

COMBINING BEACONS AND DATA ANALYTICS

f o r I n n o v a t i v e T o u r i s m A p p l i c a t i o n s

LEARNING USER BEHAVIOUR AND ADAPTING RECOMMENDATIONS

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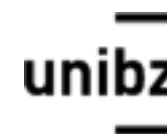
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What is a Beacon

- A small Bluetooth radio transmitter
- Transmits a unique ID which can be used to:
 - Detect a position
 - Detect proximity to a point of interest
- Can transmit additional information:
 - Provide specific information about an object
 - Temperature
 - Accelerometer data
 - URL
- Short range (0-100 m)
- Enables the implementation of context dependent scenarios, via mobile apps or bluetooth enabled devices.



Beacons Everywhere



CITY

providing information on the way
(e.g. bus timetable)



CULTURAL SITES (e.g., museums)

improving and personalize the visitor experience
providing digital contents associated to physical
artifacts



AIRPORTS

guiding travelers with
personalized information



SHOPPING MALLS

Proximity marketing



MONITORING (data analytics)

how people are interacting



Beacon Scenarios

INDOOR
Visiting a Church
(Breda, NL)



OUTDOOR
The Hidden Wood





Consorzio dei Comuni
BIM dell'Adige

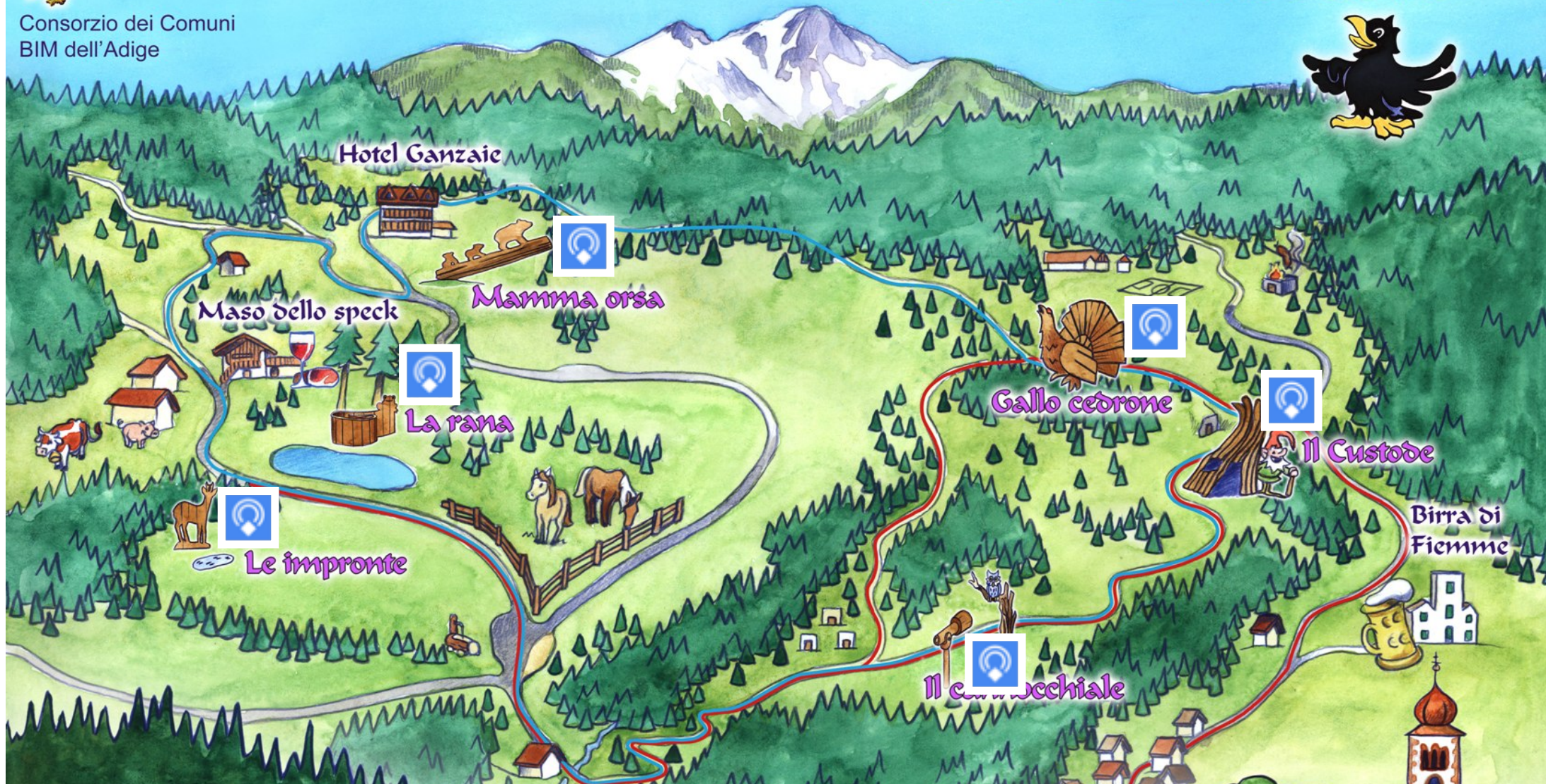
IL BOSCO NASCOSTO





Consorzio dei Comuni
BIM dell'Adige

IL BOSCO NASCOSTO





IL BOSCO NASCOSTO

scopriilo con Corvetto

MAMMA ORSA

L'orso bruno è un plantigrado che può raggiungere dimensioni variabili a seconda dell'area dove vive. Gli esemplari più grandi si trovano sulle coste a nord dell'oceano Pacifico sia nell'estremo est della Russia, quanto nei territori dell'Alaska, qui i grandi maschi possono superare i 700 kg. Nelle aree alpine, invece, le dimensioni sono relativamente contenute: le femmine hanno un peso che oscilla tra i 75 e i 150 kg, mentre i maschi variano tra i 120 e i 300 kg. Nonostante la mole è un animale piuttosto agile e in genere schivo, per questo di norma evita l'incontro con l'uomo. Molto più facile, invece, è trovarne i segni di presenza; anche perché giornalmente può percorrere distanze dell'ordine di diversi chilometri. Le tracce si possono rinvenire su terreni plastici, come la neve o il fango. Qui le sue impronte sono inconfondibili: l'orso è un semiplantigrado, questo significa che quando cammina le zampe posteriori poggiano tutto il piede sul suolo, mentre gli arti anteriori posano a terra i polpastrelli e parte del palmo. Gli unghioni, comunque, sono sempre ben visibili.

L'orso può frequentare diversi ambienti dalle praterie di alta quota ai coltivi di fondovalle ma in genere gli habitat principalmente utilizzati sono le aree boscate. Nelle foreste passa la maggior parte del suo tempo alla ricerca di una vasta gamma di alimenti che, a seconda della stagione, possono essere rappresentati dalle essenze erbacee agli invertebrati, dalla frutta alla carne, rappresentata nella gran parte dei casi dal rinvenimento di carcasse di ungulati selvatici.



impronte
nella neve




www.ilmondonascosto.com



12:34 PM 100%

Mamma Orsa



IT EN DE

Ursus arctos

L'orso bruno viene spesso erroneamente associato agli ambienti di montagna, in realtà frequenta territori molto diversificati: occupa sia habitat aperti che foreste, anche se nelle nostre zone la presenza di questo plantigrado è legata alle superfici boscate delle montagne nella fascia altitudinale compresa tra i 300 e i 1400m s.l.m.




