



Petrozavodsk State University
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Smart e-Tourism Services

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Historical tourism

- ▶ historical events and persons
- ▶ art, architecture, religion(s)
- ▶ artifacts (e.g., artworks, architectural monuments)
- ▶ cultural traditions (e.g., festivals, cuisine)
- ▶ historical POIs and their relation with other historical objects (POIs, events, persons, etc.)



Need!

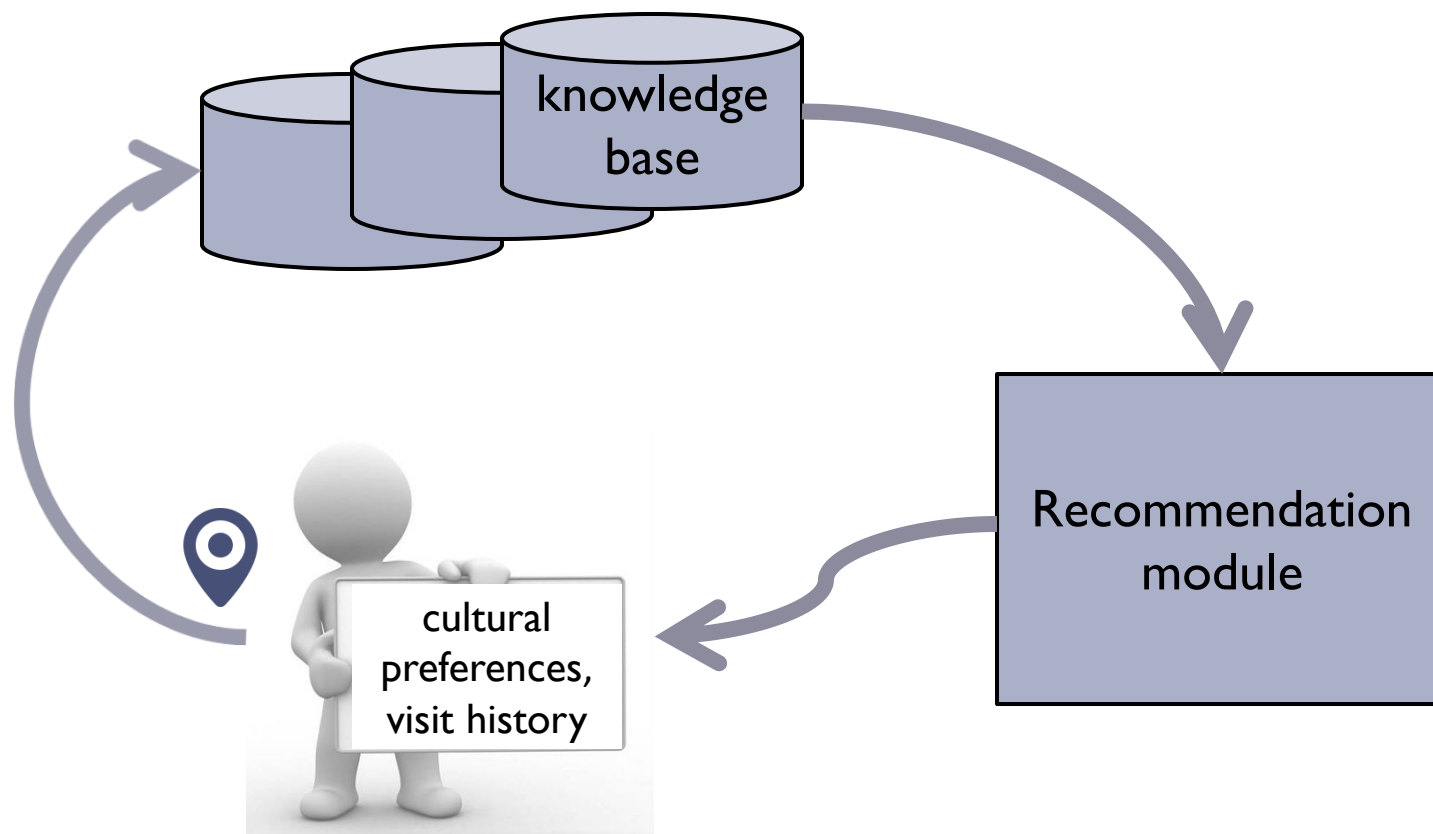


“smart” mobile assistants for historical tourists:

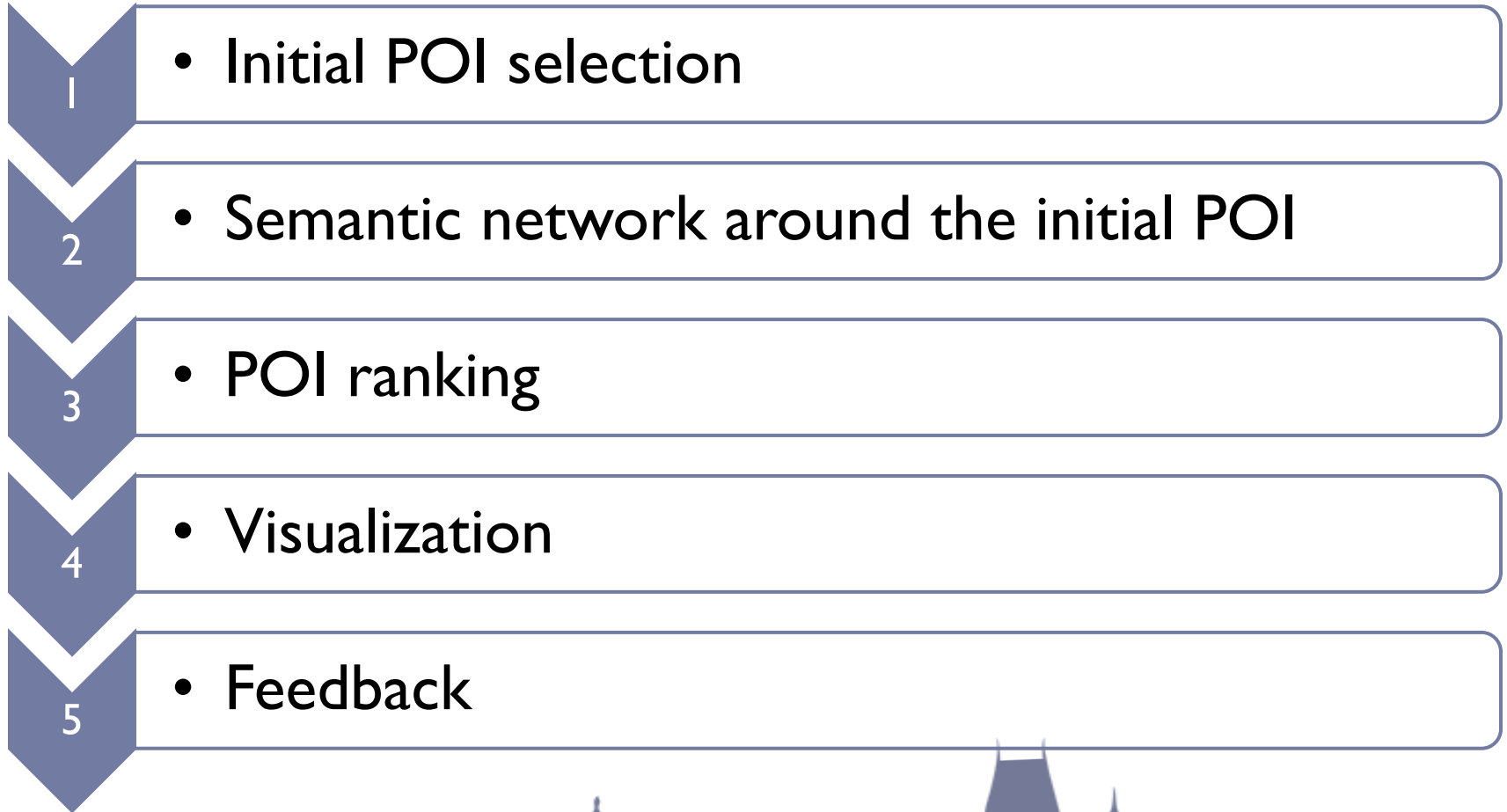
- ▶ support while traveling
- ▶ gathering required information before the trip or during the trip
- ▶ provision of touristic recommendations
- ▶ cultural heritage information



