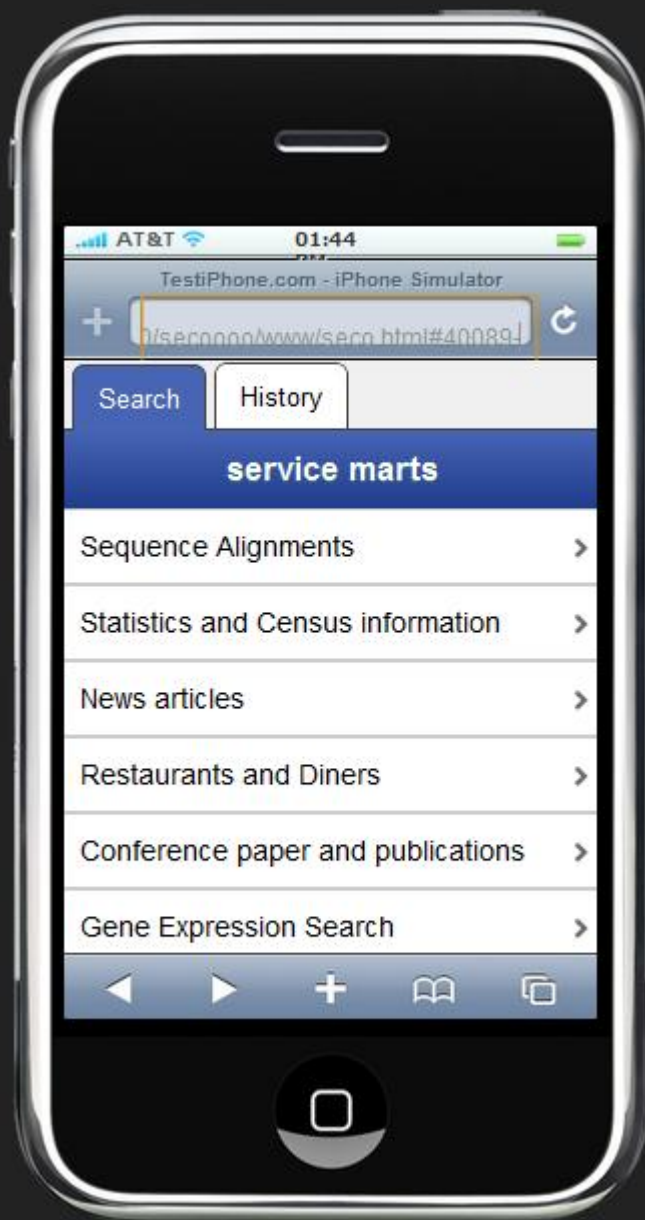
- Integrates all aspects of a mobile web application into a single language: data modeling, user interfaces, application logic, styling and web services.
- Compiler generates HTML5 / Javascript / CSS mobile web applications that run on modern Webkit-based browsers
  - iOS (iPhone, iPad), Android (2.0+), WebOS, Safari and Chrome

- Statically-typed language with type inference
- Lets specify ReSTful web service interfaces declaratively
- Integrated Development Environment
  - Eclipse based

# An Example Scenario

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‘A real estate for sale around here with an open IT position nearby’



AT&T 01:44

TestiPhone.com - iPhone Simulator

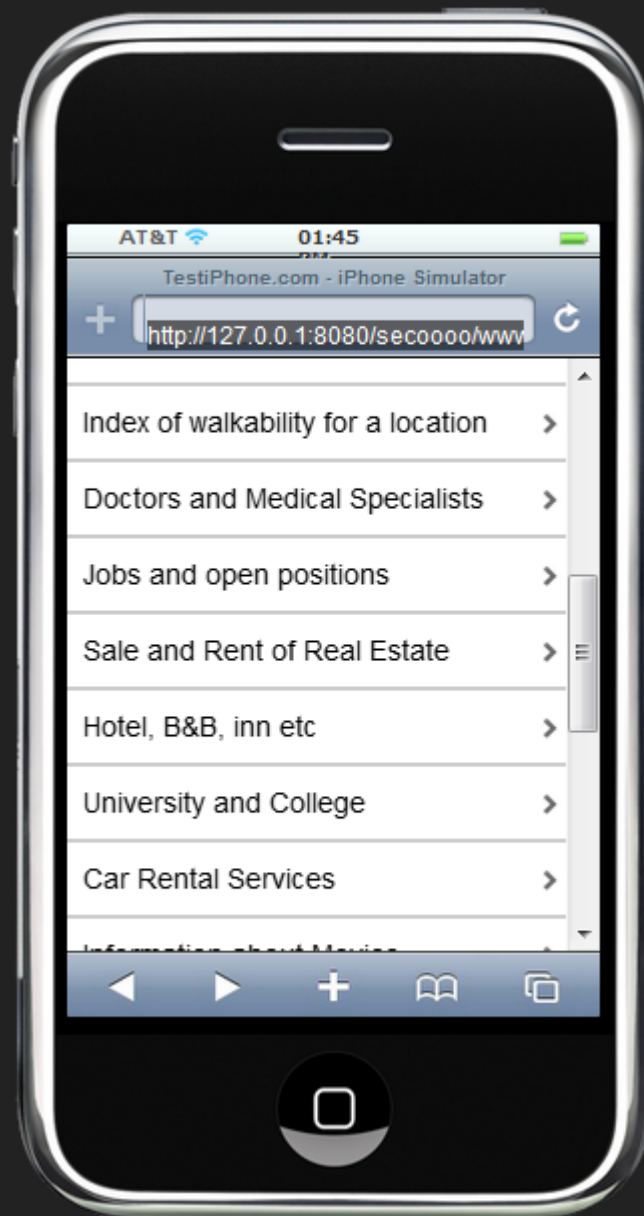
http://sec00000/www/sec0.html#40089!

Search History

### service marts

- Sequence Alignments >
- Statistics and Census information >
- News articles >
- Restaurants and Diners >
- Conference paper and publications >
- Gene Expression Search >

Navigation icons: back, forward, home, search, and dock icon.