IL BOSCO NASCOSTO
scopriilo con Corvetto

MAMMA ORSA

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impronte nella neve

www.ilmondonascosto.com

Korkbanken Application

(Breda and Hoogstraten, NL)

In collaboration with

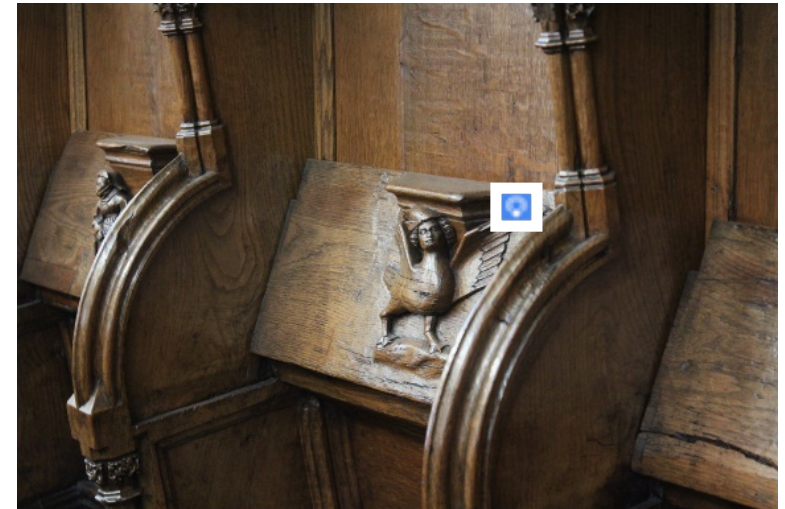
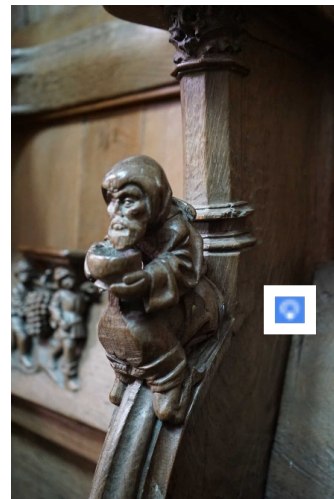
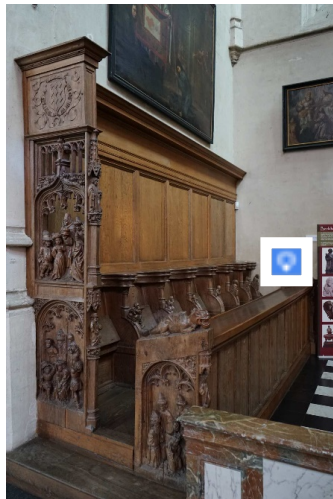
Waag Society and Radboud University (NL)



Radboud University



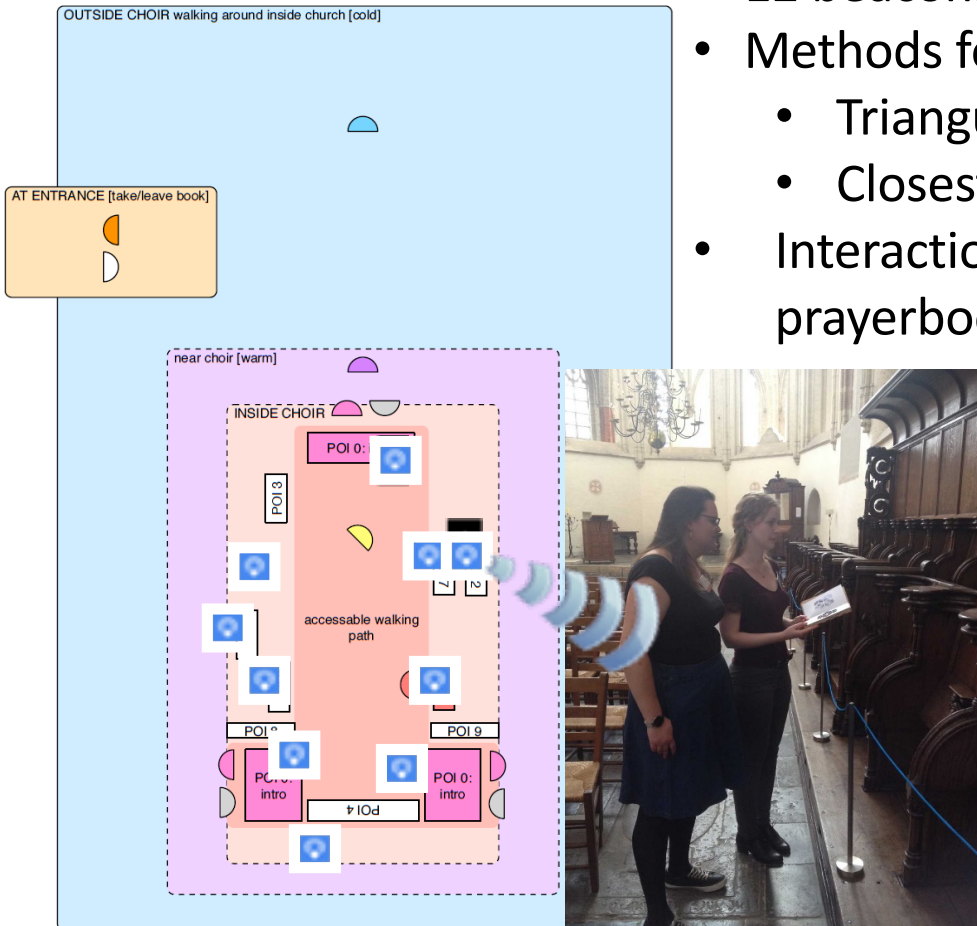
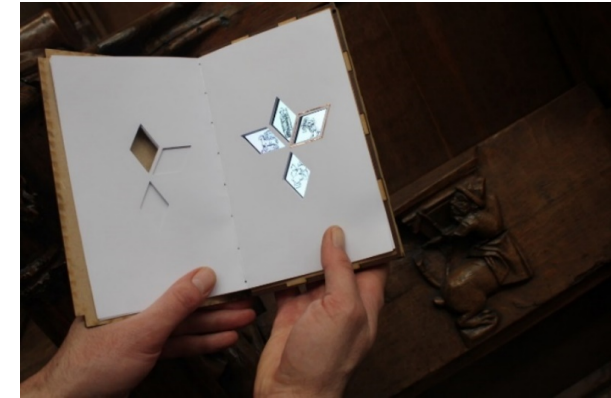
- Supporting the visiting experience in a Church (Indoor scenario)
- 12 different points of interest in the choir area (decorations on the banches of the choir)
- Guide the user and enhance the visiting experience.



