

# Interactive Memex

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## INTRODUCTION

With the development of the Internet, a great deal of information is on-line. Popular search sites could be visited million times daily and the sites related to your interest will often be visited by you. Although book-marks can be used to record frequented Web sites, browsers discard most history and trail information. The explosion of information needs a more effective mechanism. Memex has been considered in this domain. Assisted by Memex, a Web surfer can retrieve the URL trails that a user visited several months ago. In this paper, we propose a mechanism Self-modifiable Color Petri Net - SCPN to simulate the Memex functions in a Web browser. In this mechanism, an SCPN instance is used to record a trail of a topic, a place in an SCPN instance represents a Web site.

## RELATED WORK

### Petri Net

Petri Net is a graphical notation for the formal description of systems whose dynamics are characterized by concurrency, synchronization, mutual exclusion, and other conflict, which are typical features of distributed environment. A formal definition of Petri Nets is a four-tuple  $(P, T, I, O)$  (Peterson, 1981) where  $P$  is a set of places that are the state variables of a system;  $T$  is a set of transitions, which are state changing operators.  $I$  and  $O$  are the pre- and post-conditions of a transition. The dynamic performance of a Petri Net is controlled by the firing rule.

Several extended Petri Net models have been proposed to extend its application domains. Examples of which are Object Composition Petri Net (OCPN) in (Little, 1990) and Enhanced Prioritized Petri Net

(EP-net) in (Guan, 1999) and (Guan, 2002) which is an enhanced version of P-net in (Guan, 1998). The general concepts of Petri Net are described in the next section. Self-modifiable Color Petri Net (SCPN) is also introduced in the next section.

### Memex

As early as 1945, Vannevar Bush proposed a desktop personal information machine called the Memex (memory extender) (Bush, 1945). Memex focused on the problems of "locating relevant information in the published records and recording how that information is intellectually connected". An important feature of Memex is the function of associative indexing that presents the feature of hyperlinks. In addition to these links, Bush also wanted Memex to support the building of trails through the material in the form of a set of links that would combine information of relevance for a specific topic.

### Some Powerful Bookmarks, Bookmark Organizers, and Other Works

There are quite a number of powerful bookmarks and organizers developed like the Personal Web Map (PWM) (Yamada, 1999), Bookmark Organizer (Maarek, 1996), PowerBookmarks (Li, 1999), and CZWeb (Fisher, 1997). All of these provide organization and management of bookmarks but not Memex functions, that is, they do not provide surfing history and trails.

A related work which uses trails is Memoir (Derource, 2001). Trails are used to open hypermedia link services and a set of software agents to assist users in accessing and navigating vast amounts of information in Intranet environments. The trails in Memoir are mainly used to record actions on documents that users have visited. In our Memex application, trails are mainly used to record and retrieve surfing history information.

## PETRI NET AND SELF-MODIFIABLE COLOR PETRI NET (SCPN)

A Petri Net structure,  $P$ , is a four-tuple.

$$P = (P, T, I, O)$$

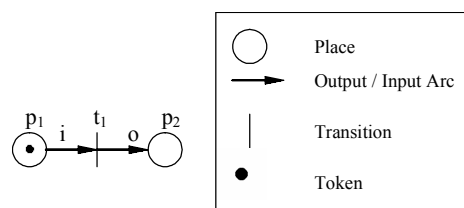
- i.  $P = \{p_1, p_2, \dots, p_x\}$ , where  $x \geq 0$ , is a finite set of *Places*.
  - ii.  $T = \{t_1, t_2, \dots, t_y\}$ , where  $y \geq 0$ , is a finite set of *Transitions*.
- where  $P \cap T = \emptyset$ , i.e., the set of the places and transitions are disjoint.
- iii.  $I: T \rightarrow P^\infty$  is the *Input Arc*, a mapping from places to bags of transitions.
  - iv.  $O: T \rightarrow P^\infty$  is the *Output Arc*, a mapping from transitions to bags of places.

Token =  $\{\text{token}_1, \text{token}_2, \dots, \text{token}_x\}$ ,  $x \geq 0$ ,  $x \in \mathbb{S}$ , is a finite set of dynamic markings on places.

The Petri Net model consists of places, transitions, arcs, and tokens.

- i. A *place*, denoted by a circle, represents the state of the system.  $p_1$  and  $p_2$  in Figure 1 are places.
- ii. A *transition*, denoted by a vertical line, represents the action of the system and is led by an output arc and trailed by an input arc.  $t_1$  in Figure 1, led by  $o$  and trailed by  $i$ , is a transition.
- iii. An *arc* represents the flow relation between transitions and places.
- iv. An *input arc*, denoted by an arc terminated by an arrowhead leading from a place to a transition, maps a place to a transition.  $i$  in Figure 1 is an input arc.

Figure 1. Petri Net segment



- v. An *output arc*, denoted by an arc terminated by an arrowhead leading from a transition to a place, maps a transition to a place.  $o$  in Figure 1 is an output arc.
- vi. A *token* is a marking that denote the current state of the system. A firing of a transition removes a token from its input place and places a token in its output place. In Figure 1, a token is marked in place,  $p_1$ .
- vii. The *input place of a transition* is the place that is connected to the transition via an input arc.
- viii. The *output place of a transition* is the place that is connected to the transition via an output arc.

The Petri Net is governed by a set of Firing Rules that allows movement from one state to another.

- i. A transition is *enabled* when all input places that are connected to it via an input arc have at least one token.
- ii. A firing of a transition removes a token from its input place and places a token in its output place.

Introducing some novel mechanisms to Petri Net gives birth to SCPN which can handle user interaction flexibly. Unlike in Petri net, SCPN has two types of tokens: color tokens and resource tokens. Resource token are divided into two sub-types: a forward token that moves in the same direction with arcs and a reverse token that moves in the opposite direction with arcs. In SCPN, certain commands for each mechanism are also introduced.

For the new mechanisms to work, some new rules are defined to assist SCPN to complete its functions:

- A color token will be injected into each place that contains resource token(s) when a user interaction occurs.
- When a color token is injected, the execution of the model will be interrupted.
- When all the commands associated with a color token have been executed, this color token will be deleted. Then the playback of resource tokens will be resumed.

The commands associated with each color token can be designed according to the corresponding user interaction. In the following, we use some solid examples to demonstrate how color tokens are used to realize Memex functions in Web surfing.

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