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QUANTITATIVE MODELS FOR OLDER ADULTS' HIERARCHICAL STRUCTURE BROWSING

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ABSTRACT

Hierarchical structures are one of the most commonly used methods of presenting electronic information. Older users, however, may experience problems accessing it because of ageing-related decline. This paper demonstrates two quantitative models of the time older adults took to browse expandable and sequential structures to reach the target information. The first model utilises GOMS to break down browsing activities into various components, such as mouse movements, reading and eye movements. The second model presents a parametric model of browsing time. Our research demonstrates that these two models managed to model the experimental data quite well, suggesting that it is possible to model older adults' browsing activity quantitatively.

Keywords

older adults, ageing, hierarchical structures

1. INTRODUCTION

Hierarchical structures (e.g. menus) are one of the most commonly used methods of presenting electronic information . Hierarchical structures are also the most commonly found web structure . Realising the importance of hierarchical structures various studies on different aspects of hierarchical information had been conducted, investigating issues such as the effect of depth vs. breadth and the effect of displaying the hierarchy in expandable vs. sequential formats, etc , .

It is a general knowledge that older adults experience a combination of age-related cognitive, motor and perceptual decline, which may affect how they use computers and access electronic information. A significant increase in the older population using online information (e.g. the Internet) has led to various studies investigating the effects of ageing on information retrieval. However, these studies are mostly qualitative or limited to statistical analysis rather than trying to model quantitatively how older adults access online information. Although qualitative and statistical studies are a helpful first step in understanding the effect of ageing, to be able to put forward a quantifiable argument and replicable results, a quantitative model will be more appropriate

2. BROWSING ACTIVITIES

Many people still prefer browsing to using search engines to find information in a hierarchical structure . This makes the task of quantitatively modelling older adults accessing online information easier, because there are lower individual differences in browsing behaviour than in searching behaviour.

There are various ways to model older adults' browsing behaviour. There are also various measurable things under the umbrella of behaviour (e.g. search effectiveness, time or error). This paper demonstrates two methods of modelling the time older adults required to browse a hierarchical set of links to reach a certain target.

The first method uses GOMS[1] methodology to break the browsing activity into tasks and integrates ageing constants or equations into these tasks. The GOMS model for browsing activity is described in Figure 1.

There are several advantages of breaking down the browsing activity into smaller tasks. First, there are established times derived from a large pool of experimental data for various cognitively singular operators (e.g. clicking mouse button = 200 ms), making the modelling task easier. Second, it is easier to verify the model experimentally by testing various sub-activities rather than by testing the whole activity. Third, there are established task-specific formulas to represent ageing effect . It should be noted that there is also a general ageing theory, which suggests that older adults are 1.4 times slower than younger adults regardless the type of task performed .

The second model expanded an existing parametric model to include age-related parameters to represent age-related differences in browsing hierarchical structures.

The following model was proposed and validated:

$$BT = complexity(E(I)t_{age} + k_{age} + c)$$

The inherent complexity of a structure is defined by the actual number of pages the user has to go through to reach the target.

BT is browsing time, t_{age} and k_{age} are the ageing-adjusted times for the time to "read and process one option" and the time for "human response" respectively. The reading and processing times were estimated from a sub-set of the actual browsing experiment data and the human response time was estimated from the Fitts' Law[2] experimental data.

Method for goal: *find information on X*
Step 1. Decide: if hand is not on mouse, move_hand to mouse (eye movement + hand movement).

[1] GOMS stands for Goals, Operators, Methods and Selection Rules. GOMS represents the procedural knowledge required to operate a system.

[2] Fitts Law states that the time to acquire a target is a function of the distance to and size of the target

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Step 2. Accomplish goal: *locate information*.
Step 3. Decide: if no information is found and it is not the beginning of the information set then accomplish goal: *backtrack page*.
Step 5. Return with goal accomplished.

Method for goal: *Locate information*
Step 1. Compare information on the screen with target information in the Working Memory (number of words * (eye movement + comprehension).
Step 2. If target information is a link then accomplish goal: *click link* then Goto 1.
Step 3. Return with goal accomplished

Selection rule set for goal: *Backtrack x*
Accomplish goal *click back arrow.*
Accomplish goal: *locate information*.
Return with goal accomplished.

Method for goal: *Click x*
Step 1. Visually locate x on the screen.
Step 2. Move cursor to x (Fitts' Law).
Step 3. Press mouse button down and release.
Step 4. Return with goal accomplished.

Figure 1: GOMS model of the browsing activity

Both models were tested with the same set of experimental data collected from 24 older and 24 younger adults browsing online health information organised in expandable and sequential hierarchical structures with varying depths and breadths. Both of the models managed to predict browsing times of the different experimental conditions with high accuracy and also managed to capture the age-related differences in those tasks.

3. CONCLUSIONS

This paper demonstrates that it is possible to model quantitatively older adults' behaviour in accessing online information. The two models presented were able to capture the most important elements of the time older adults require to browse online hierarchical structures (as shown by successful models' validation using the experimental data).

The strong point of using a quantitative model is that it allows a quantifiable argument to be put forward to support suggestions to improve the usability of online information for older users.

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