Korkbanken Application

(Breda and Hoogstraten, NL)

- 12 beacons
- Methods for position identification
 - Triangulation
 - Closest beacon
- Interaction led through an «augmented» prayerbook (a tablet is hidden in it)



THE USER EXPERIENCE

- A book is given at the entrance
- Near to the choir area, a music is played
- Look for the next point of interest
- Audio guide at the point of interest

Suggesto Marketplace

- The previous applications exploit the results of Suggesto Marketplace (SM) project
- SM is a hardware and software platform for implementing IoT based applications
- Three years project - funded by Trento Province

(applied research programme for industry - Legge Provinciale 6)

PROJECT PARTNERS



ECTRL Solutions srl



Free University of Bozen-
Bolzano

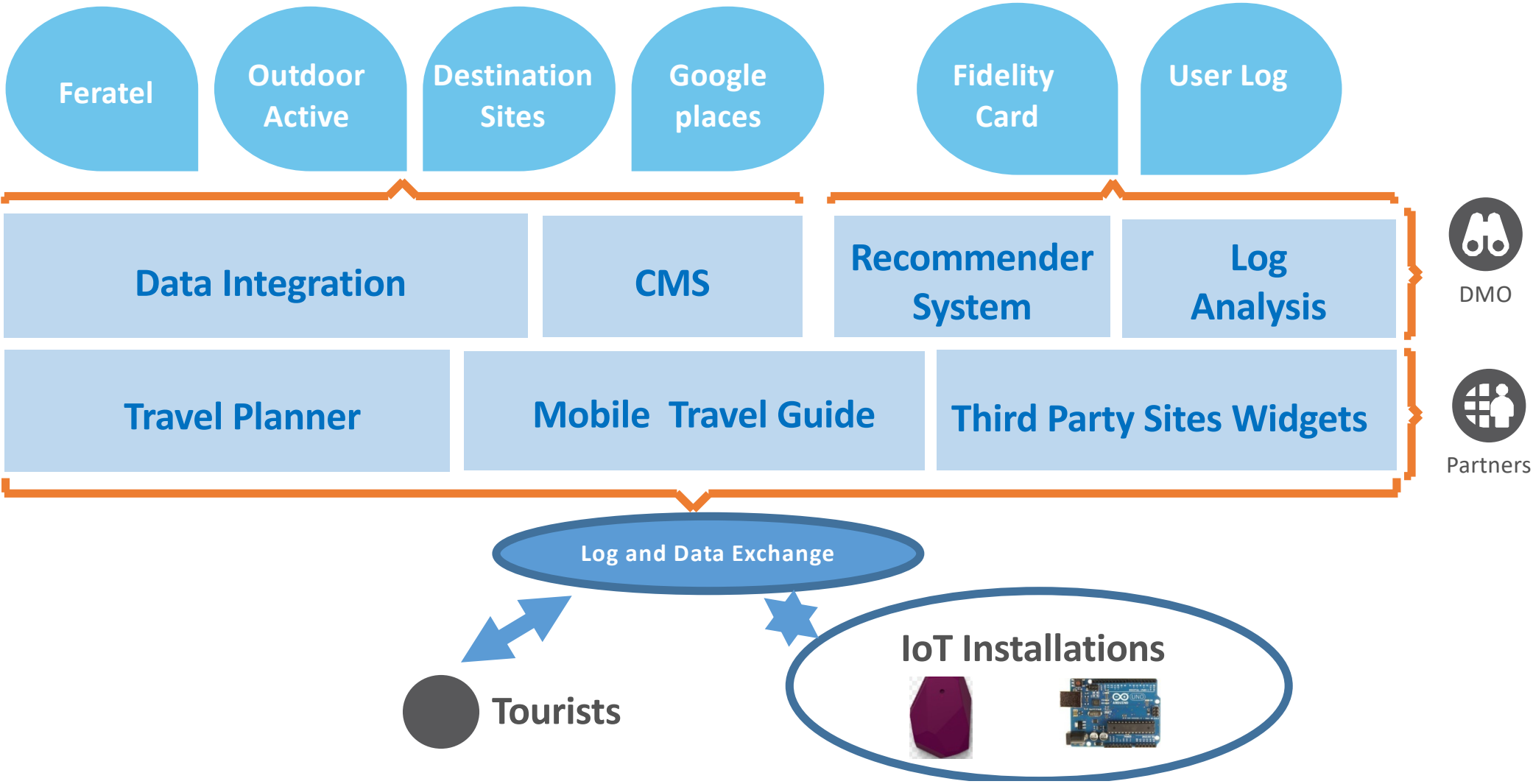


Fondazione Bruno Kessler



Provincia Autonoma di
Trento

Suggesto Marketspace Platform



Beacon + Log App

Support tourists in finding places of interests (POIs)

Huge variety of different POIs

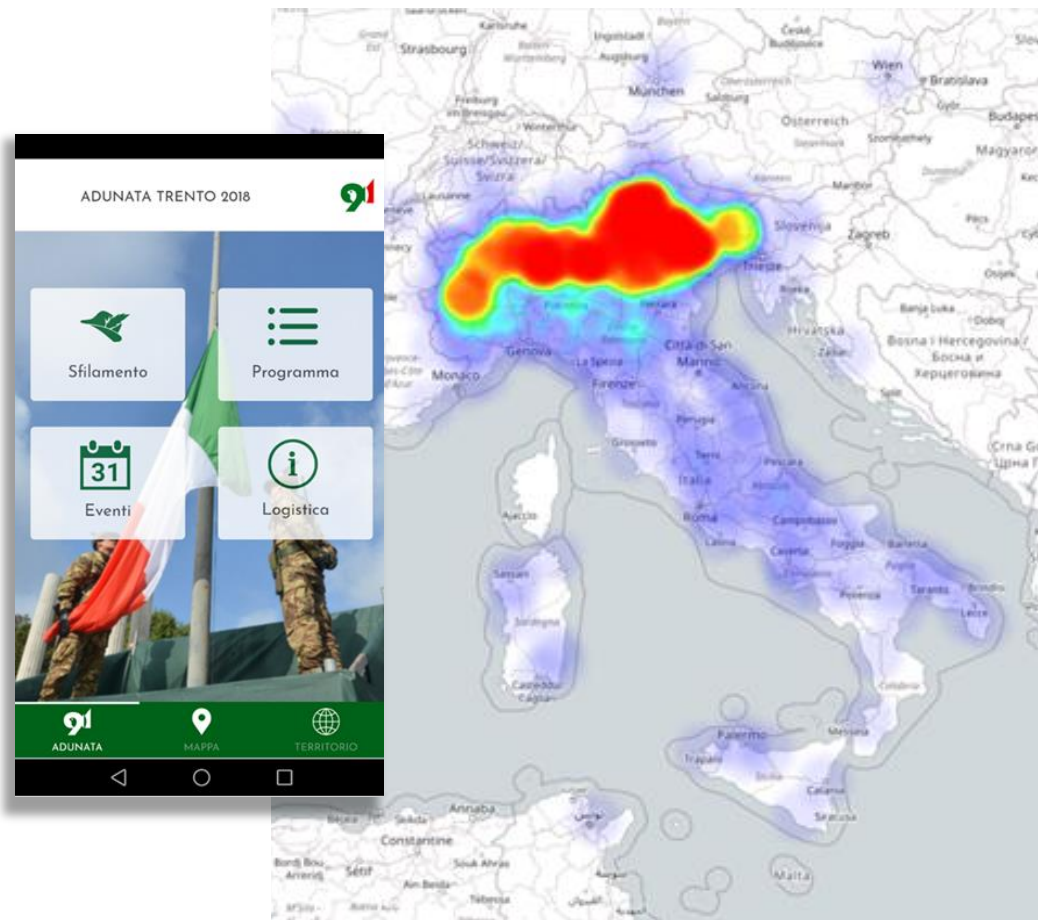
Understanding User preferences in Context

