Navigation in Maps :
Remembering Strategies Across Episodes

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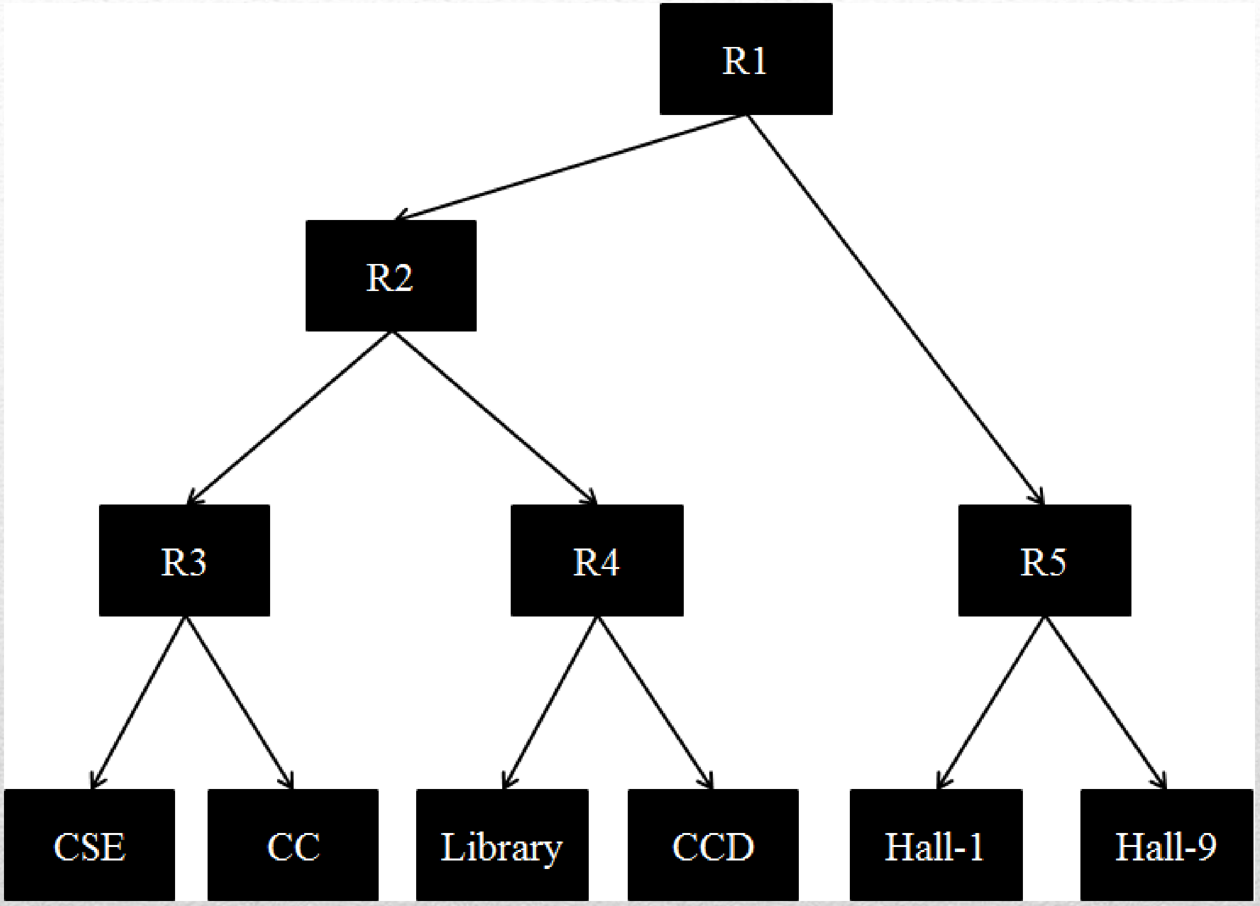
Introduction

- Humans organize spatial information in the form of hierarchy
- Humans choose from a set of heuristics in spatial reasoning
- Some studied heuristics are –
- Fine-to-coarse strategy (Wiener and Mallot 2003)
- Cluster Method (Gallistel and Cramer 1998)
- Least Decision Load (ONeill 1992)

etc..

Navigation : Remembering Strategies Across Episodes



A hierarchy for IITK map. Clustering is conceptual and not only based on nearness as evident from seeing Hall-1 and Hall-9 clubbed even though they are very far but both refer to the same concept of student hall.

Formal Description of Problem

- Given a set of landmarks, in which order will you visit them
- Each candidates answer is some permutation of the set of landmarks
- Answer is based on the hierarchical structure developed
- Develop a strategy that matches closely with the human reasoning given the hierarchical structure

Previous Work (Nayak, Mishra, Mukerjee 2011)

- Divides navigation into episodes
- In each episode choose a heuristic with a given probability
- Learn these probability using stochastic modeling
- No memory of previous heuristic exists – Memoryless Model

Hypothesis To Be Tested

First Order Markovian Memory

" Chances of using a heuristic is increased in a given episode if it was used in the previous episode"

Methodoloy

- For each heuristic compute equivalent 0-1 normalized feature $\{F_i\}$
- For each episode compute cost of each heuristic

$$\text{Cost} = a\,F_1 + b\,F_2 + c\,F_3 + d\,\text{Bias}$$

- Choose the heuristic with minimum cost
- Here the Bias factor is 0 for heuristic that was used in last episode and 1 for all other heuristics

Methodoloy contd..

- For a given value of (a,b,c,d) we find the distance from the user answer using Jaro-Wrinkler Distance
- Use simulated annealing to find the optimal value of (a,b,c,d) in R^4
- Experiment is repeated without Bias and results are compared

References

- [Nayak et al 2011] Nayak, Mishra, Mukerjee Towards a Cognitive Model for HumanWayfinding Behavior in Regionalized Environments, AAAI 2011

- [Wiener and Mallot 09] Wiener, J., and Mallot, H. 2003. Fine-to-coarse route planning and navigation in regionalized environments. Spatial Cognition and Computation 3(4):331–358.

- [Hirtle and Jonides 85] Hirtle, S., and Jonides, J. 1985. Evidence of hierarchies in cognitive maps. Memory & Cognition 13:208–217.

- [Reitman and Reuter 80] Reitmann, J., and Rueter, H. 1980. Organization revealed by recall orders and confirmed by pauses. Cognitive Psychology 12:554–581.

THANK YOU

Extra Slide

Finding Common Cluster

- Given various tree, one for each subject, how to find a single optimal tree

- Create Distance Matrix of size nxn where n is the number of subject

- Find distance between tree T_i and T_j as follows :

  [Jackknifing Hirtle 85]
  If there are t landmarks such that on deleting them the tree becomes same then distance is t

Finding Common Cluster Contd..

- Find the tree such that the average distance from all other tree is minimum in the distance matrix graph
- This tree along with the learned parameters (a,b,c,d) can be used in navigation system

Jaro-Wrinkler Distance

- Given two strings s_1 and s_2 the Jaro-Wrinkler distance is defined as –

- Let m : number of matching characters
- T is half the number of transpositions

$$d_j = \begin{cases} 0 & \text{if } m = 0 \\ \frac{1}{3}\left(\frac{m}{|s_1|} + \frac{m}{|s_2|} + \frac{m-t}{m}\right) & \text{otherwise} \end{cases}$$

- Two characters are considered matching if they are not farther than

$$\left\lfloor \frac{\max(|s_1|, |s_2|)}{2} \right\rfloor - 1$$

image courtesy wikipedia