AT&T

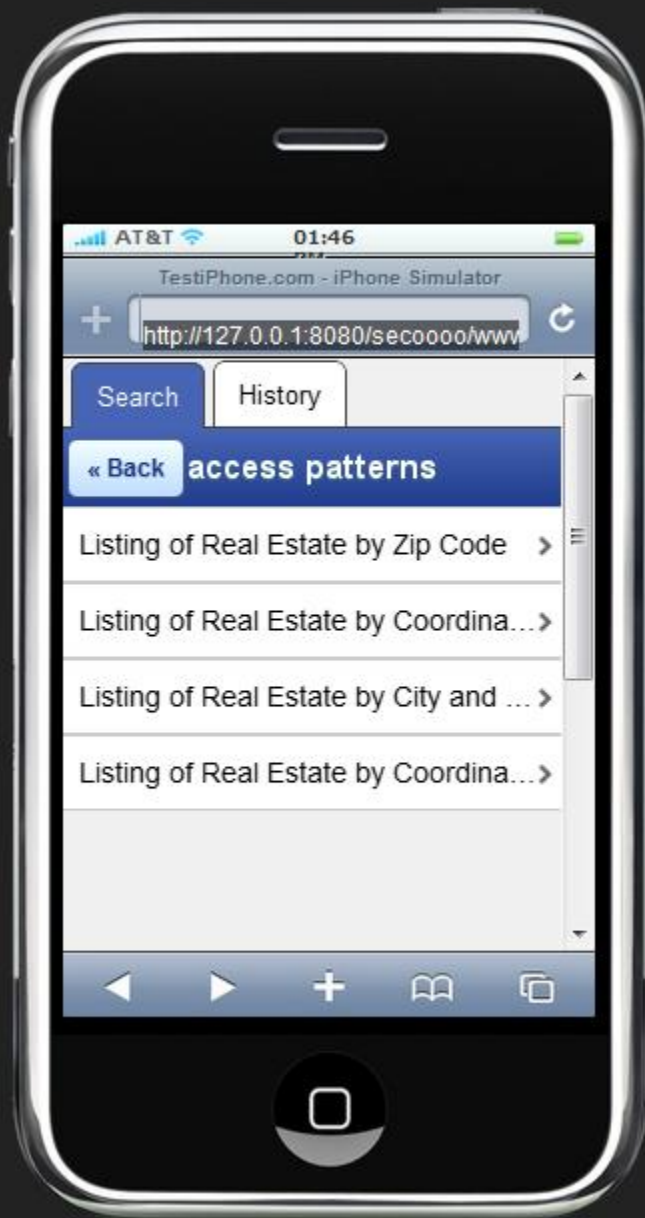
01:45

TestiPhone.com - iPhone Simulator

http://127.0.0.1:8080/sec0000/www

- Index of walkability for a location >
- Doctors and Medical Specialists >
- Jobs and open positions >
- Sale and Rent of Real Estate >
- Hotel, B&B, inn etc >
- University and College >
- Car Rental Services >





AT&T 01:46

TestiPhone.com - iPhone Simulator

http://127.0.0.1:8080/sec0000/www

Search History

« Back access patterns

- Listing of Real Estate by Zip Code >
- Listing of Real Estate by Coordina...>
- Listing of Real Estate by City and ...>
- Listing of Real Estate by Coordina...>

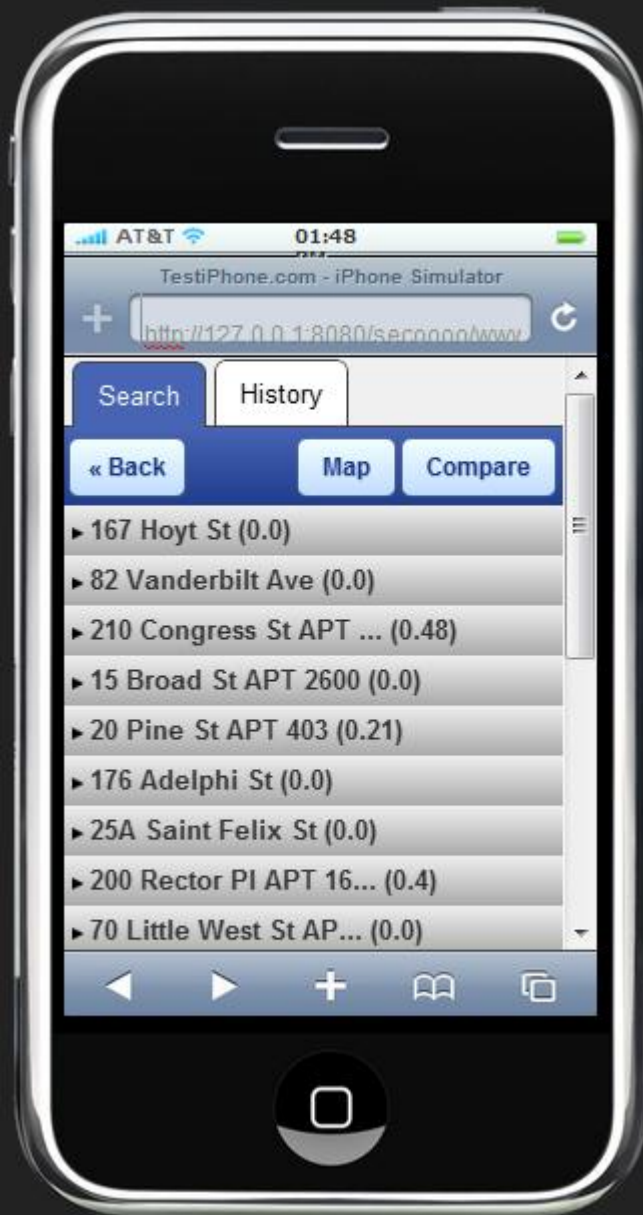
Navigation icons: back, forward, home, search, refresh