-  SUNNY
-  AFTERNOON
-  COFFEE BAR

Adapting recommendation to user group behaviour



Statistics and Market Segmentation



Case study: Event Adunata Alpini 2018

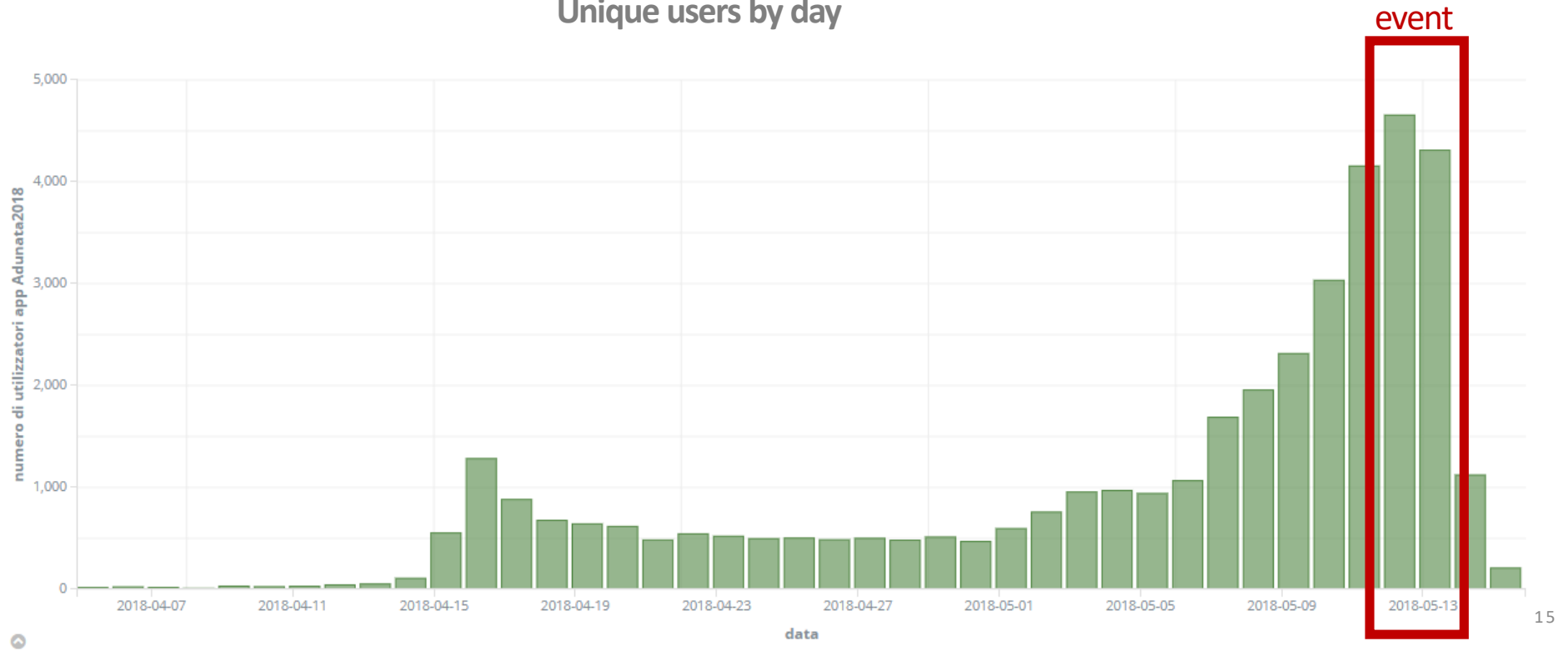
Data logs of the official app: GPS and 20 beacons

- Where users come from
- Days of advance for travel planning
- What they are looking for
- What they do onsite
- How context influences informational needs (daytime, week day, location,....).