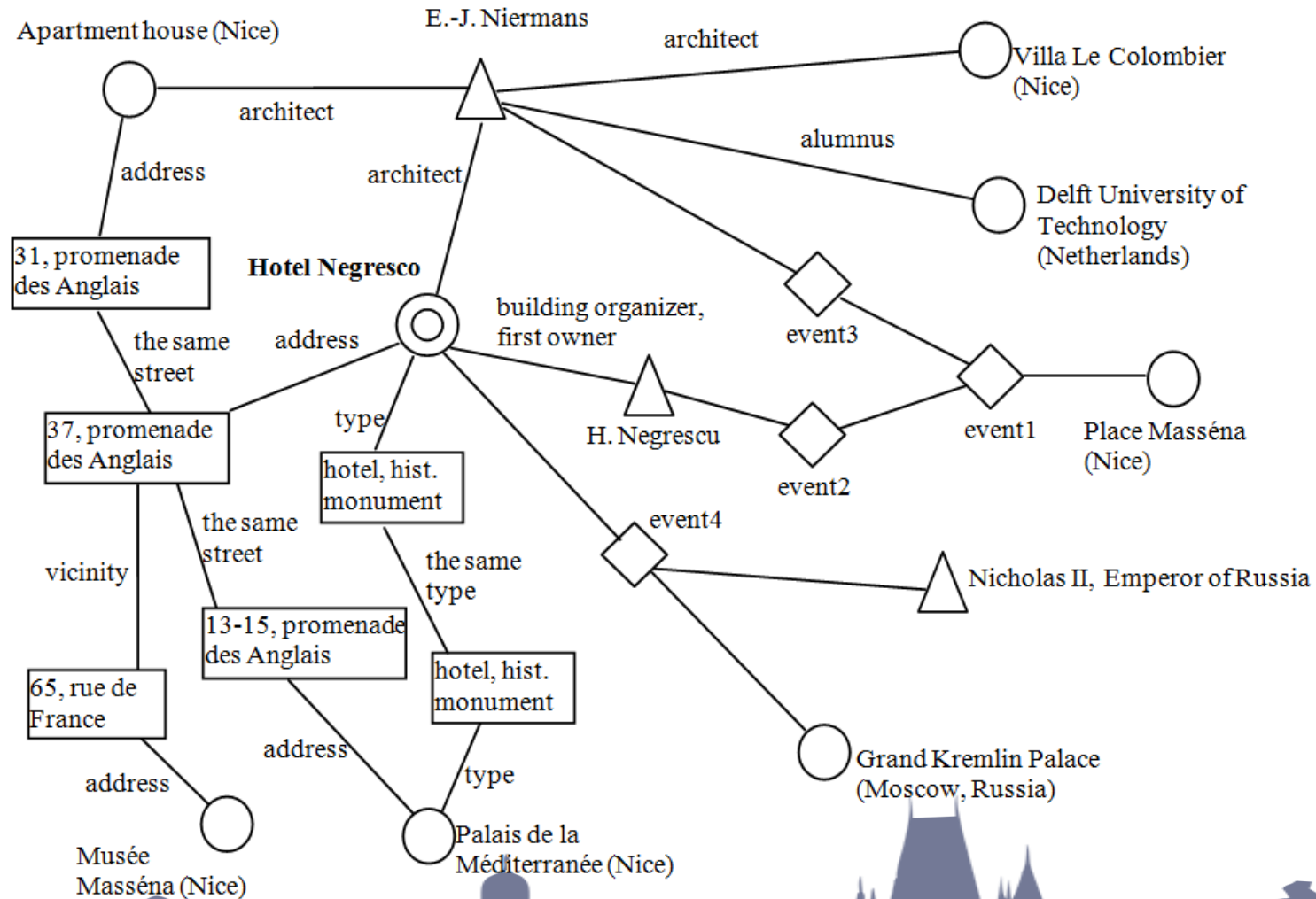
Idea



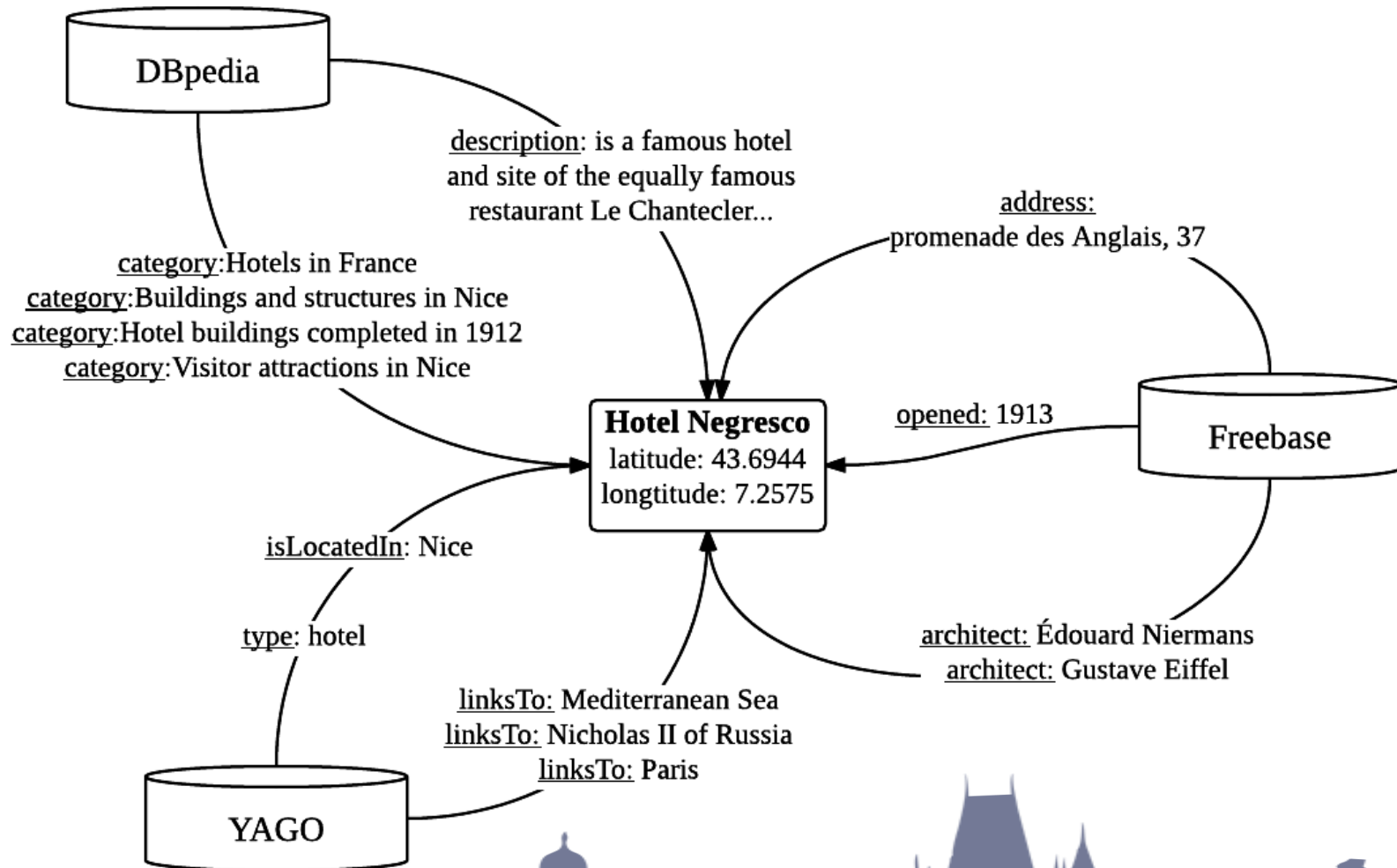
Scenario of Recommendation Service



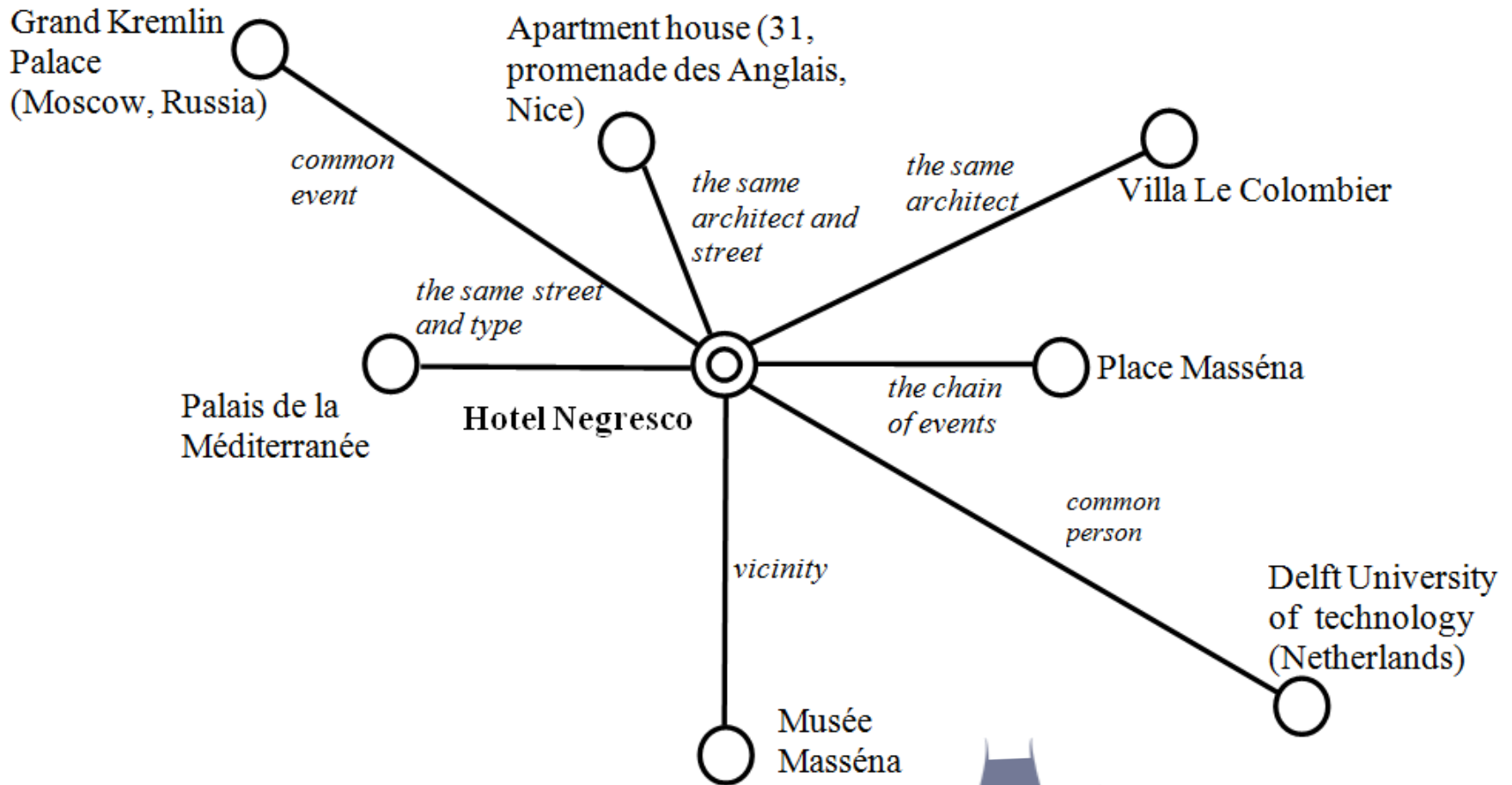
Sample semantic network: historical relations of Hotel Negresco