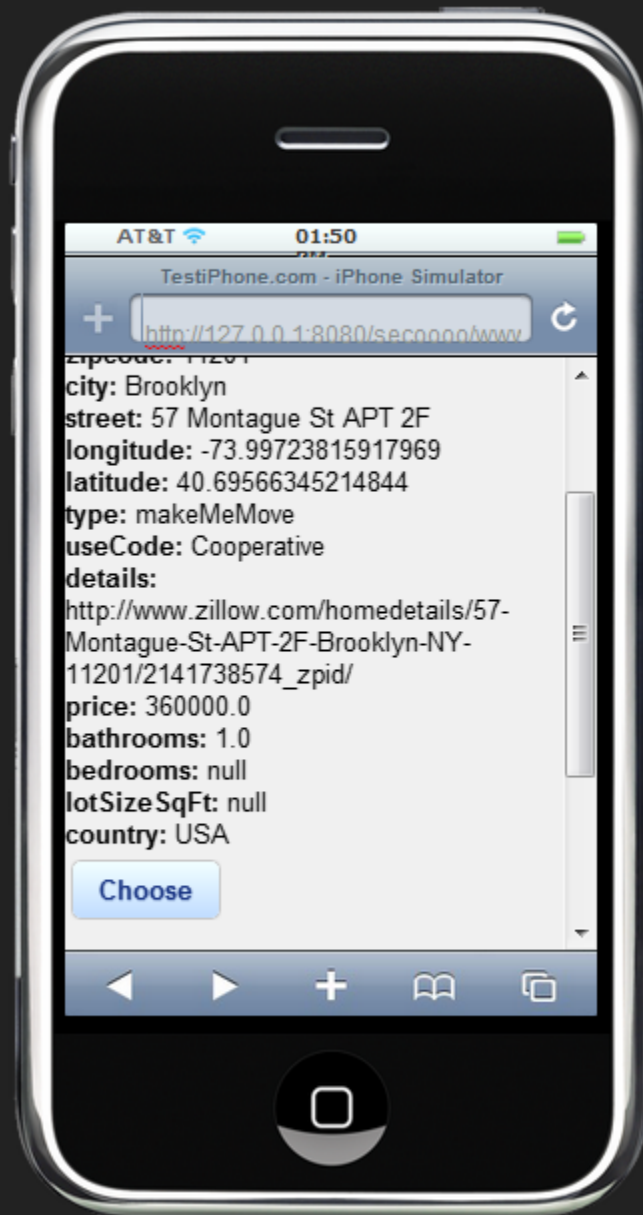












AT&T 01:50

TestiPhone.com - iPhone Simulator

http://127.0.0.1:8080/seconnoo/www

zipCode: 11201

city: Brooklyn

street: 57 Montague St APT 2F

longitude: -73.99723815917969

latitude: 40.69566345214844

type: makeMeMove

useCode: Cooperative

details:

[http://www.zillow.com/homedetails/57-](http://www.zillow.com/homedetails/57-Montague-St-APT-2F-Brooklyn-NY-11201/2141738574_zpid/)

[Montague-St-APT-2F-Brooklyn-NY-](http://www.zillow.com/homedetails/57-Montague-St-APT-2F-Brooklyn-NY-11201/2141738574_zpid/)

[11201/2141738574\\_zpid/](http://www.zillow.com/homedetails/57-Montague-St-APT-2F-Brooklyn-NY-11201/2141738574_zpid/)

