An Approach to Personalization and Adaptivity in Hyperlink-Based Systems

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Agenda

- **Part 1**: Motivation, Some Problems and Responses
- **Part 2**: Towards One Possible Solution
  1. A Model of Hyperlink-Based Interaction
  2. Adding Personalization
  3. Adding Adaptivity
- **Part 3**: Contrast, Limitations, Possibilities, Conclusions

Motivation

- Does **personalization + adaptivity** $\rightarrow$ **effectiveness**$\uparrow$?
- It is likely that empirical evidence will be demanded.
- Activity so far has been mostly ad-hoc, hands-on, system- and technology-driven.
- This makes it difficult to test the above hypothesis at a general enough level.

Some Problems and Responses (1)

Problems

1. Why are tailoring actions required?
2. What is the purpose of tailoring actions?
3. Which tailoring actions could be made available?
4. Which tailoring actions should be made available?

Some Problems and Responses (2)

Responses So Far

1. to transfer ownership from designers to users
2. to revise design decisions as to content, navigation and rendering
3. (?)
4. (?)

Technical feasibility and ad-hoc experimentation determine what existing implemented systems provide.

Some Problems and Responses (3)

Our View

1. Yes.
2. Yes.
3. The choice of <u>possible</u> actions should not be system- and technology-driven, but rather fall out from an abstract model.
4. Any <u>actual</u> choice should be ultimately subject to empirical tests.

Some Problems and Responses (4)

Derived Problems

1. How to model interaction with a hyperdocument?
2. How to transfer ownership of the interaction process from designers to users?
3. How to make design decisions more explicit and revisable?
4. How to distinguish (and model (and implement)) tailorable hyperdocuments and non-tailorable ones?
5. How to distinguish (and model (and implement)) personalization and adaptivity?

Some Problems and Responses (5)

State of Play

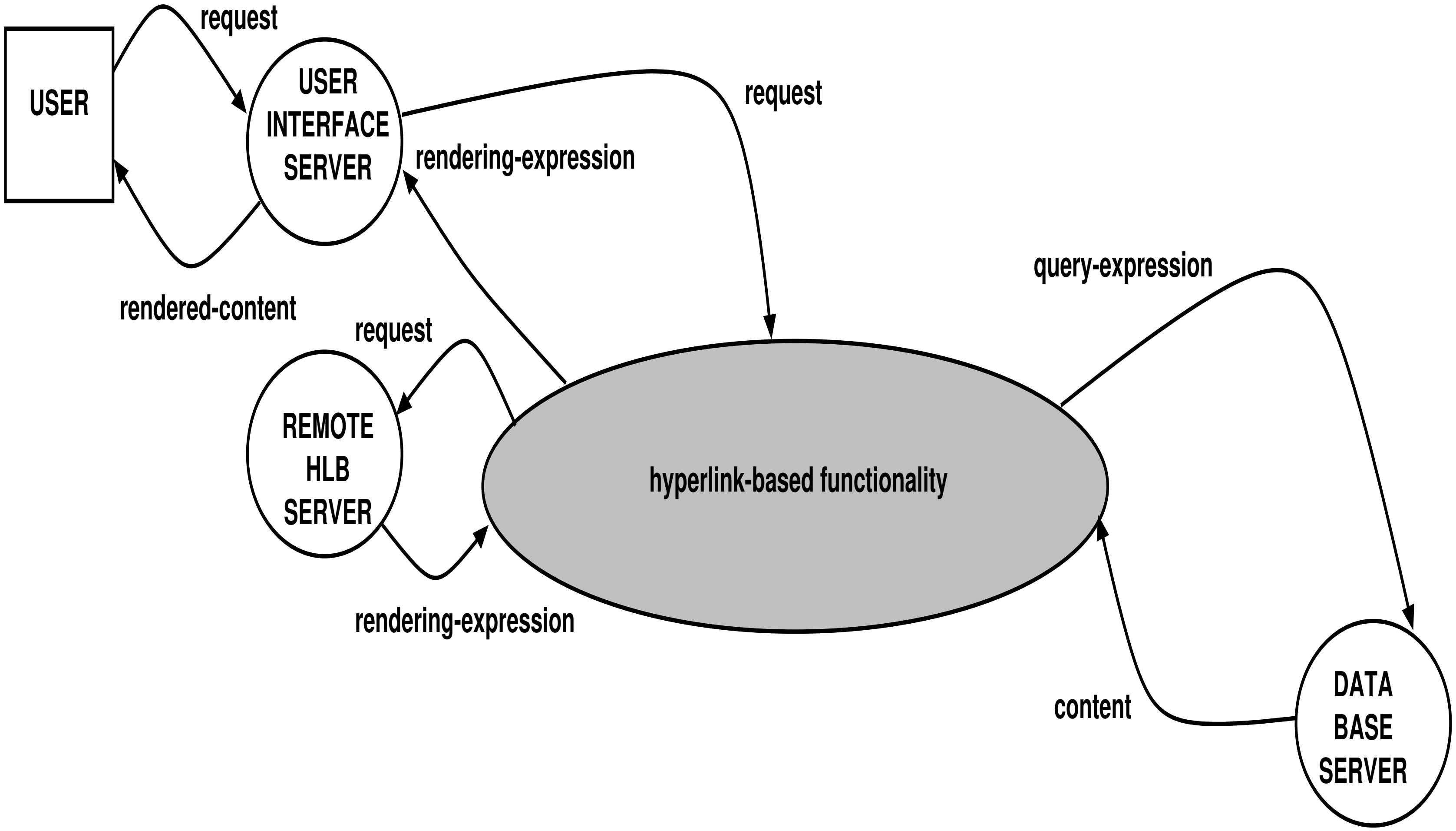
1. Simply coding a tailoring action into a system is not enlightening enough. Generalization is difficult.
2. Design decisions are often difficult to parse, and revise.
3. Personalization and adaptivity (P&A) are not always clearly distinguished,
4. This makes it difficult to test their independent impact (or are they one and the same?)