Hotel Negresco: Information extraction from different sources



Star graph example: Hotel Negresco and recommendations on its historical surrounding

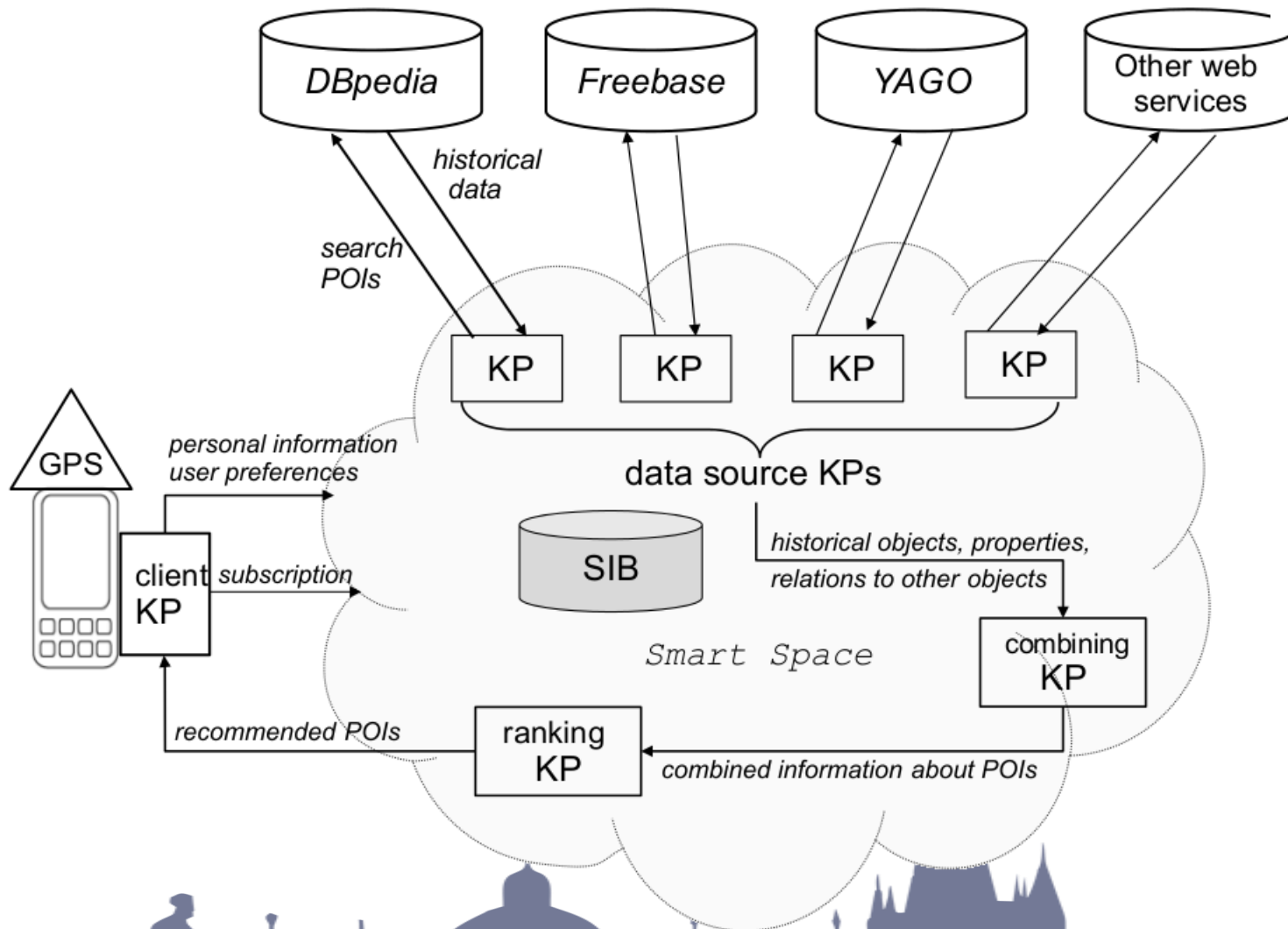




“Smart” mobile assistant

- ▶ The service is based on Smart-M3 platform distributed architecture
- ▶ The KP provides access to external information service and translates obtained information to the common space
- ▶ The SIB is a semantic information sharing service.

