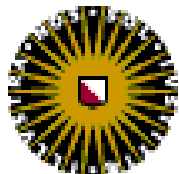


Automating Web-Navigation Support Using a Cognitive Model

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IIIT-H

Web-Navigation

- Good UI facilitates easy navigation
- Leads to less mouse-clicks & less **cognitive load**
- No standardization in UI
- Unclear menus & navigation structures

Ways for providing Navigation Support

- Recording browsing steps & allowing users to replay
- Representing navigational objects in form of a map
- Keeping track of user's behavior & navigation history to find out what could be interesting to the user (requires initial training of the system)
- Merging browsing & searching techniques, & using information foraging theory (based on information scent, the most relevant links on the web page get highlighted, leading to user goal)

Why a Cognitive Model for Web-Navigation simulation is preferred

- Predicts navigation pattern & provides support to user
- Works well with first time website visit, no initial training or browsing history required

LICAI (Linked Model of Comprehension-based Action Planning & Instruction taking)

SNIF-ACT (Scent-based Navigation and Information Foraging in ACT Architecture)

MESA (Method for Evaluating Site Architectures)

CoLiDeS (Comprehension-based Linked Model of Deliberate Search)

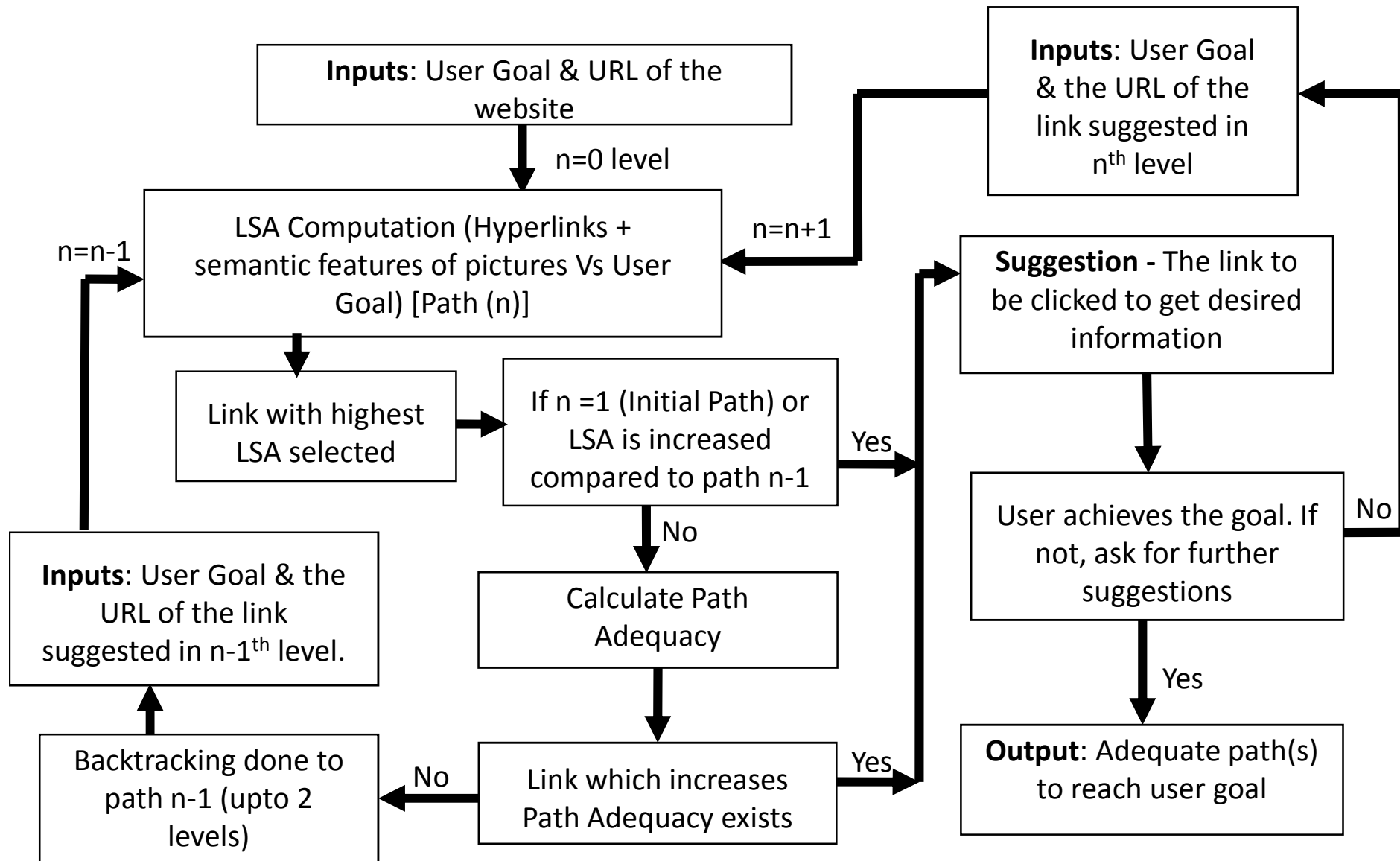
CoLiDeS