Towards One Possible Solution

Our Approach

1. to characterize a core of hyperlink-based functionality viewed as a client technology;
2. to view tailoring actions as ranging over entities within this core and as effecting the transfer of ownership from designers to users;
3. to make design decisions explicit and therefore easier to revise;
4. to model **personalization** as *user-initiated tailoring* and **adaptivity** as *system-initiated personalization*;
5. to propose this distinction as a basis to analyze and measure their independent and compound effects.

Isolating Core Hyperlink Functionality



External Architectural Features

- Loose coupling with UI and DB servers leaves a distinguishable core.
- UISs channel in requests.
- DBSs may be queried for content and reply with refreshed data.
- The core composes the returned data into a renderable text as specified.
- A UIS renders the returned response.

Internal Architectural Features

- The core contains at least one group of functions that model interaction with non-tailorable hyperdocuments: the **H-region**.

- Adding the **P-region** allows **personalization requests**, i.e., tailoring actions initiated by the user.

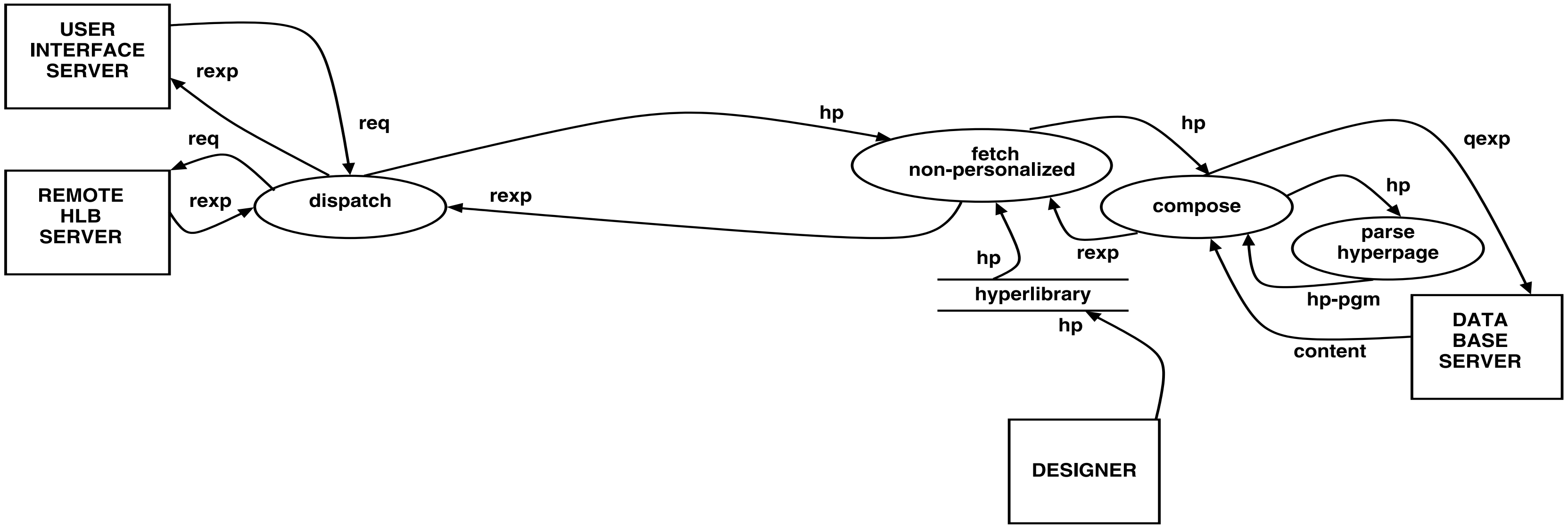
- Adding the **A-region** allows **adaptivity actions**, i.e., personalization requests initiated by the system.

- The P- & A-regions consecutively presuppose, but require no modification on, the previous one.

H-Region: Requests

- With only the H-region, all that users can request is for hyperpages to be rendered.
- Designers' decisions as to the content, navigation and rendering features of a hyperdocument cannot be revised.
- Hence, the H-region offers *non-tailorable interaction*.

H-Region



LEGEND

req == request
rexp == rendering expression
hp == hyperpage
qexp == query expression
hp-pgm == hyperpage program

H-Region: Features

- A hyperlibrary stores hyperpage specifications.
- The semantics of a hyperpage specification is an abstract program whose main actions are
  1. to fetch content from DBSs if necessary,
  2. to compose a renderable text (including navigation elements) and
  3. to return it to a UIS for rendering.

H-Region: A Hyperpage Spec

```
page{
  chunk {
    entry     { [<A NAME="welcome">]
              }
    content   { X := 'hello',
                Y1 := ', world'
              }
    rendering { [<B>] X [</B>]
                [<B> <I>] Y1 [</I> </B>]
              }
        }
  chunk {
    content   { X := [SELECT * FROM welcome]
              }
    rendering { [<I> <B>] X [</B> </I>]
              }
    exit      { [<A HREF="http://www.gold.ac.uk/"> next </A>]
              }
        }
    }
```