Multi-Agent Architecture

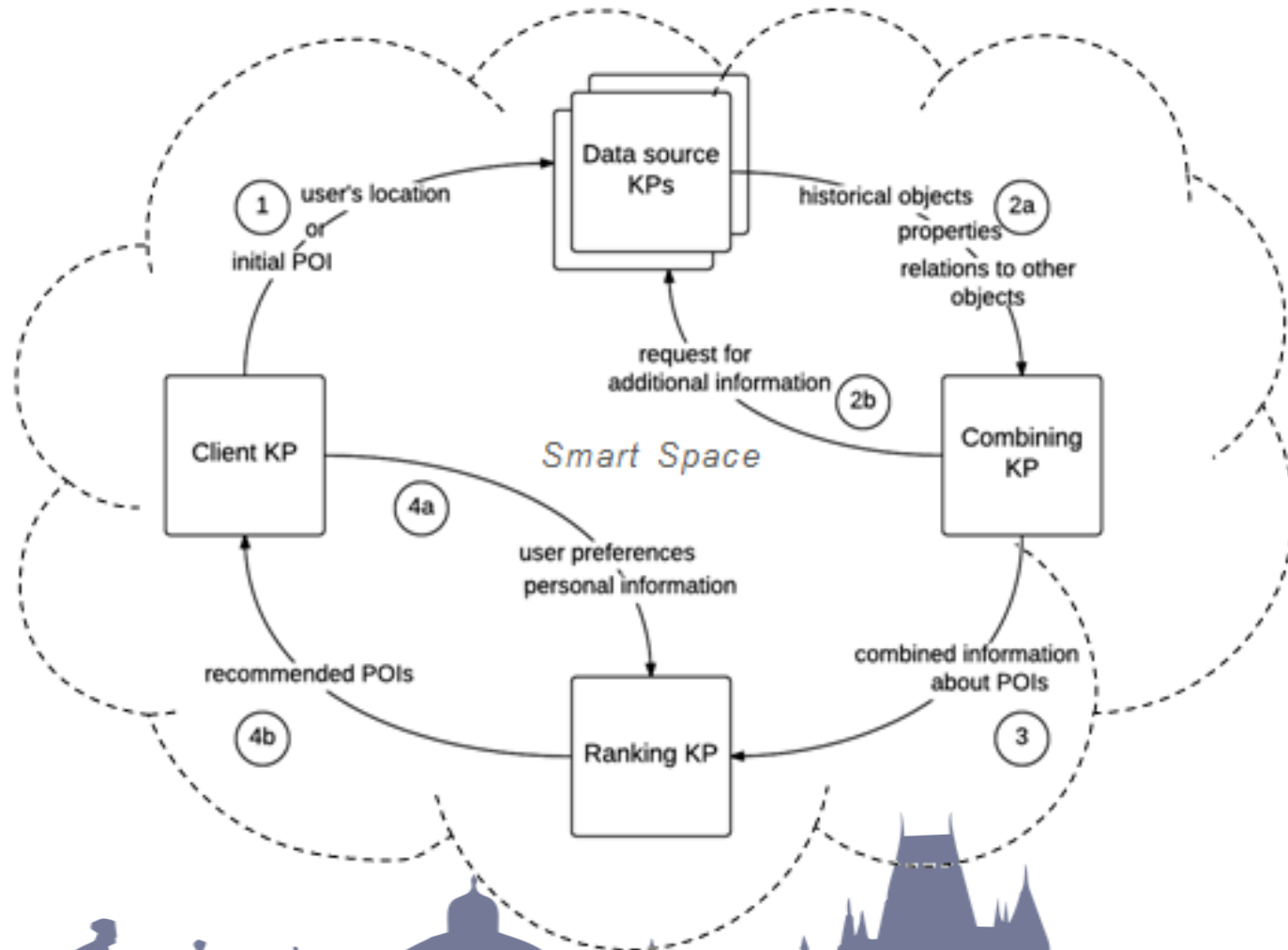




Description Agents

- ▶ **Client KP** is responsible for providing information about the user and users preferences and gets results trip planning service.
- ▶ **data source KPs** provides information about attractions (position, description, images, etc.) from third-party services.
- ▶ **Combining KP** combines functions for review attractions or events.
- ▶ **Ranking KP** create attraction rank.
- ▶ This architecture can be changed by adding or removing KPs and modules.

KPs interact in smart space to construct a recommendation service



| Step | Operation | Found information |
|------|---|---|
| 1 | initial POI | Hotel Negresco |
| 2 | Data source KPs publish information about POIs in the smart space via the SIB. | <ol style="list-style-type: none"> 1. Hotel Negresco is located at Promenade des Anglais, 37 2. The architect of Hotel Negresco is E.-J. Niermans. 3. First owner of Hotel Negresco is H. Negrescu |
| 3 | Combining KP advances the description information on the POIs. New POIs are retrieved and Combining KP creates a semantic network around Hotel Negresco (see Figure 1). | <p>Apartment house, Palais de la Méditerranée (POIs on the same street);</p> <p>Place Masséna, Villa le Colombier, Apartment house (POIs by the same architect);</p> <p>Place Masséna (POIs related H. Negrescu)</p> |
| 4 | The Ranking KP ranks the found POIs using specific criteria. For instance, Apartment house receives the highest rank since the POI is a) located on the same street and b) designed by the same architect | <p>Sorted list:</p> <ol style="list-style-type: none"> 1. Apartment house 2. Place Masséna 3. Palais de la Méditerranée 4. Villa le Colombier |