- The model uses Latent Semantic Analysis (LSA) to determine *information scent* between user goal & content of hyperlinks on a given web page
- **Information scent** - measure of value/cost/access path of information sources obtained from proximal cues
- **LSA** - An unsupervised machine learning technique that builds the semantic space;
Includes computation of **term frequency, inverse document frequency (TF-IDF)**;
Cosine similarity is computed using **dot products** of the two TF-IDF vectors (one for user goal & the other for hyperlink-text)

Variants of CoLiDeS

- **CoLiDeS+** includes structural dimension: Path adequacy (semantic similarity between the navigation path traversed so far during the session & user's goal)
- **CoLiDeS+Pic** includes semantics from pictures (obtained through user annotation)
- **Proposed model - CoLiDeS++Pic**
Takes into consideration both structural dimension & information from semantic features of pictures.
Expectations:
 - i) CoLiDeS++PIC model will predict behavior better;
 - ii) Information seeking performance will be improved with CoLiDeS++Pic

Process Diagram of the tool



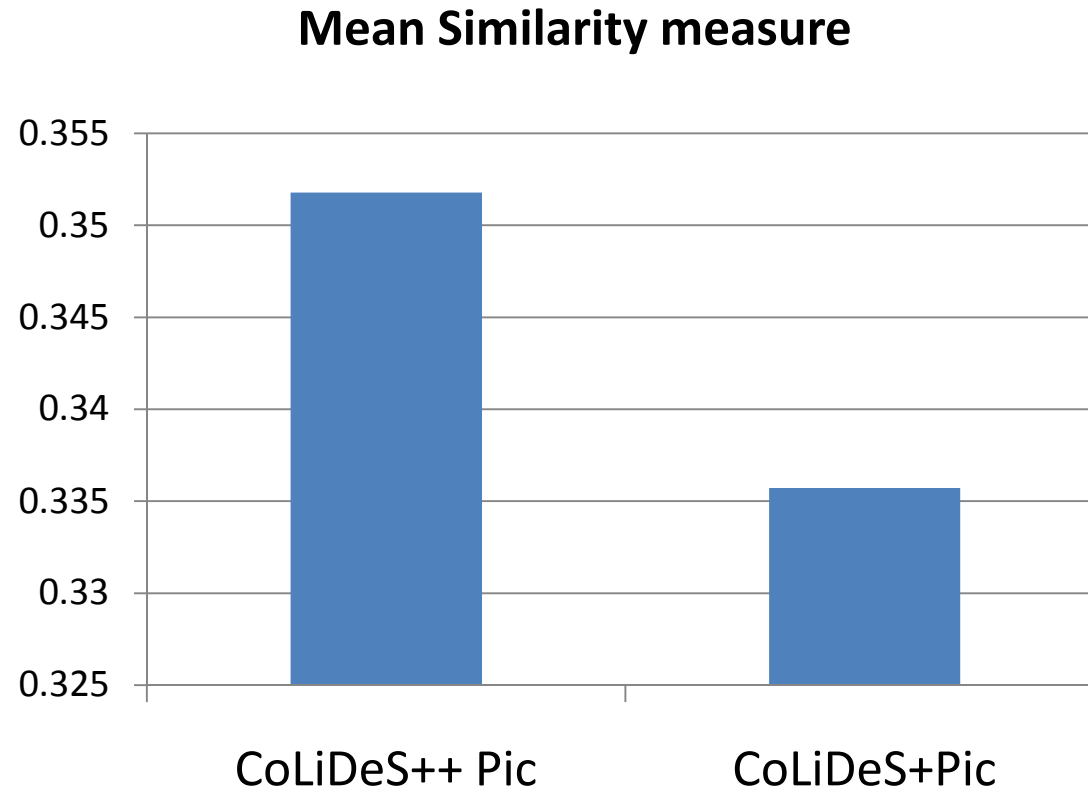
Example on a mock-up website

	LSA Value	
<i>Level 1</i>		
<i>Respiratory System</i>	0.251	
<i>Nervous System</i>	0.251	
<i>Digestive System</i>	0.270	
<i>Circulatory System</i>	0.273	
	LSA Value	Path Adequacy
<i>Level 2</i>		
Cardiovascular System	0.238	0.284
Lymphatic System	0.242	0.308