price: 360000.0

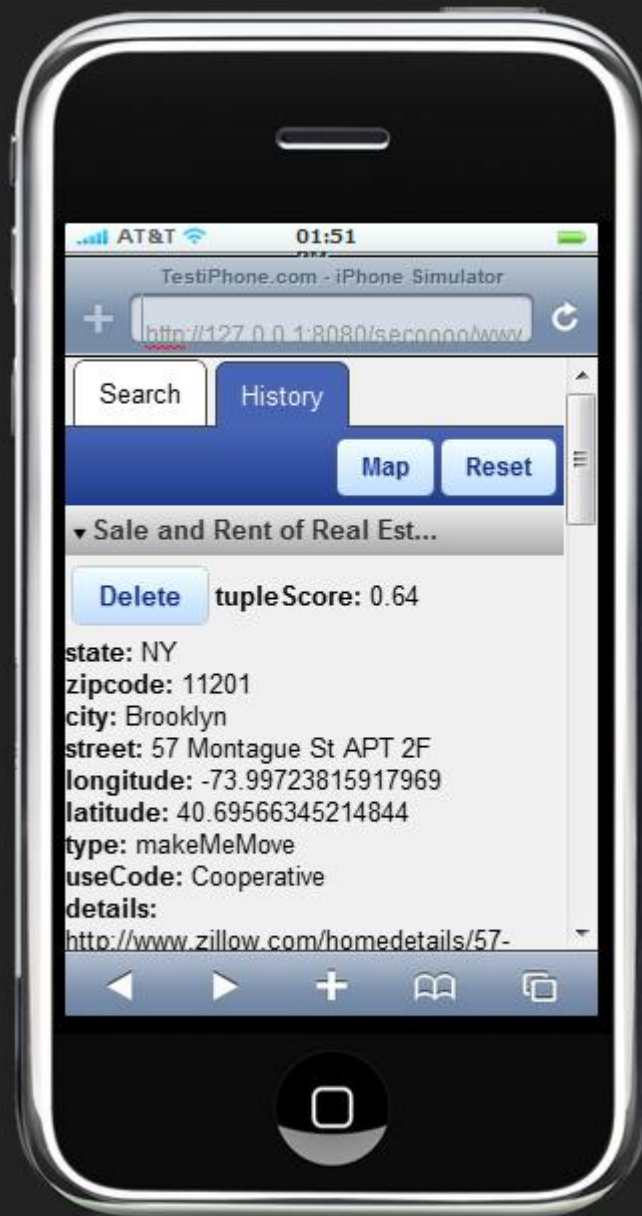
bathrooms: 1.0

bedrooms: null

lotSize SqFt: null

country: USA

Choose



AT&T 01:51

TestiPhone.com - iPhone Simulator

http://127.0.0.1:8080/secondo/ww

Search History Map Reset

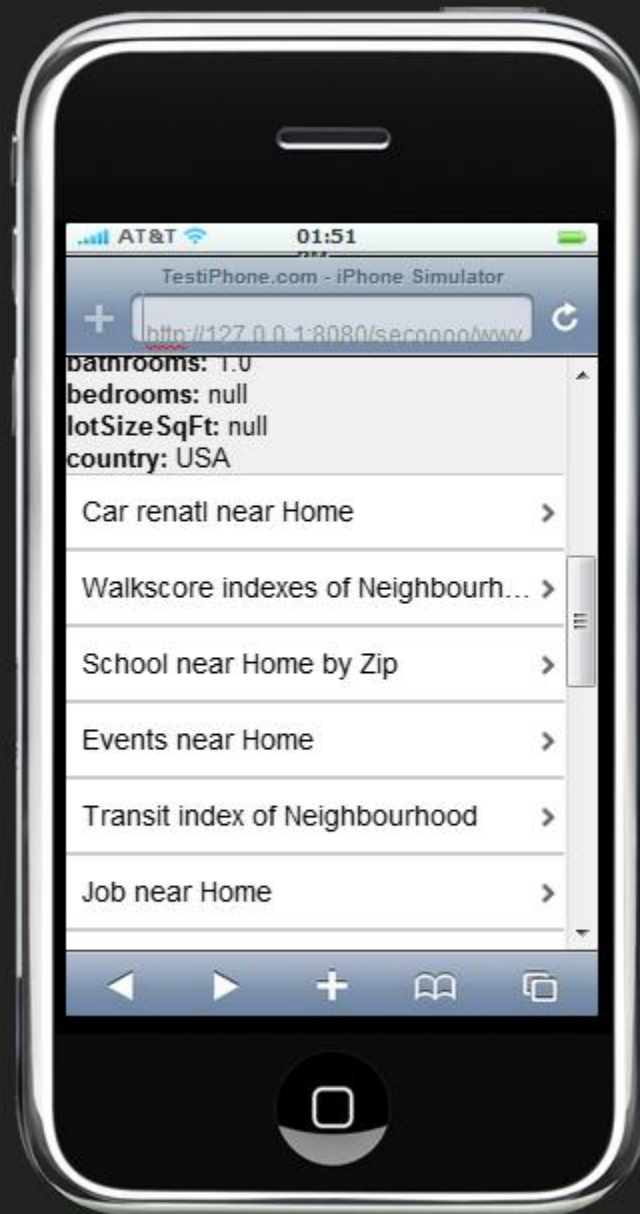
▼ Sale and Rent of Real Est...

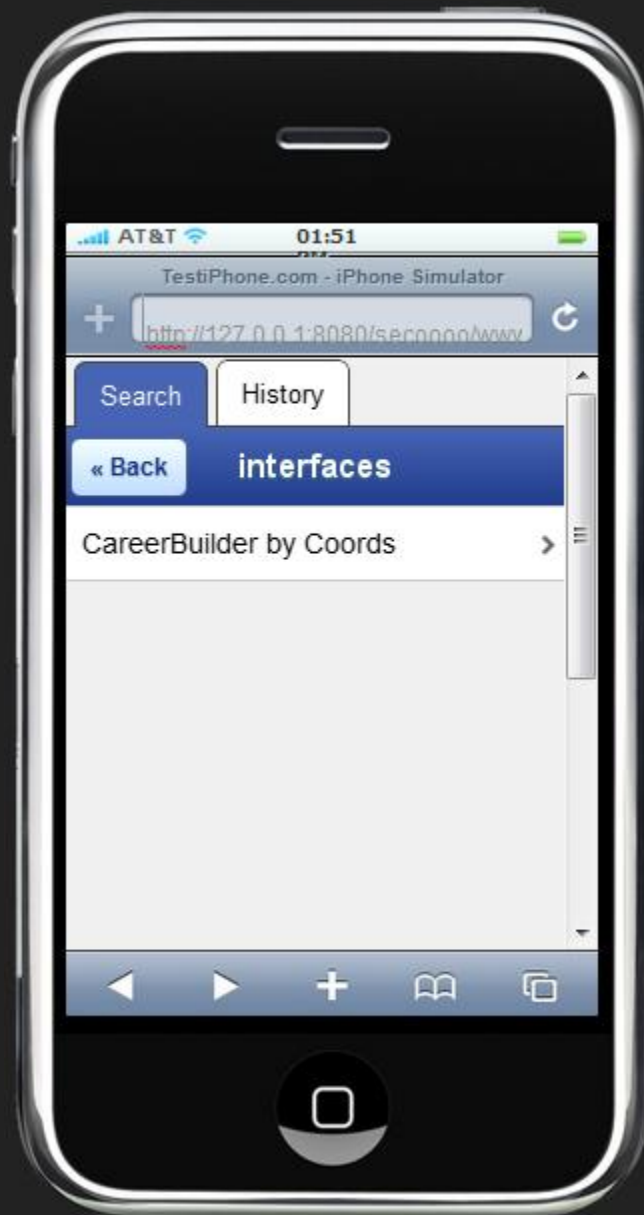
Delete tupleScore: 0.64

state: NY  
zipcode: 11201  
city: Brooklyn  
street: 57 Montague St APT 2F  
longitude: -73.99723815917969  
latitude: 40.69566345214844  
type: makeMeMove  
useCode: Cooperative  
details:  
http://www.zillow.com/homedetails/57-

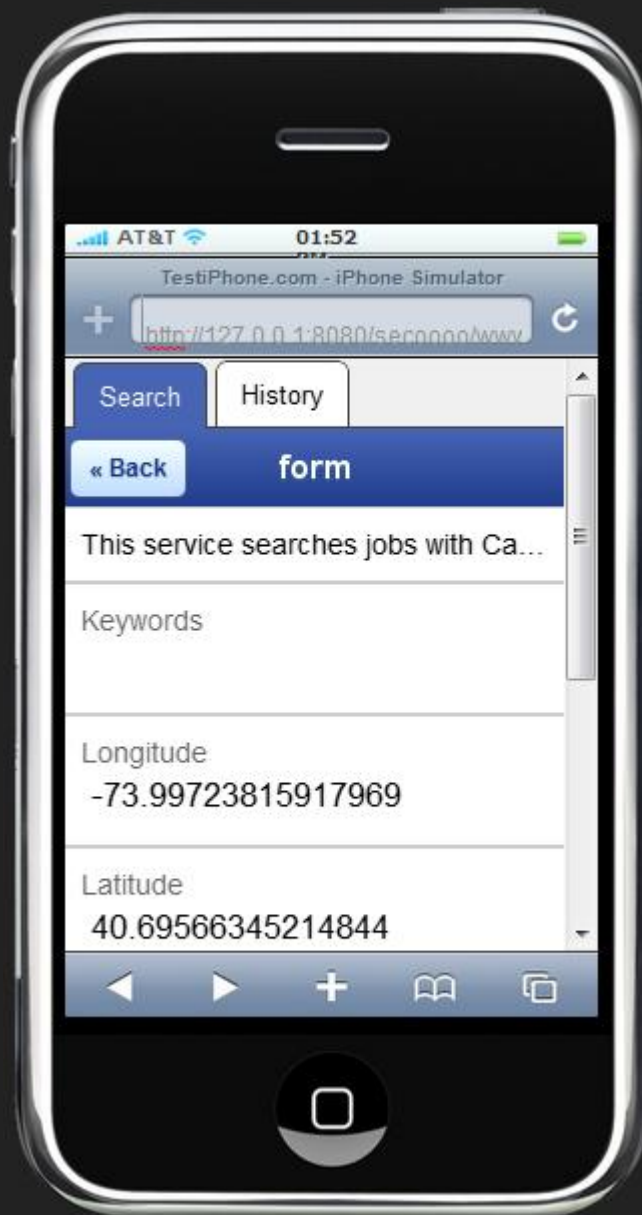
Navigation icons: back, forward, home, search, share











