

Generalization of Place and Location Representation -for transforming representation-

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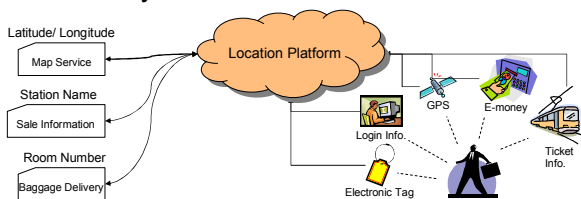
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Background

- There are many positioning devices.
 - But, each device has its limit in positioning accuracy and service area.
- In ubiquitous computing, various positioning devices should be chose according to user's circumstance.
 - In the outdoor, GPS, etc...
 - In the indoor, WiFi, RF-ID, etc...

End Goal

- Deal with location information in various expressions from multiple devices uniformly.



Problem (1/2)

- Each device outputs user's location information in its own representation style.
 - GPS : latitude, longitude, altitude
 - WiFi : access Point ID, coordinates in local system
 - RF-ID : tag reader ID
- One place can be represented by various style.
 - L1, NAIST, N34.43.45,E135.44.10, 〒630-0192, ...

Problem (2/2)

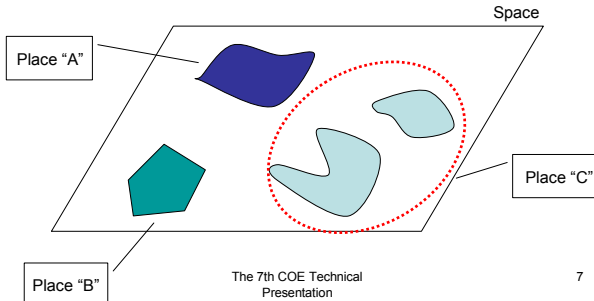
- The difference in the representation style of the acquired information and needed information
 - Someone wants to use map service on the Web.
 - He has RF-ID only (tag reader ID or room No. is available)
 - Map service supports lat, long, alt only
 - Room No. needs to be transformed into lat, long, alt.
- It is necessary to establish how to transform a certain representation style into another one.

Current Situation

- There are some implementation to transform location information representation style.
 - These are mainly based on one-to-one mapping database.
 - postal code ↔ address
 - lat, long ↔ address
- Until now, it seldom argued about the theoretical meaning of transforming representation style.
- In this presentation, I discuss an abstract theory of transforming.

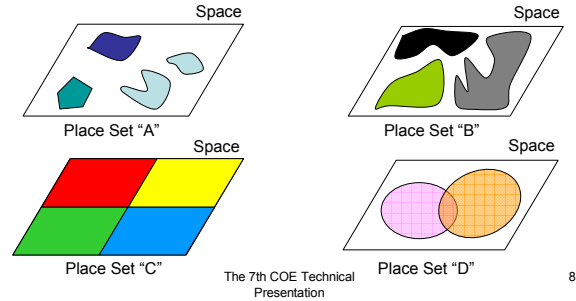
What is "Place"?

- "Place" ; A set of one or more regions in space
- A set of "Place" can be defined as "Place Set".

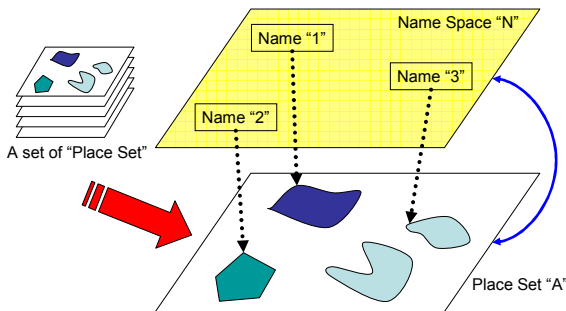


"Place Set"

- The definition method of a "Place" in a certain space is innumerable.
- So, "Place Set" in a certain space is also innumerable.



Name of "Place"



- A set of "Name Space" and "Place Set" can be called "Place Representation Style".

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What is "transforming"?

- It is "approximating a certain place by another one".
- e.g.
 - The place named "L1 room" might be able to be transformed into the one named "NAIST" or "Ikoma-Shi" or "Nara-Ken".
 - But each name indicates entirely different place.
 - In each context, it can only be disregarded that the place of a transforming result differs from the original place geographically.

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Candidate for Transformation Result

- There can be two or more places that is to be the candidate of a certain place transformation.
- Some candidate might be produced from some place in a certain place set newly.
 - The candidate for "L2" ; The north half of "Ikoma-Shi".

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Error in Transforming

- "Error" ; The geographical difference between the original place and the candidate.
 - In most case, the original place doesn't correspond with the candidate.
- In order to choose the optimal transformation result from several candidates, it is necessary to evaluate the error each candidate has.
 - The candidate with the smallest geographical error is not necessarily the optimal.
 - "The optimal" is context-dependent.

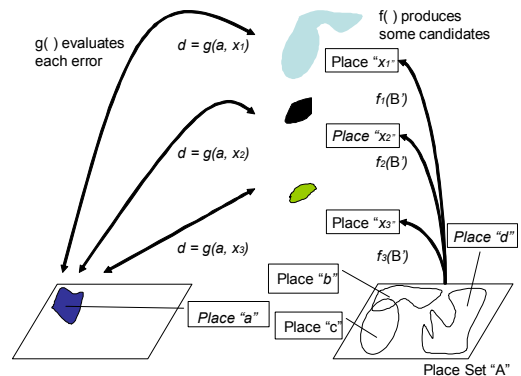
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Transforming Theory

- Function “ f ”; produces a candidate “ x ” from some place in Place Set “ A ”
 - $x = f(A)$
- Function “ g ”; evaluates an error in transforming a original place “ a ” into a candidate “ x ”, and gives it score “ d ”
 - $d = g(a, x)$
- The “ x ” which makes “ d ” the minimum is the optimal transformation result of “ a ”.

Example



Applying the Theory for the Real World

- There are some challenge.
- The limit in representing place
 - How to represent an abstract region such as “the north-half of Ikoma-shi” in a digital space?
 - All the places need to be represented geometrically or in analysis so that computers can be treated?
- Context-dependency in evaluating error
 - How to define function “ g ” which reflects user’s context-dependent demand for transforming correctly?

Summary

- For seamless positioning, it is necessary to transform a certain representation style of location information into another.
- In this study, I attempt to construct the abstract theory of transforming representation style.
- By developing the argument based on these considerations, it is expected that the effort towards the improvement in reusability of location information can be promoted.