Understanding Segments and Patterns

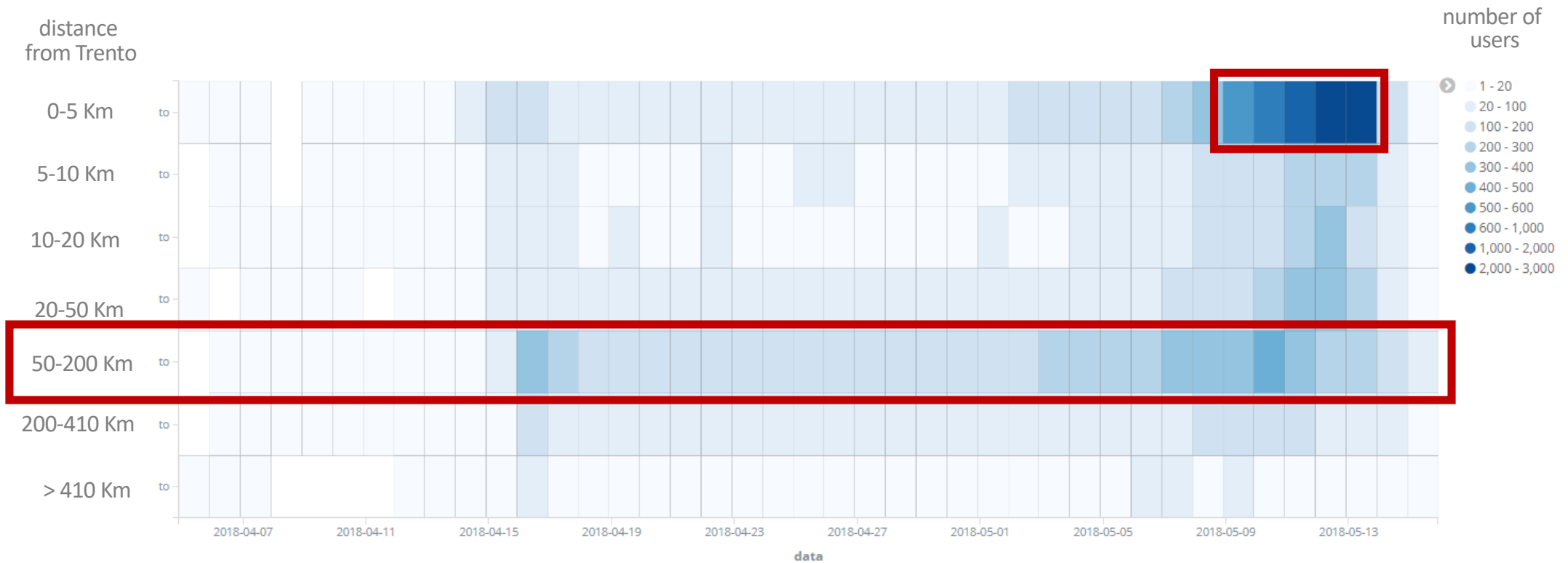
10.930 total users

Unique users by day



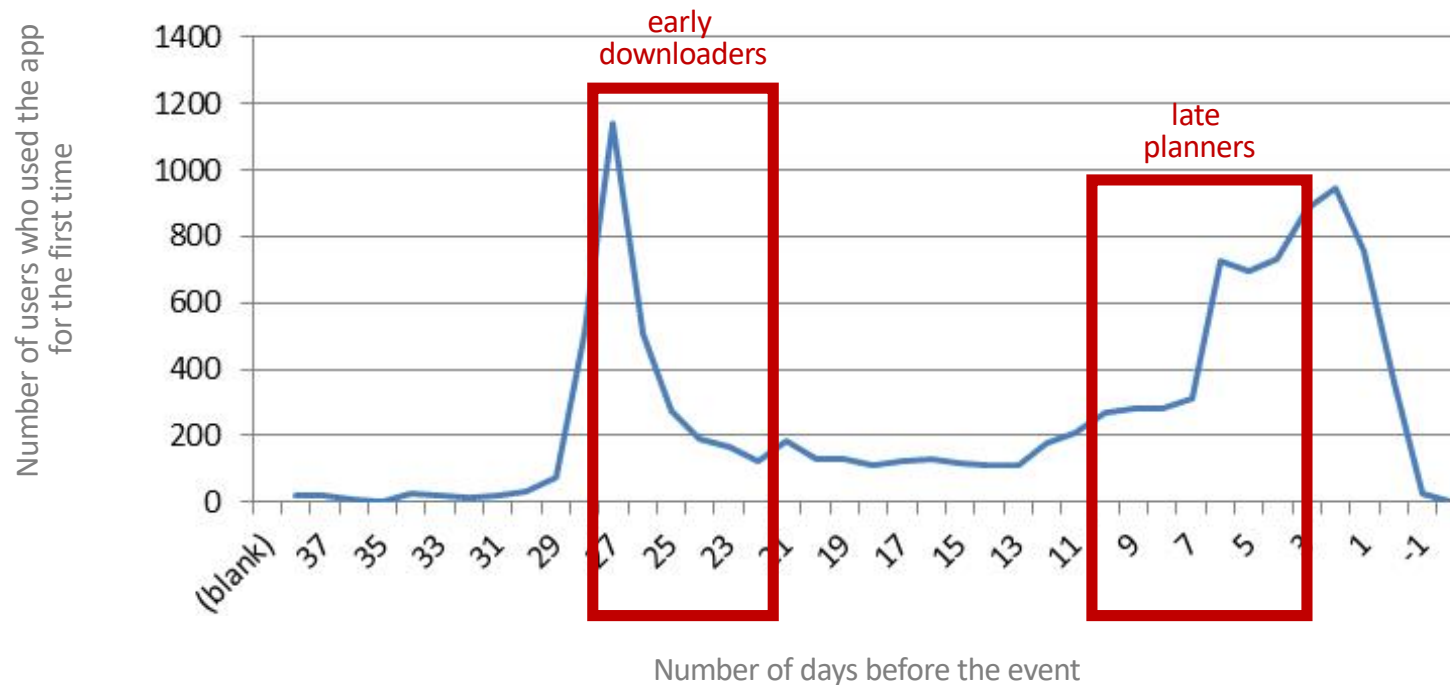
Understanding Segments and Patterns

Users segmented by day and by distance from Trento when using the app



Understanding Segments and Patterns

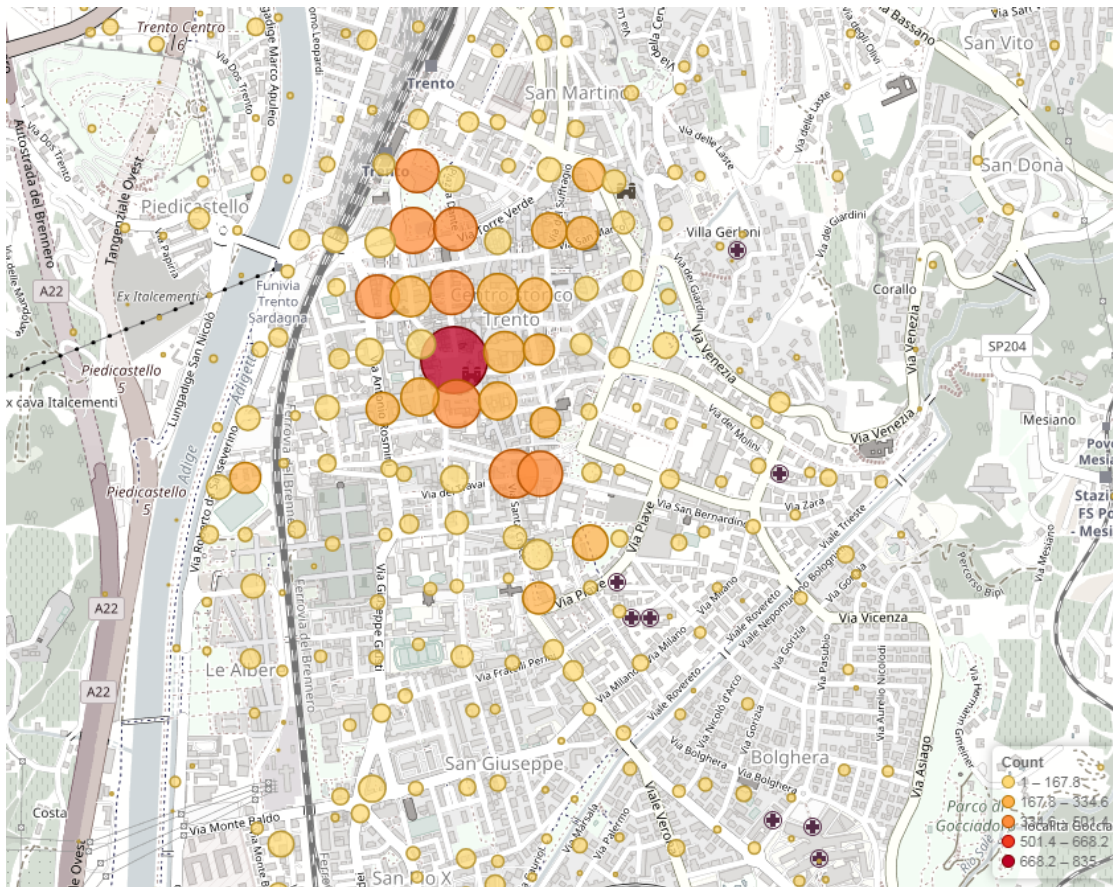
Advance with which the app is first used (download)



Average # of visited pages per visitor: 47 (std dev 46, median 34)

Repeated usages of the app in different days

What Do Users Do Onsite?