AT&T 01:52

TestiPhone.com - iPhone Simulator

http://127.0.0.1:8080/secondo/www...

Search History

« Back form

This service searches jobs with Ca...

Keywords

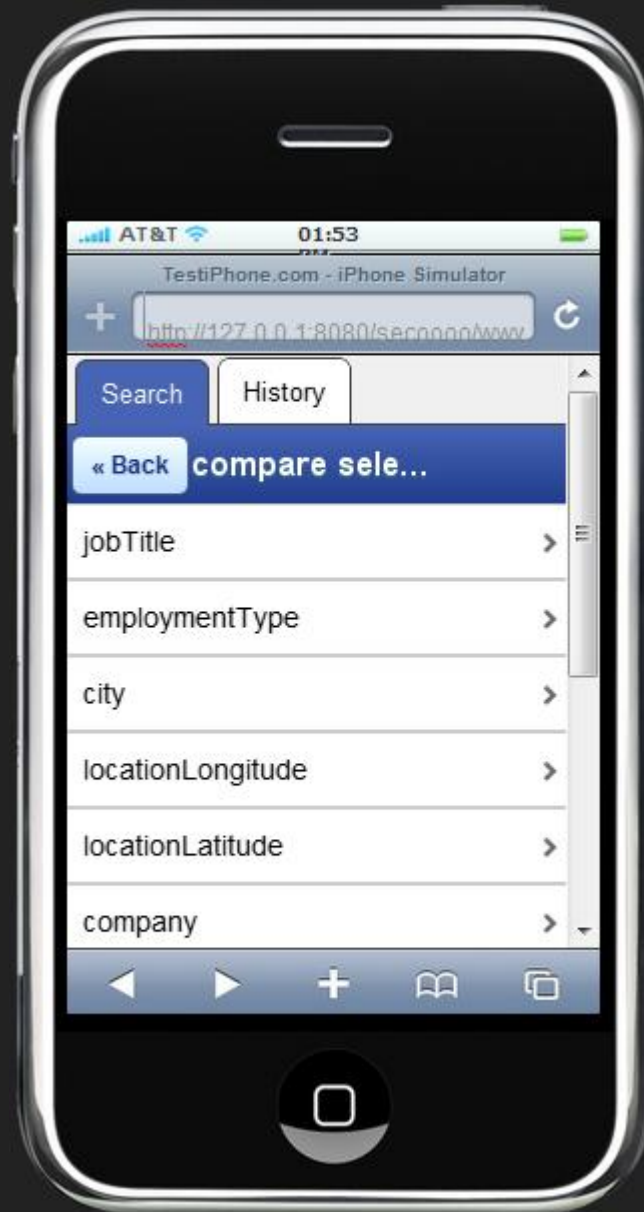
Longitude  
-73.99723815917969

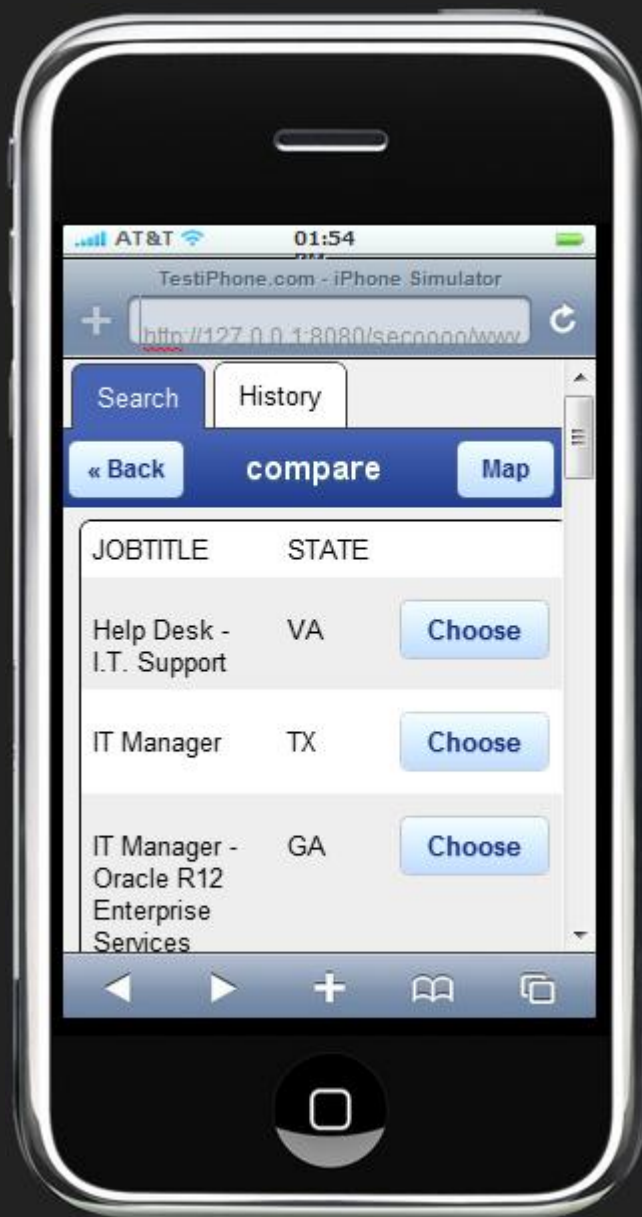
Latitude  
40.69566345214844

Navigation icons: back, forward, home, search



AT&T 01:52  
TestiPhone.com - iPhone Simulator  
+ http://127.0.0.1:8080/sec0000/www  
Search History  
« Back Map Compare  
▶ Help Desk - I.T. Sup... (1.0)  
▶ IT Manager (0.99)  
▶ IT Manager - Oracle ... (0.98)  
▶ Field IT Engineer - ... (0.97)  
▶ IT Specialist and IT... (0.96)  
▶ Help Desk Specialist... (0.95)  
▶ IT21 - Programmer An... (0.94)  
▶ Advisory Services Ma... (0.93)  
▶ Chief Information Of... (0.92)