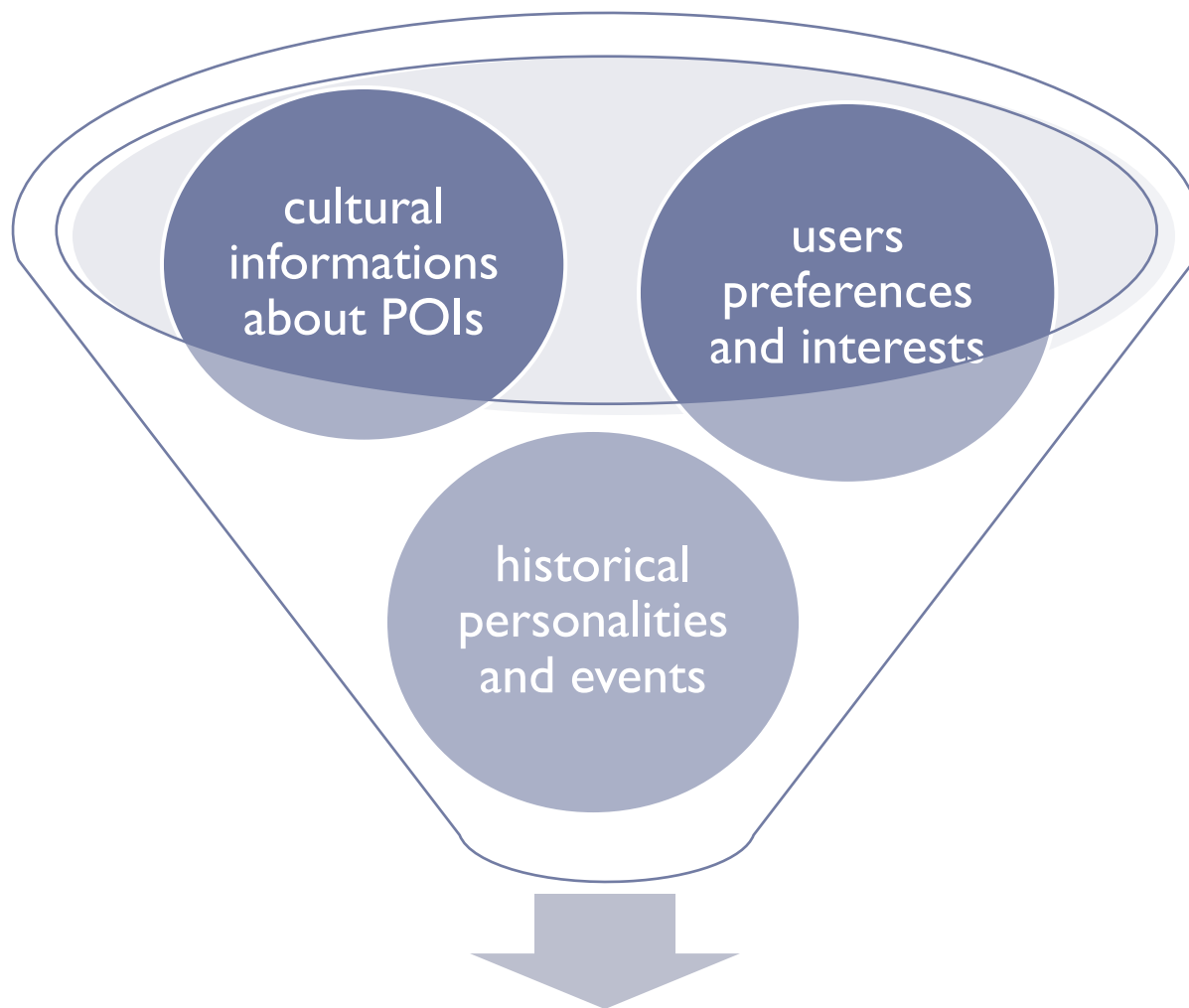


Ontological Representation of Data

- ▶ structuring knowledge
- ▶ semantic links
- ▶ RDF, OWL
- ▶ “An explicit specification of a conceptualization”
[Tom Gruber 1993]

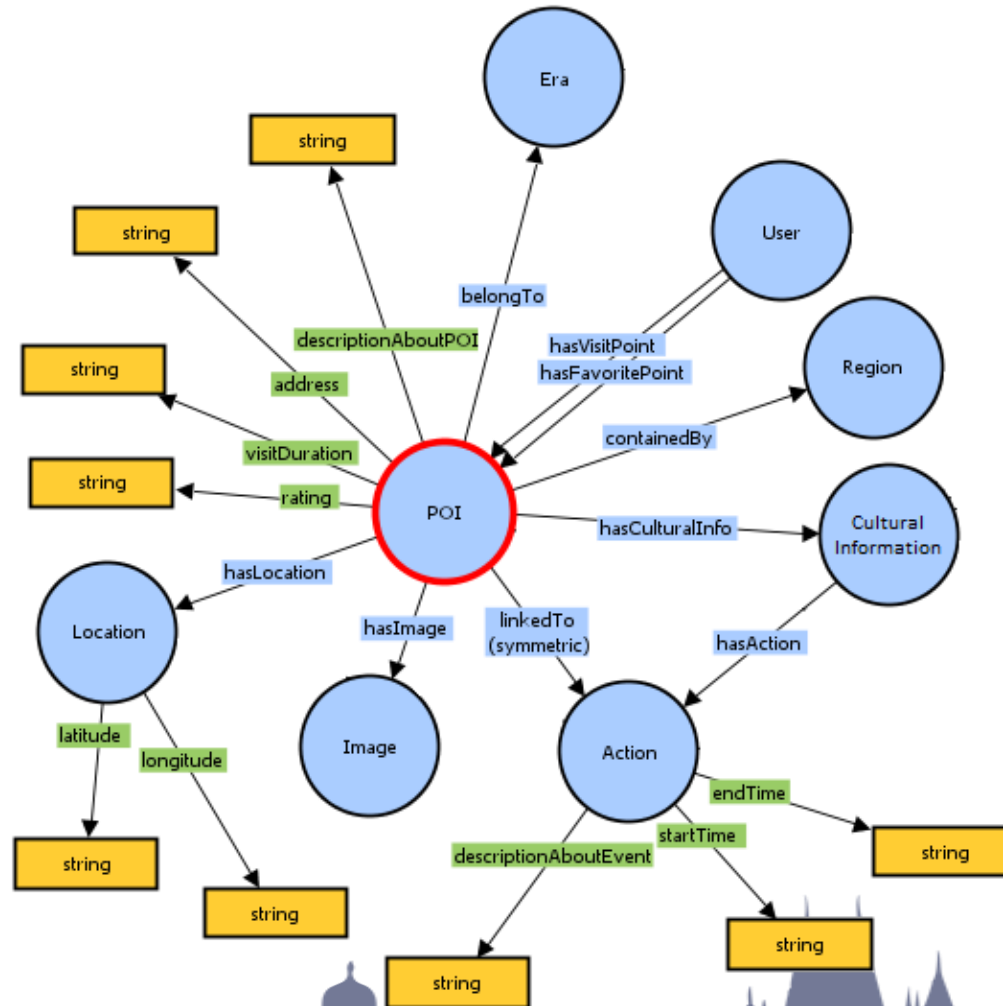
Individuals
Classes, concepts
Class attributes, properties
Relations