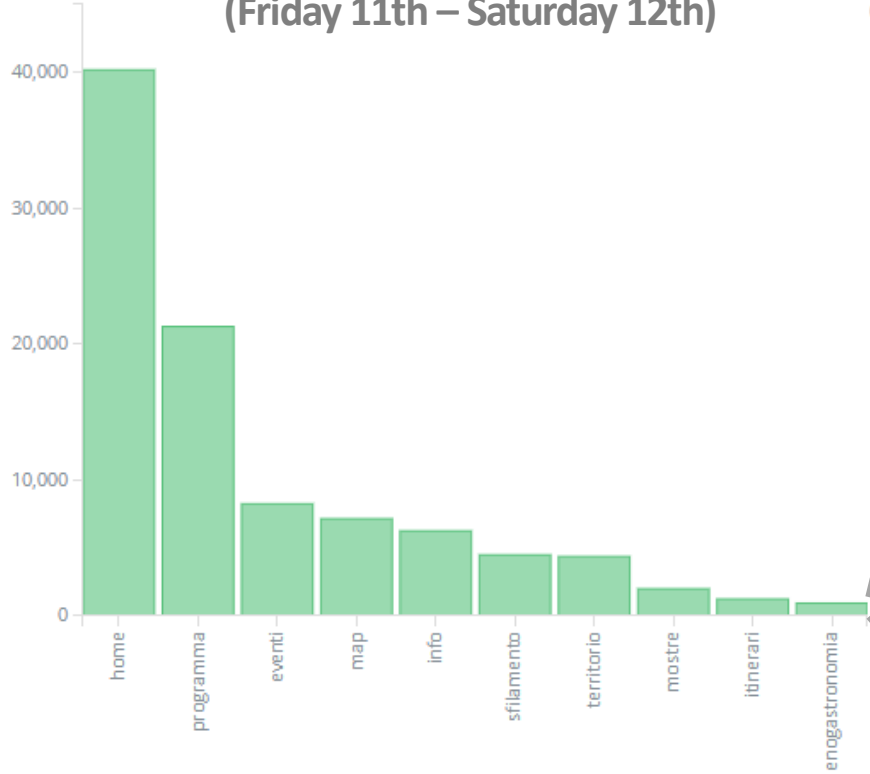


Opportunity to monitor at what time and where visitors need information

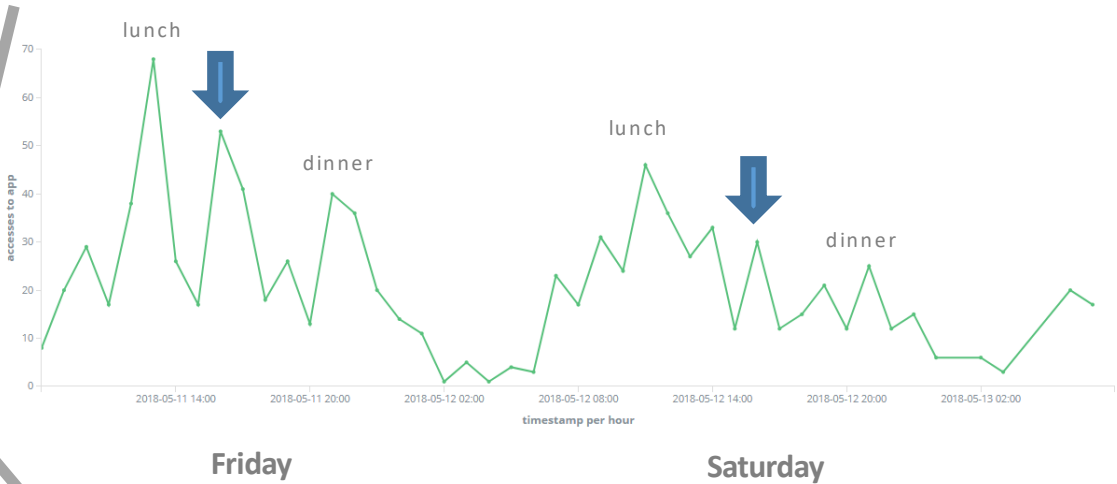
Saturday 12th May 2018,
app usages + beacon notifications

What Do Users Do Onsite?

Most visited app pages
(Friday 11th – Saturday 12th)



Searches for enogastronomia by hour



How Beacons Help

SOURCE OF LOCALISATION

In the two days of adunata 48% of logs without gps coordinates

Possibility to track user movements also when they are not interacting with the app

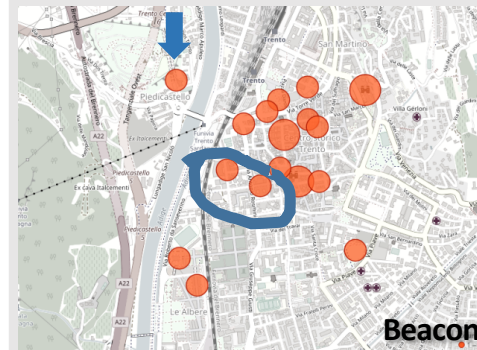
Indoor localisation

FEEDBACK ON USER JOURNEY

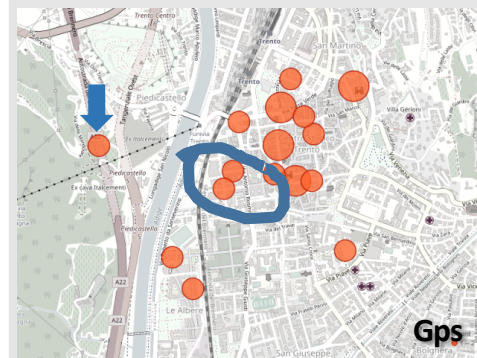
Feedback on whether users visited a POI

Time spent in place

INSIGHT ON INTERACTION



NOTIFICATIONS SENT



NOTIFICATIONS OPENED

Case Study: Behaviour Learning and Recommendation in Florence

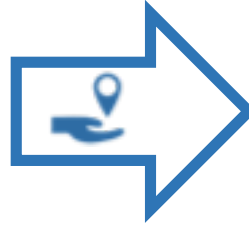




Battistero



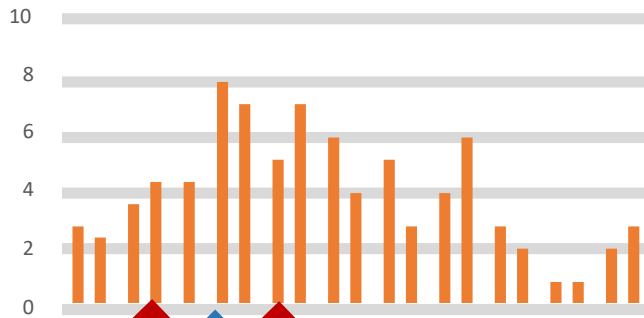
Cupola del
Brunelleschi



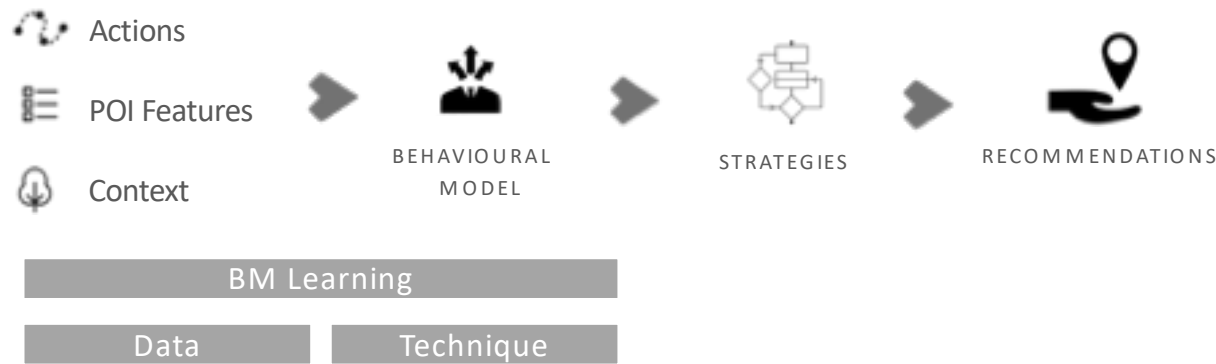
Uffizi



Museo San Marco



Case Study: Behaviour Learning and Recommendation in Florence



DATA

 Actions (Muntean et al.)