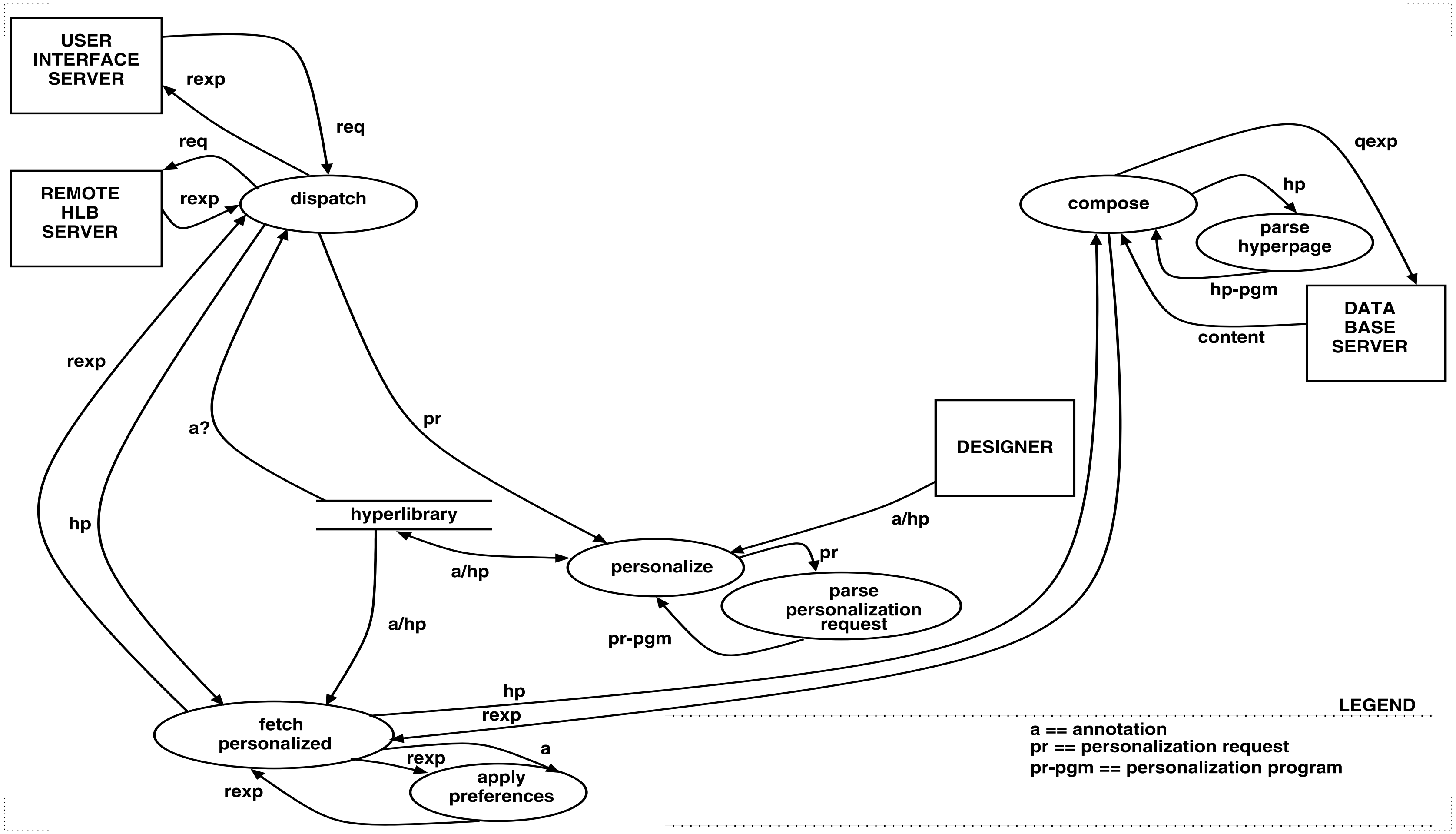
P-Region: Requests

New available initiatives are:

1. **annotation**, ranging over:
   (a) **attribute assignment**, for a range of attributes which qualify designer decisions as to contents and navigation, and
   (b) **post-composition rewrite**; and
2. **personalization**, allowing a user to version a hyperpage spec by rewriting the designer specification, entirely if need be.

Annotations make possible requests for **alternative** and **comparable hyperpages**, as well as, for the **current values of attributes** of a hyperpage spec.

P-Region


USER INTERFACE SERVER
rexp
req
req
REMOTE HLB SERVER
rexp
dispatch
rexp
a?
pr
hp
hyperlibrary
a/hp
a/hp
personalize
pr
parse personalization request
pr-pgm
DESIGNER
a/hp
compose
hp
parse hyperpage
qexp
hp-pgm
content
DATA BASE SERVER
hp
rexp
fetch personalized
rexp
a
apply preferences
rexp
LEGEND
a == annotation
pr == personalization request
pr-pgm == personalization program

P-Region: Features

- An annotation causes a hyperpage spec to be versioned and paired with that annotation.
- The hyperpage spec/annotation pair is bound to the user who defined it.
- A personalization request that rewrites the hyperpage spec also causes versioning and binding to the user who requested it.
- If a hyperpage spec is versioned because it has been annotated, then, if a post-composition rewrite is requested, this is effected after the H-region has composed the renderable text.
- It is also open to designers to annotate hyperpage specs.