abstract model of some domain

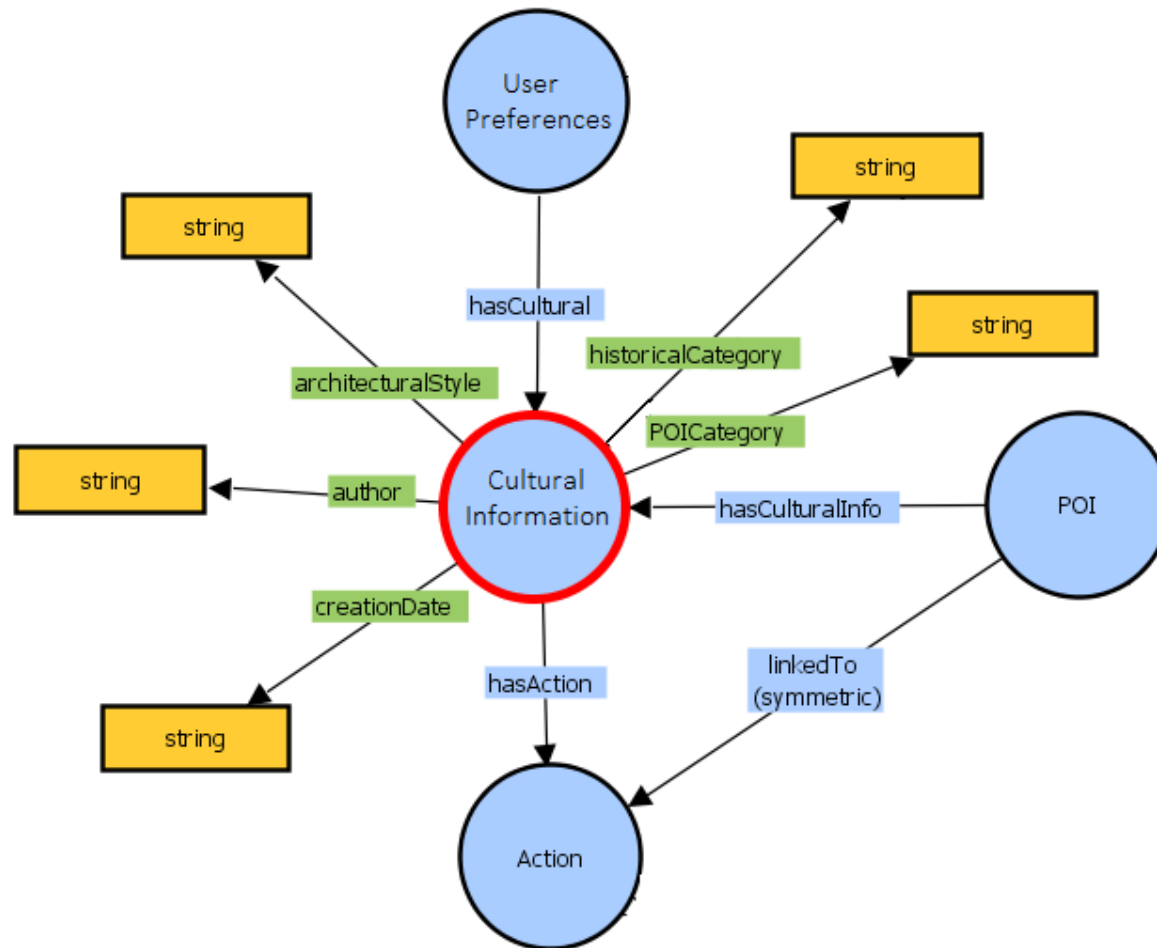


Tourist Ontology

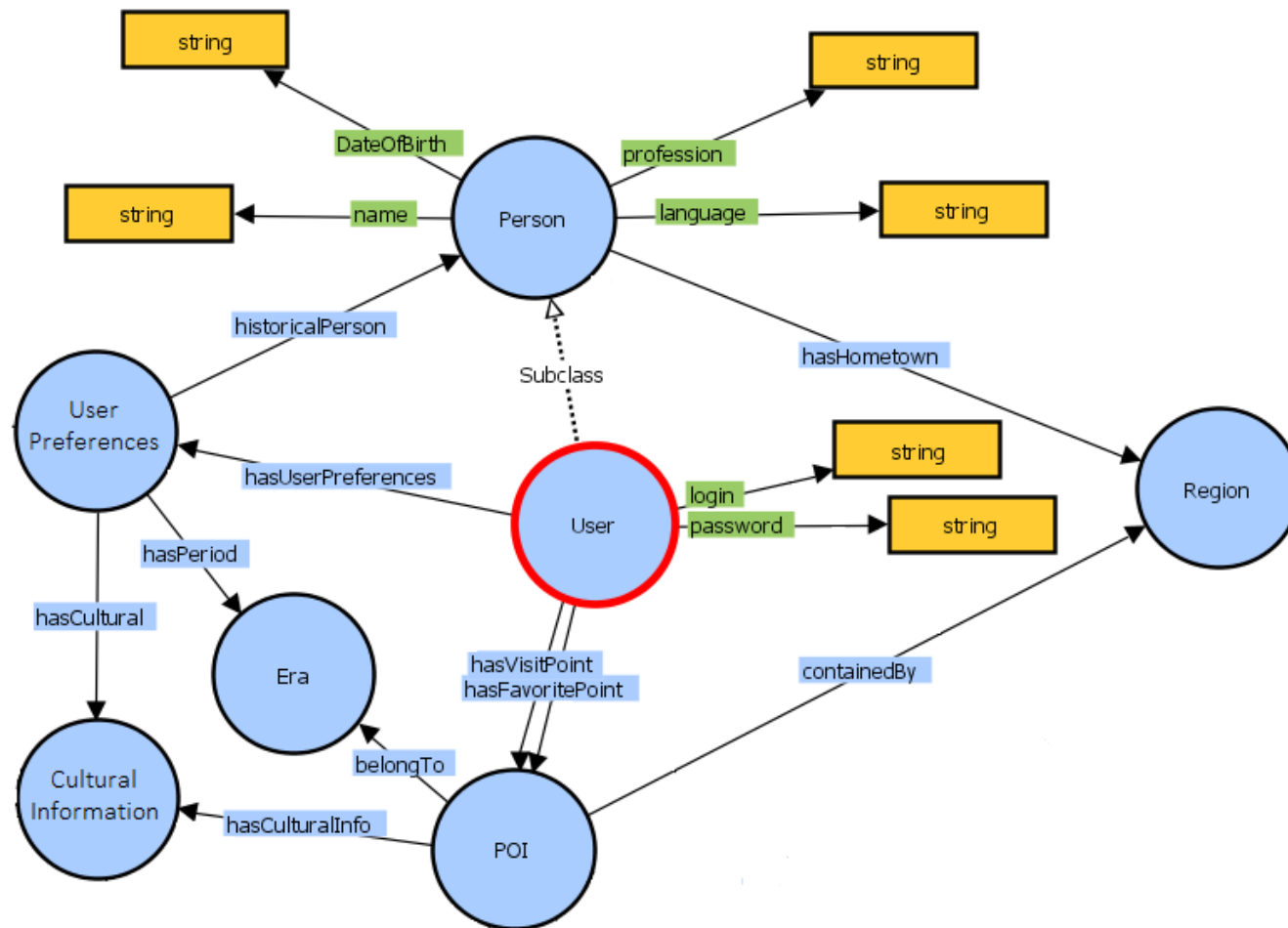
Fragment of Tourist Ontology: POI



Fragment of Tourist Ontology: historical and cultural information about the POI



Fragment of Tourist Ontology: personal information's and user preferences



$$\int_0^1 \frac{\varphi(s) - \varphi(t)}{s-t} ds = \sum_{n=1}^{\infty} \frac{1}{n} \sqrt{1 - z^n} \frac{1}{p} \frac{\partial M}{\partial p} \frac{1}{1 - p^{-s}}$$

$$u_t - u_{xxt} + 3uu_x - 2u_x u_{xx} - uu_{xxx} = 0$$



Computations methods

- ▶ The final step of service construction is ranking over the personalized POI structure.
- ▶ Each candidate POI becomes assigned with a rank value.
- ▶ The client KP can use these values for representation of recommended POIs to the user.
- ▶ Well-known mathematical methods can be then used for these computations.



$$\int_0^1 \varphi(s) \varphi(t) ds = \sum_{n=1}^{\infty} \frac{1}{\sqrt{1 - z_n^2}} \frac{1}{p} \frac{1 - p^{-s}}{1 - p^{-t}} = 0$$

$$u_t - u_{xxt} + 3uu_x - 2u_x u_{xx} - uu_{xxx} = 0$$



Symbol notation

| | |
|--|------------------------------|
| u | User |
| P | Content |
| K_i | universal knowledge base |
| S | set of all the POIs in K_i |
| personalized structure POIs is directed graph, where nodes | |
| $s_0, s_0 \in S$ | the initial POI |
| $c_u, c_u \subset S$ | visited POIs |
| $S \setminus (s_0 \cup c_u)$ | candidate POIs |

- $$\rho^i(c_u, s) = \min_{t \in c_u} \rho(T_t^i, T_s^i)$$
- ▶ The aggregated distance $\rho^i(c_u, s)$ can be determined as the minimal (or average) distance within the set of all distances $\rho^i(c_u, s)$

$$\int_0^1 \frac{1}{\zeta(s)} ds = \sum_{n=1}^{\infty} \frac{1}{n^s} = \frac{1}{1-2^{-s}} \prod_{p \text{ prime}} \frac{1}{1-p^{-s}}$$