AT&T 01:54

TestiPhone.com - iPhone Simulator

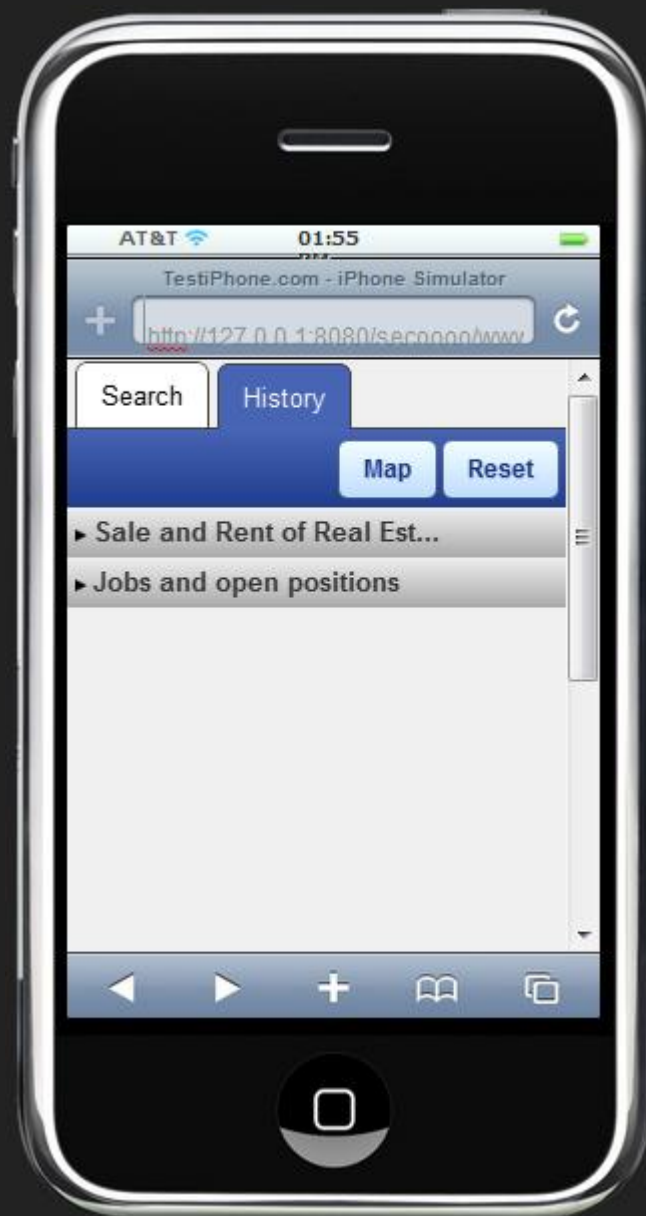
http://127.0.0.1:8080/sec0000/www

Search History

« Back compare Map

JOBTITLE	STATE	
Help Desk - I.T. Support	VA	Choose
IT Manager	TX	Choose
IT Manager - Oracle R12 Enterprise Services	GA	Choose

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- We propose a solution for multi-domain search and exploratory search performed on mobile devices
- Our main focus is on non-functional requirements
- Proposed solution is also implemented as a mobile web application.



- The proposed application paradigm
  - helps the user to develop complex multi-domain queries
  - with the aim of exploring the results from credited sources with ease
  - and possibly associate them with one another