Note: bold links are selected by the system

User goal - "*Lymphatic System contains immune cells called lymphocytes, which protect our body from antigens. They are produced by lymph nodes. Name at least three locations in the body where lymph nodes are present*".

Model Behavior of CoLiDeS++Pic compared with CoLiDeS+Pic



Mean LSA values for correct links given by both models for 8 tasks on a given mockup website

Usefulness of the tool

Helps reducing cognitive load on the user & saves time

Particularly for:

- Visually-impaired persons
- Elderly people having memory problems
- New internet users
- Expert users doing multi-tasking

Validation Experiment

Goal: tool-support based on the links chosen by the model will help users during navigation; particularly during multi-tasking.

Study on the influence of **support** and **multi-tasking** on performance of participants (completion time, task accuracy, disorientation)

Validation Experiment

- 2x2x4 factorial design, where the first two factors (**tool-support and multi-tasking**) were between-subjects-variables, & the third factor (**4 levels of task**) was within-subjects.
- **Parameters measured :**
Time, Accuracy, Disorientation (based on the ratio of the visited and the optimal node counts: $L = \sqrt{((N/S - 1)^2 + (R/N - 1)^2)}$ and R is minimum no. of pages needed to visit in order to finish task, S is the actual no. of pages visited, N is the no. of distinct pages visited & L is the disorientation. As users become increasingly lost the value of N/S tends to be 0 and also R/N tends to be 0, while for users who are not lost the ratios tend to be 1)

Participants: 40 students of IIT-H, 34M, 6F, (M age=27.14, SD=6.75).

Validation Experiment

- Mockup website (two versions)

Please write the answer to the following question by navigating through this website and click on submit
If a blood sample contains A-antigens and anti-B antibodies, what name is given to this according to ABO system?

Exploring Human Body

NAVIGATION MENU

- HOME: Introduction
- Respiratory System
- Nervous System
- Digestive System
- ▶ **Circulatory System**
 - Cardiovascular System
 - Lymphatic System

← BACK

CIRCULATORY SYSTEM

The circulatory system is an organ system that moves nutrients, gases, and wastes to and helps stabilize body temperature and pH to maintain homeostasis. This system is a distribution network, but some consider the circulatory system as composed of the cardiovascular system, the lymphatic system, and the lymphatic system, which distributes lymph. Humans as well as other vertebrates have a circulatory system (meaning that the blood never leaves the network of arteries, veins and capillaries, other than in the case of an open system).

The main components of the human circulatory system are the heart, the blood, and the lymphatic system. The pulmonary circulation, a "loop" through the lungs where blood is oxygenated, and the systemic circulation, a "loop" through the rest of the body to provide oxygenated blood. An average adult contains about 5 liters of blood, which consists of plasma, red blood cells, white blood cells, and platelets. The circulatory system provides the nutrients the system needs to keep the heart pumping.

Two types of fluids move through the circulatory system: blood and lymph. The blood circulates through the cardiovascular system. The lymph, lymph nodes, and lymph vessels form the lymphatic system and the lymphatic system collectively make up the circulatory system.

INTERESTING FACTS

- The heart beats around 3 billion times in the average person's life.
- The heart beats 100,000 times each day. And it pumps the blood...