$$u_t - u_{xxt} + 3uu_x - 2u_x u_{xx} - uu_{xxx} = 0$$



Probabilistic approach

- ▶ in different knowledge bases, there will be systematic differences in the values of distances between the sets of categories
- ▶ Formally, $U = \{u_1, u_2, \dots, u_n\}$
- ▶ let X and Y be two random subsets of U
as two binary vectors x and y , which are constructed as follows: $x_i = 1$ if only $u_i \in X$, otherwise $x_i = 0$ (similarly for y and Y)
- ▶ $p_i, i = 1, \dots, n$ the probability of u_i appearance in the subset
- ▶ Then we can carry out a random experiment, which consists of n independent tests.

- ▶ Each test can have one of the four possible outcomes

$$A^i_{\alpha\beta} = \{x_i = \alpha, y_i = \beta\}$$

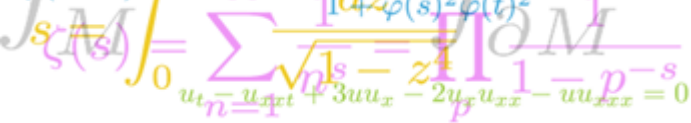
where $\alpha, \beta \in \{0,1\}$, i – number of a test

- ▶ let $I(A)$ – an indicator of a random event A ;
- ▶ a, b, c, d – overall quantities of outcomes $A_{11}^i, A_{10}^i, A_{01}^i, A_{00}^i$
- ▶ $a = |X \cap Y|, b = |X \setminus Y|, c = |Y \setminus X|, d = |U \setminus (X \cup Y)|$

where $|X|$ is the quantity of elements in X .

► Then $I(A_{11}^i) + I(A_{10}^i) + I(A_{01}^i) + I(A_{00}^i) = 1$,

$$a + b + c + d = n.$$



$$B = \left\{ \left(A_{11}^1, A_{10}^1, \dots, A_{00}^n \right) : \sum_{i=1}^n I(A_{11}^i) = a, \right.$$

$$\left. \sum_{i=1}^n I(A_{10}^i) = b, \sum_{i=1}^n I(A_{01}^i) = c, \sum_{i=1}^n I(A_{00}^i) = d \right\}$$

- Usually different distances between the sets are described as functions of a, b, c, d i.e., $\rho(X, Y) = h(a, b, c, d)$.

► Then the function of distribution of the random value $\rho(X, Y)$ could be described as follows:

► Where $C = \{ (a,b,c,d) \in \mathbb{Z}^4 : a,b,c,d \geq 0, a+b+c+d = n, h(a,b,c,d) < t \}$

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Thank you for attention!