575 User POI-visit trajectories

Geolocalized

Temporally ordered



 Context

Hourly weather summary

Temperature

Daytime



 POI Features

Category

Historic period

Historic related person

User Decision Making Problem

Markov Decision Process (MDP)

S State space

A Action space

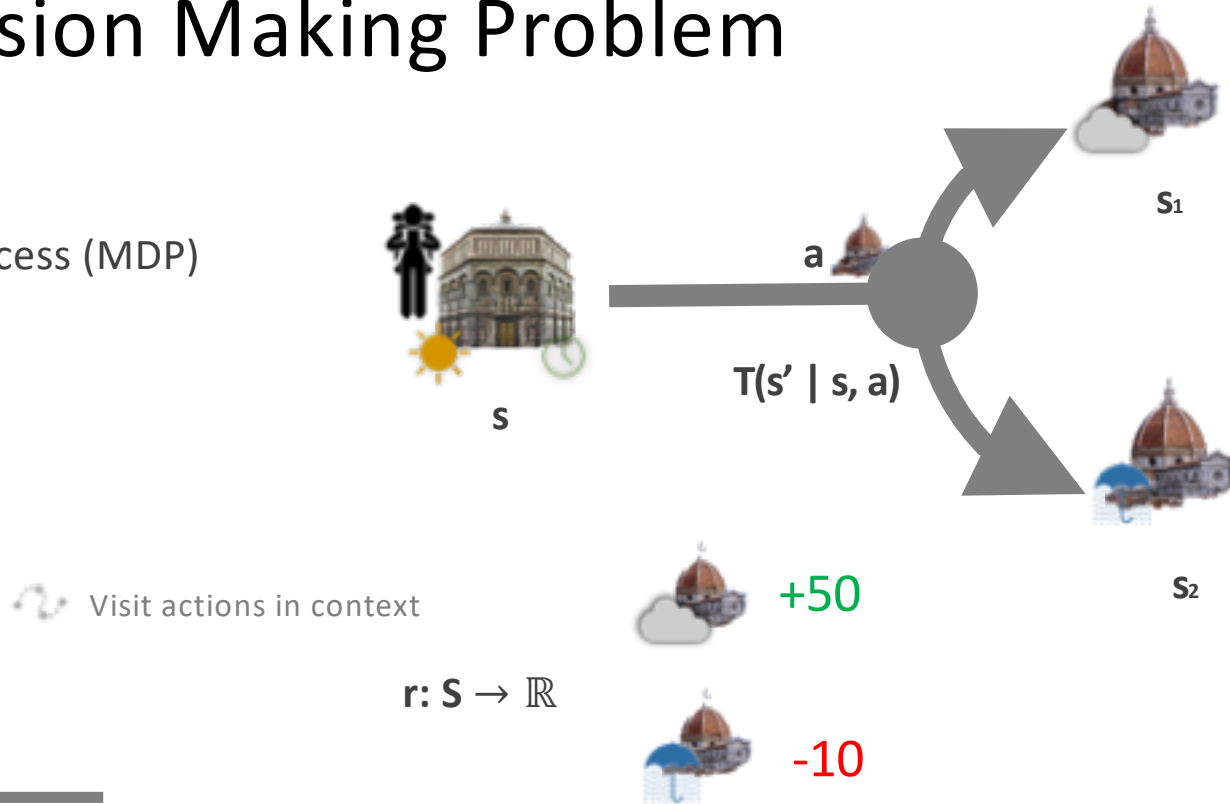
T Transition model

Z Users observations

r Reward

POLICY $\pi^*: S \rightarrow A$

Maximises the cumulative reward that the user obtains by acting according to π^* (optimal policy)



Learning the Decision Making Policy

THE USER BEHAVIOURAL MODEL IS LEARNT IN TERMS OF



Reward



Action-selection **policy**

Inverse Reinforcement Learning tries to learn the user **reward** function:

$$\mathbf{r}(s) = \boldsymbol{\phi}(s) \cdot \boldsymbol{\theta}$$

$\boldsymbol{\phi}$ is the vector of feature associated with the state (known).




$\boldsymbol{\theta}$ is the vector that represent the extent a user likes state features (unknown).

$\boldsymbol{\phi}(s)$ Binary vector representing the presence/absence of attributes

105  POI Features

9  Context + Travelled distance (from s to s')

-  SUNNY
-  AFTERNOON
-  MUSEUM

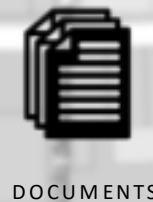
-  SUNNY
-  AFTERNOON
-  GARDEN

CLUSTERING

NMF – Non Negative Matrix Factorization

Bundle **trajectories** according to a common **semantic** structure that explain the resulting clusters.

Document-like representation of users trajectories (state features as terms)



| #Term | Topic 1 | Topic 2 | Topic 3 | Topic 4 | Topic 5 |
|-------------|--------------|------------|------------|------------|-------------|
| 1 | cold | morning | warm | clear | evening |
| 2 | afternoon | cold | afternoon | cold | cloudy |
| 3 | cloudy | cloudy | cloudy | monument | cold |
| 4 | monument | monument | monument | warm | warm |
| 5 | century 14 | century 16 | century 14 | century 15 | monument |
| 6 | century 15 | square | century 16 | morning | century 16 |
| 7 | Brunelleschi | Vasari | century 15 | afternoon | church |
| 8 | century 16 | century 15 | palace | century 14 | Giambologna |
| 9 | square | century 19 | building | evening | century 14 |
| 10 | Giotto | building | Vasari | Donatello | century 19 |
| #Trajectory | 270 | 177 | 277 | 114 | 131 |



| #Term | Topic 1 | Topic 2 | Topic 3 | Topic 4 | Topic 5 |
|-------------|-------------------|------------|------------|------------|--------------------|
| 1 | cold | morning | warm | clear | evening |
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| 4 | monument | monument | monument | warm | warm |
| 5 | century 14 | century 16 | century 14 | century 15 | monument |
| 6 | century 15 | square | century 16 | morning | century 15 |
| 7 | Brunelleschi | Vasari | century 15 | afternoon | church |
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 Context