With no suggested links

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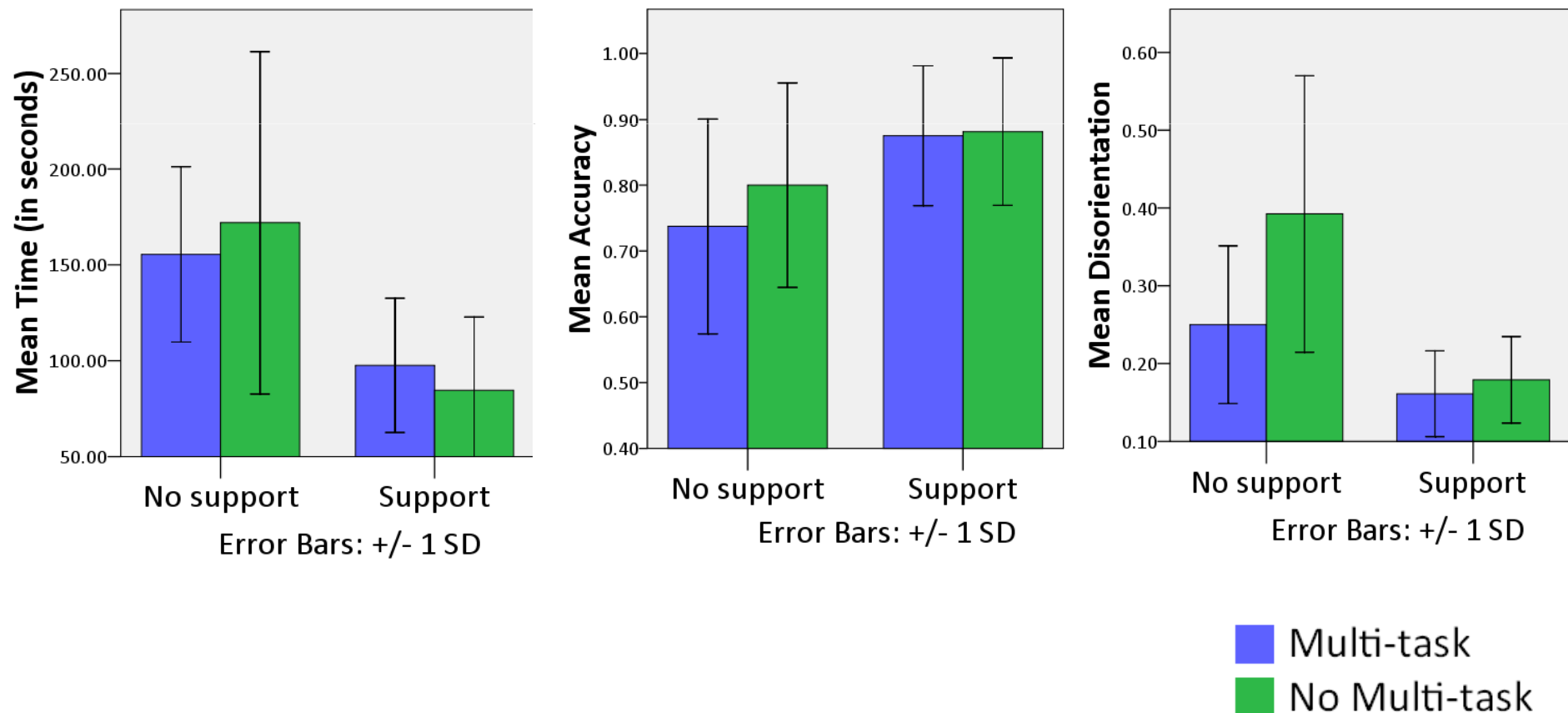
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INTERESTING FACTS

With highlighted suggested links

Validation Experiment Results

Effect of support in Multi-task & no Multi-task conditions



Validation Experiment Results (stats)

- Three Mixed design ANOVA's were performed to statistically analyze the effects on dependent variables:
 1. A strong positive effect of tool-support, $F(1, 36) = 16.54, p < .001$, while there was no significant effect of multi-tasking on **total time** *nor* interaction
 2. A significant difference in **accuracy** between support & no-support conditions, $F(1, 36) = 6.40, p < .05$, while no effect of multi-tasking & its interaction with tool-support
 3. Effect of support on **disorientation** was highly significant, $F(1, 36) = 18.99, p < .001$);
The effect of multi-tasking was also significant $F(1, 36) = 5.35, p < .05$, however the disorientation was unexpectedly higher in the no-multi-tasking condition

Conclusion & Future scope

Significant positive impact of the tool-support is observed in terms of time needed to perform search tasks, disorientation in navigation and task-accuracy.

Thus, making use of cognitive model for navigation support is a useful and promising research area.

Further: Automation of the semantic feature extraction from pictures, Quantitative testing of the tool with real time websites, more experimentation with complex mock-up websites and more memory taxing secondary task.



Thank you