P-Region: An Example Annotation

```
annotation{
  page                          : level := 1;
  [any, chunk                  ]: keyword := 'dynamic content';
  [1, chunk                    ]: keyword := 'introduction';
  [2, chunk (C-spec)           ]: keyword := 'clusters', keyword := 'galaxies';
  [2, chunk (1, exit-point)    ]: level := 1;
  [2, chunk (any, exit-point)]: level := 5;
  [2, chunk (R-spec)           ]: keyword := 'JPEG', keyword := 'greyscale';
  [3, chunk (C-spec)           ]: keyword := 'planets', level := 5;
  [4, chunk (C-spec)           ]: level := 1;
  page                          : "center" -> "centre"
}
```

P-Region: PR Examples (1)

```
select-page-if [any, chunk (entry-point)] contains "www.cs.gold.ac.uk"
then-do {
   [any, chunk (entry-point)]: "cs" -> "cis"
   }

select-page-if true
then-do {
   retain-if [any, chunk] contains "1998"
   }

select-page-if true
then-do {
   insert [1, chunk]: level := 1;
   }

select-page-if [any, chunk] contains "Goldsmiths"
then-do {
   insert page: keyword := "Goldsmiths College";
   }
```

P-Region: PR Examples (2)

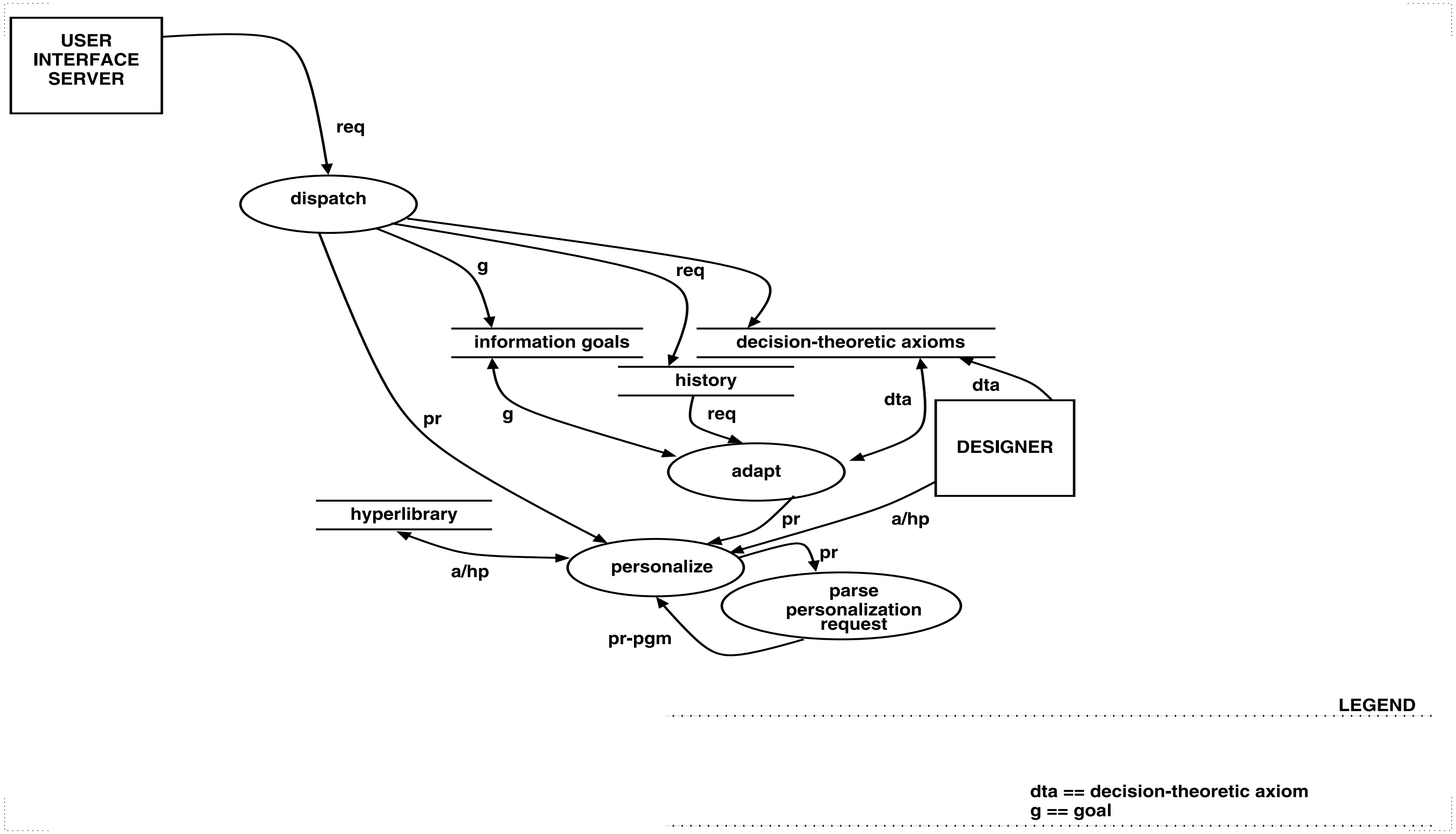
```
select-page-if true
then-do {
   insert [1, chunk (R-spec)]
          "These pages belong to Goldsmiths College"
   }
then-do {
   page : "GB" -> "UK";
   }

select-page-if page contains "1997"
then-do {
   delete [2, chunk]
   }

select-page-if not [5, chunk] contains "secret"
then-do {
   delete [5, chunk]
   insert [5, chunk]
          chunk {
             content   { X := 'The information in this page is not classified.'
             rendering { [<I>] X [</I>] }
          }
}
```