 POI Features

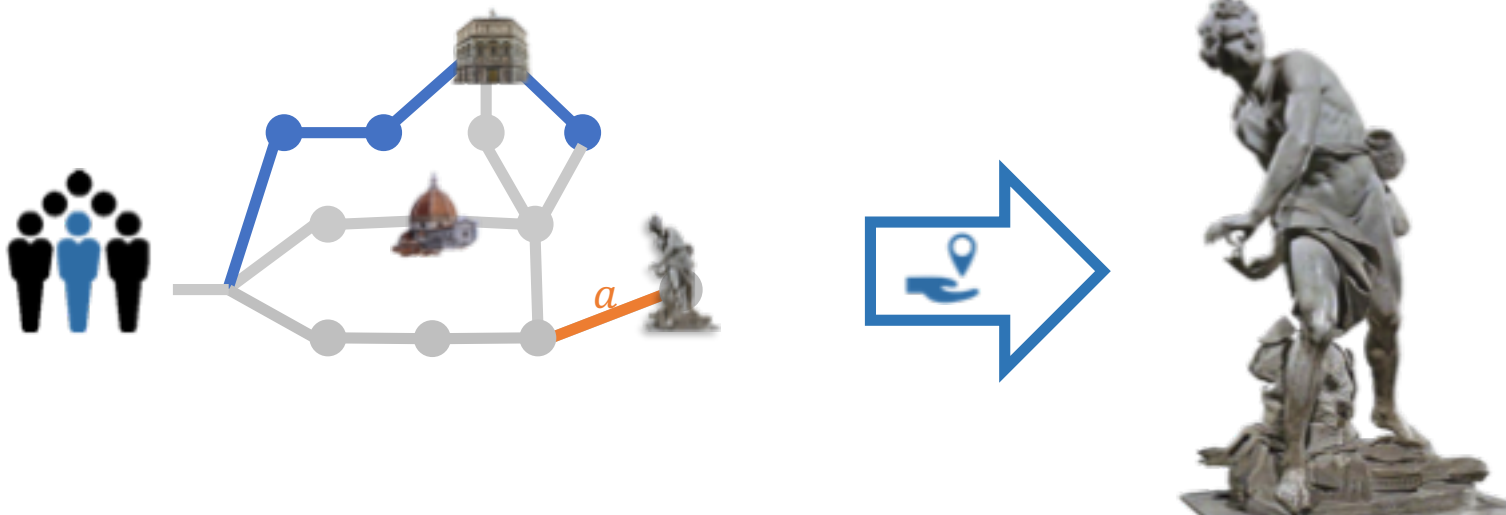
Optimizing Recommendations for a Group

1 Cluster Behaviour Based Recommendations



π_c Cluster action-selection policy

a optimal action $\operatorname{argmax}_a Q_{\pi_c}(s, a)$



IoT Environment Simulator



Test the deployment of a real IoT infrastructure



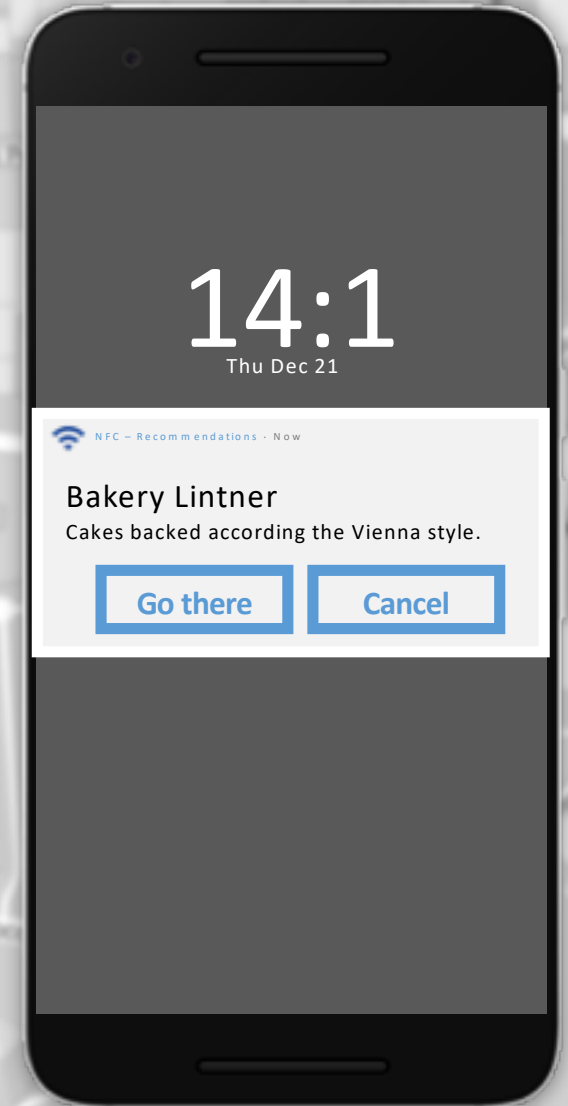
Collect user's feedback (like/dislike) on POIs to evaluate recommendation strategies

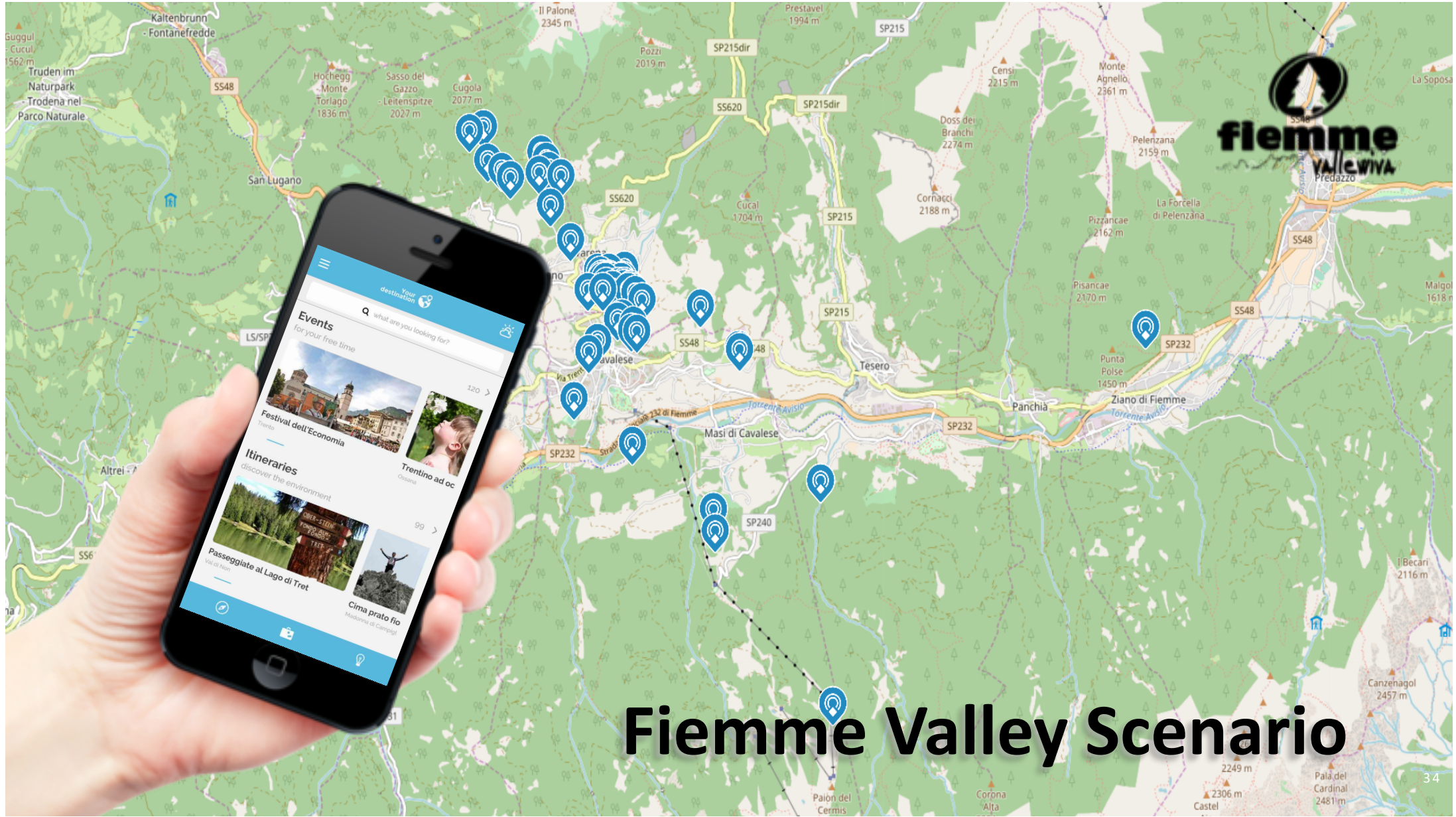


Evaluate the effectiveness of mobile apps that supports tourists in the physical space (IoT augmented)



Simulate users' decisions in a range of alternative and possibly new contextual settings





Fiemme Valley Scenario

COMBINING BEACONS AND DATA ANALYTICS

for Innovative Tourism Applications

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