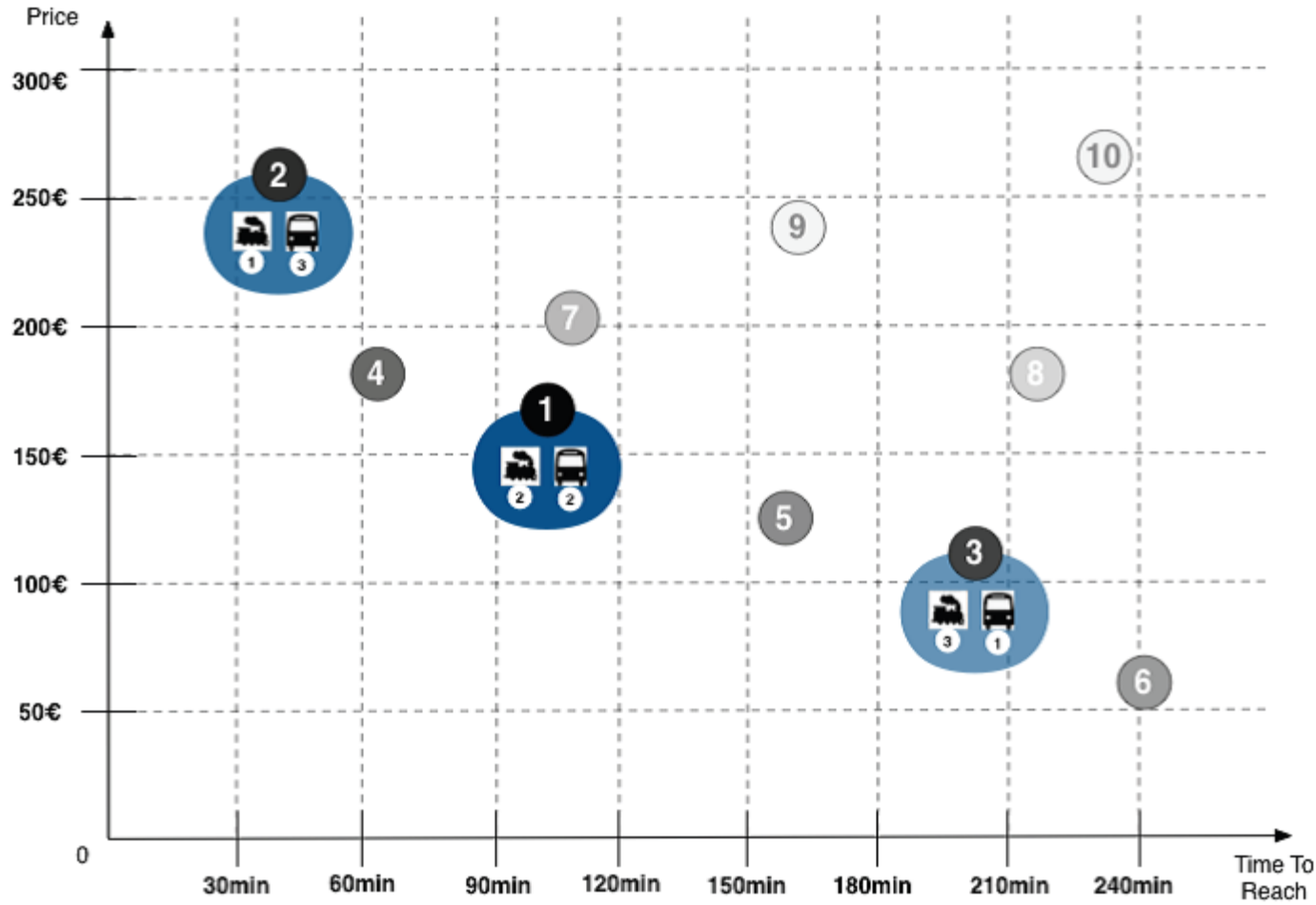


- It increases the usability of exploratory search in mobile devices w.r.t. the desktop computers
- It exploits the strengths of the mobile devices interaction paradigms by channeling them to the search process.