P-Region: Semantics of PRs

Work is in progress to give a formal semantics to personalization requests.

The approach is to formalize the meaning of a personalization request in terms of a relational algebraic expression over a relational model of the hyperlibrary.

A-Region


USER
INTERFACE
SERVER
req
dispatch
g
req
information goals
decision-theoretic axioms
history
dta
dta
pr
g
req
DESIGNER
adapt
hyperlibrary
pr
a/hp
pr
personalize
a/hp
parse
personalization
request
pr-pgm
LEGEND
dta == decision-theoretic axiom
g == goal

A-Region: Features

[– *this is future work* —]

- The system would take the initiative of personalizing the interaction.
- It would do so by deciding on and launching a personalization request.
- Based on a model of the user's information goals, the history of the user's interaction and a general model of what best to do and when.
- A knowledge base would capture information goals, usage history, and some decision theory.
- Inductive and deductive reasoning would cooperate to trigger actions.

Contrasts

Some contrasts between related work [see (Brusilovsky, Peter, *Adaptive hypermedia, an attempt to analyze and generalize.*, LNCS 1077, pp. 288-304, 1996) for a good survey] and the work presented here:

- implement/experiment v. abstract model to explore possibilities;
- systems tied to specific application areas v. general model;
- monolithic, black-box systems v. explicit view of design decisions;
- PA v. P $\underline{\triangle}$ A;
- narrow v. wide applicability if empirical studies are needed.

Limitations

Many limitations, of course, among which a few important ones are:

- the still rather low-level formalization (e.g., imperative, state-based);
- there has been no thorough investigation of a principled, well-motivated attribute set;
- personalization requests quite probably admit a more elegant expression;
- deliberately keeping an eye on the WWW (and hence, on HTML), which is not the best of models;
- deliberately no knowledge of UIS and DBS languages, which means that the scope for more high-level tailoring actions is blocked.

Possibilities

A few possibilities that suggest themselves from existing limitations are:

- to move on to more modern architectures for hyperlink-based systems;
- to explore how entry and exit points can be defined by rules or constraints (approximating, e.g., the idea of generic links and anchors);
- to embed more knowledge of UIS and DBS languages into the composition function so as to open the way for more high-level tailoring actions.

Conclusions

In conclusion, this work is a first step towards:

- a foundation for exploring systematically the nature, scope and effects of tailoring actions (e.g., in hypermedia-based learning);
- greater conceptual clarity in describing personalization and adaptivity;
- implemented systems whose behaviour can be better explained and generalized.