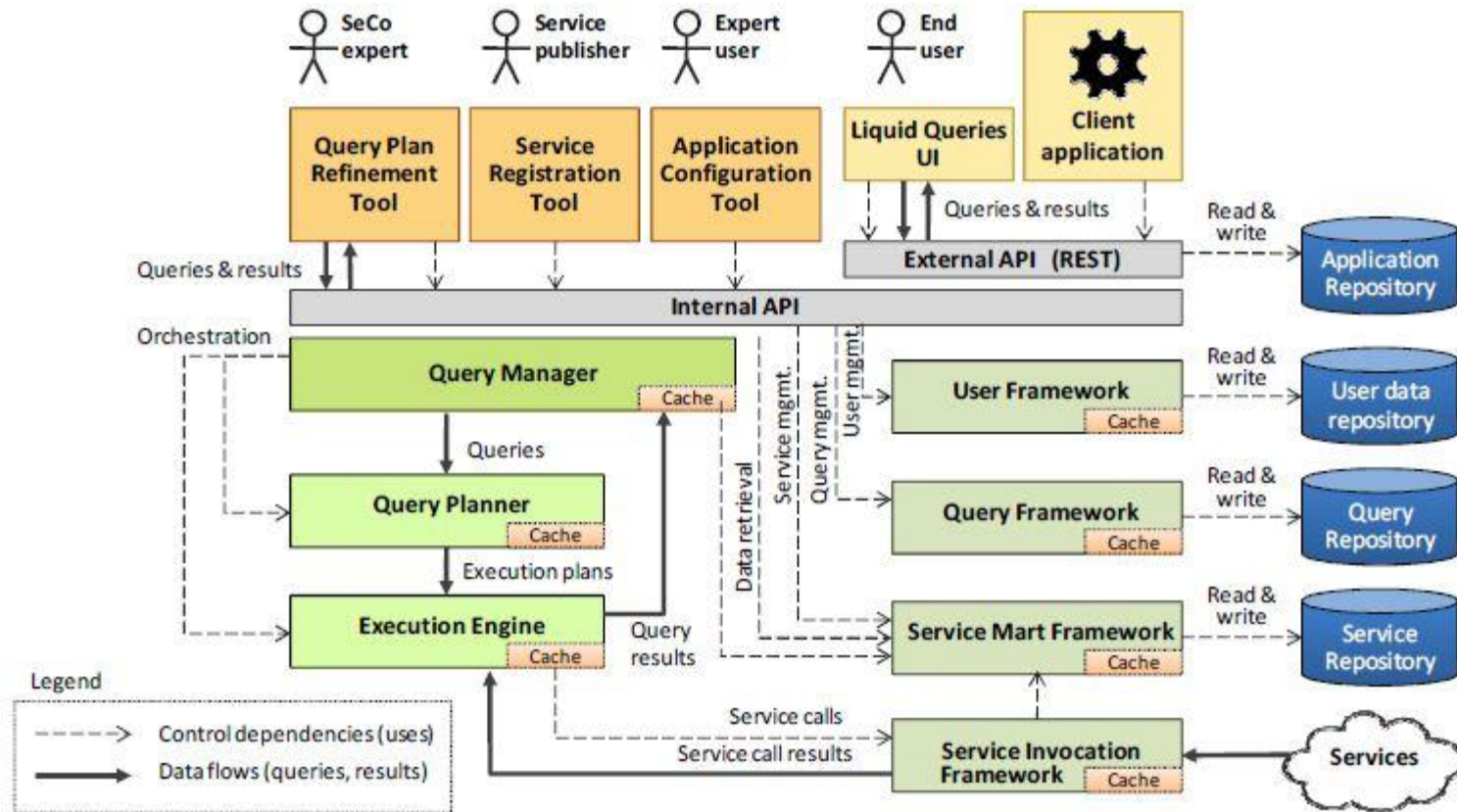
Thank you for your time



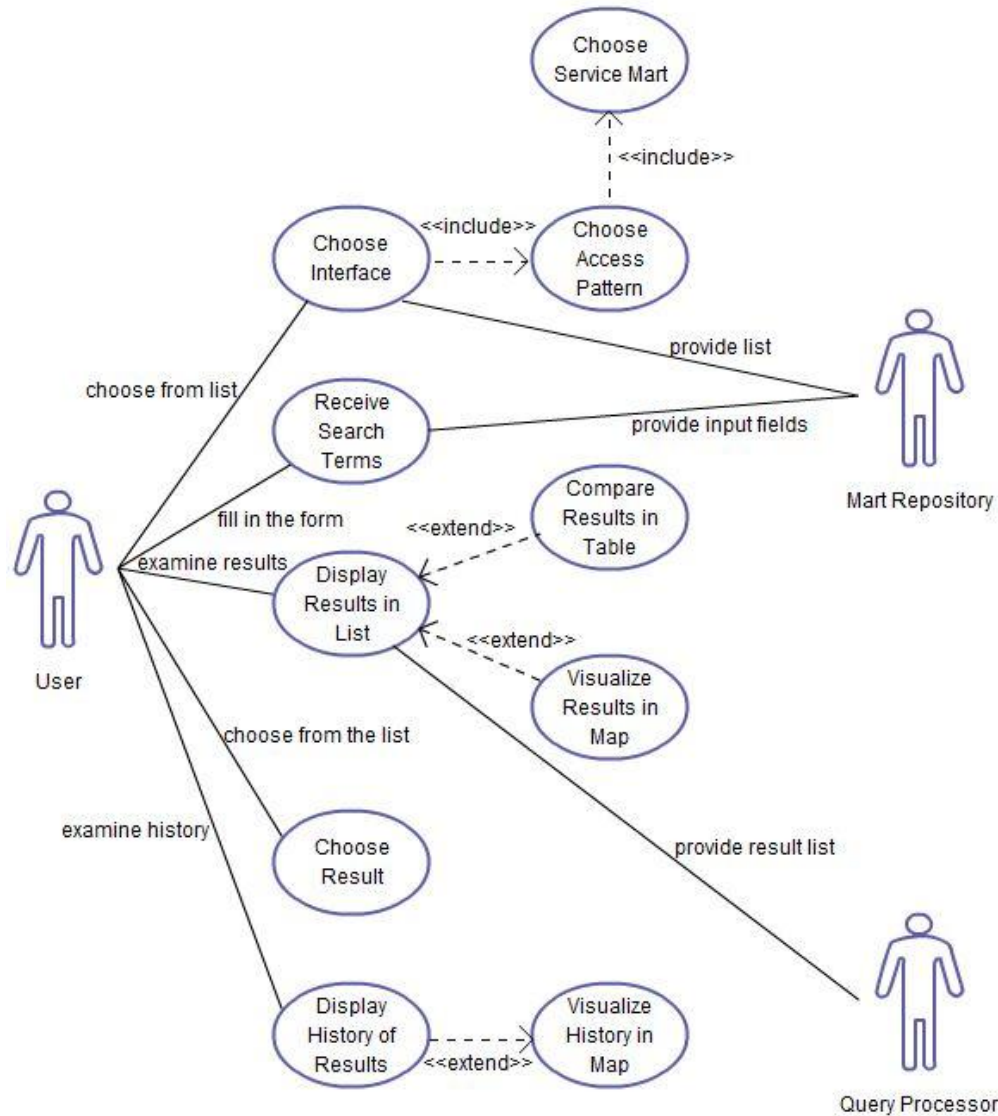
# Appendix



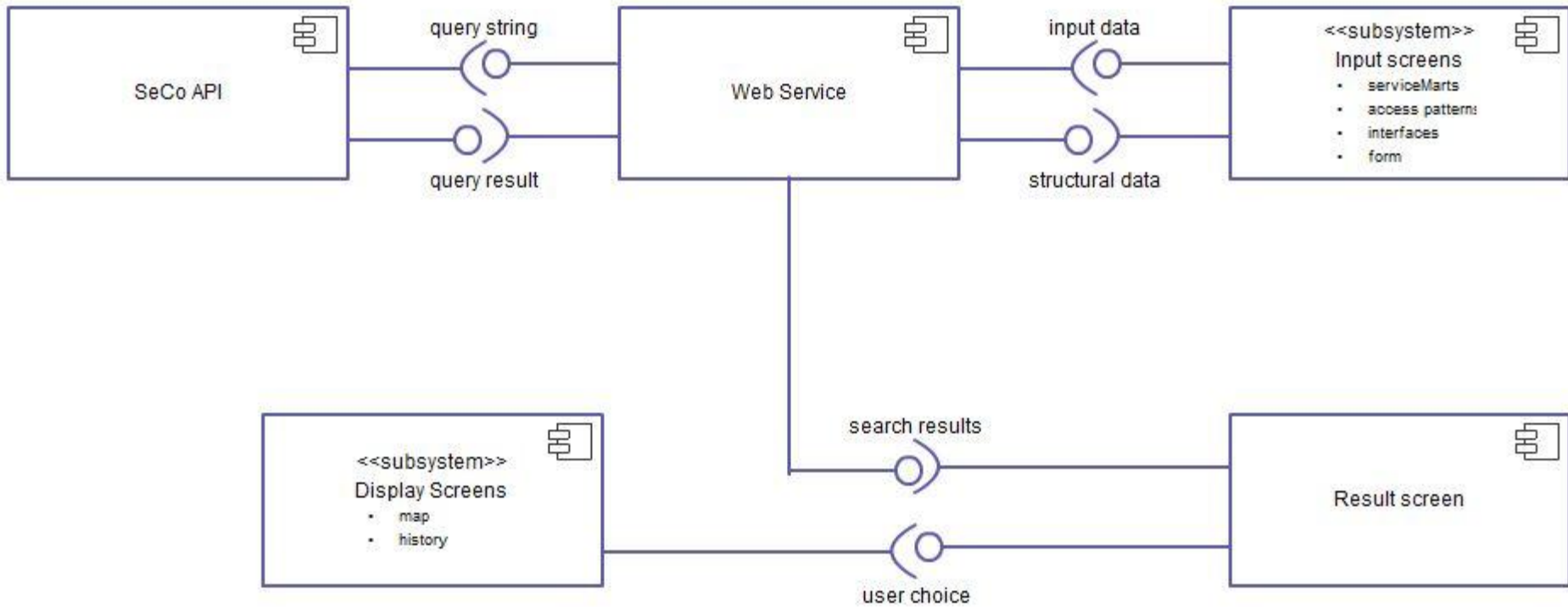
# Appendix



# Appendix



# Appendix



# Appendix

