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P4P: Role-Specific Web Experiences

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Abstract - Recommendation systems or real-time click mining are common means to create a personalised customer interaction in today's Internet. However, one major aspect of customisation and adaptation has thus far been neglected – one user might assume multiple roles. Searching as a buyer for a present for an 11-year-old daughter is a role with a different preference profile than evaluating workstations for the purchasing department.

This paper proposes the role gate – a site on the Internet where users can create, maintain, or share different roles with specific preference profiles for various types of Web interactions, such as listening to music or shopping. We code-name the framework underlying the role gate "Profile- and Preference-based Personalisation for Personae" (P4P). Before embarking on an electronic shopping trip, a buyer can pass the role gate, choose the appropriate role, and thus ensure that the corresponding preference profile is available to the merchants 'along the way'. As a result of this, the user can enter shops or portals with a role-specific 'skin'. Our prototype implementation of the P4P role gate server, role representation, and protocol is based on open standards and emerging technologies such as the platform for privacy preferences (P3P), Web Services, and peer-to-peer (P2P) computing.

1 Introduction

If a buyer (Bob) returns to an e-Commerce shop he has visited before, various measures of personalisation (adaptation to the buyer profile) can be applied, such as preloading Bob's demographic data and known preferences, customised advertising, or recommendations on the basis of Bob's general buyer classification [12]. The goal of these personalisation measures is to support the buyer in finding the right product whilst also creating a lock-in situation, in which the buyer's motivation to switch to another merchant is reduced owing the burden of repeating the personalisation process.

While the application of such personalisation measures generally leads to improved buyer-shop interaction, a problem arises if this time Bob is looking for a product in the e-Commerce shop from a different background than the previous times. There is no way for the merchant to detect whether Bob plans to purchase a product for himself or on behalf of somebody else [2]. We conceptualise the shopping background (such as needs, preferences, click and transaction history, etc.) with the notion of a *Web role*. Bob might, for instance, have the role of an employee in the purchasing department, and the role of a father to a teenage girl (Alice). If personalisation measures assume the wrong role, the result can be annoying for the buyer. If Bob so far used an online bookshop predominantly to buy books for Alice, but now tries to find work-related literature, recommendations and advertisements for the latest and greatest teenager entertainment will probably be less helpful if not downright irritating. Hence, the goal of supporting the user in the product selection is missed, and the effect of personalisation might even be reversed, increasing the likelihood of buyers switching to other merchants.

With real-time personalisation based on click-through clustering, this undesirable consequence can be avoided to some extent, but then historical data is not incorporated in the personalisation, and the adaptation is very vague and error-prone, at least at the beginning of a shopping session when only few characteristics are identifiable [2].

We therefore believe that the solution to this problem is that the buyers themselves reveal their current shopping role: 'father of a teenage girl,' 'agent in the purchasing department' etc. Unfortunately this is a very tedious task to perform every time the buyer visits a shop, and the means to enter a profile might vary from shop to shop. Hence, we propose the *role gate* to support a buyer in the task of creating, maintaining, and slipping into different shopping roles – or Web roles in general. This role gate is part of our *Profile- and Preference-based Personalisation for Personae* (P4P) framework, and an abstraction of our earlier work on the shopping gate [16], which focused only on personalised eCommerce shopping.

We noticed that the concept of role-based shopping is transferable to other types of Web interaction. A user of the role gate would be enabled to listen to a similarly personalised stream of digital radio from various providers, or to browse a news site on the basis of the same customised profile as her friend. For illustration purposes in this paper, we continue to use the familiar shopping example, but note that the technolo-

gies demonstrated here are, in principle, applicable to arbitrary types of Web interaction.

The contribution of the P4P concept to Web intelligence is two-fold. First, web-mining-based personalisation measures of sellers or content providers can be much more effective if correct Web-role specifications are available. Second, a rich Web-role specification, e.g. with fine-tuned content-evaluation criteria, enables the user to hand over structured tasks such as content matchmaking or offer ranking to an autonomous software agent, thus leaving the buyer more time for the actual decision-making and Web experience.

The remainder of this paper is organised as follows: in the next section, an informal usage scenario for the role-gate functionalities is outlined. An overview of our work in progress regarding the P4P prototype architecture, role representation, and suggested interaction protocol is provided in Section 3. Finally, preliminary findings are discussed and evaluated in Section 4.

2 Role-gate scenarios

We envision the role gate to be a site on the Internet where users can open an account for one or more roles, and which is run by a trusted third party.

A Web role is defined by properties, preferences, and a history of past transactions and clicks. Role properties comprise, for instance, the age or the sizes of the user in a specific context. Preferences are either limited in their scope to one role or shared among several roles of the same user. Our preference structure comprises:

- General tastes and high-level interests (horses, 70ies, yellow).
- Needs in terms of product/content types (e.g. books, stock quotes, attire).
- Essential attributes of these types (e.g. number of words, encoding quality).
- Preferred values for these attributes (fabric = cotton, delivery time = 2 days).
- Evaluation criteria defined as utility functions for attributes.
- Relative importance of the evaluation criteria (e.g. ‘price is much more important than delivery time’).

The usage models for Web roles can be illustrated on the basis of two role-gate scenarios: skin browsing and skin hopping.

2.1 Skin browsing

Before visiting, for instance, an e-Commerce shop, Bob will enter the role gate and select the appropriate role for the shopping trip – or create a new one if no existing role fits the current background. The role gate retrieves an existing or generates a new run-time specification for the preference profile, and Bob can start browsing Web sites in the same manner as without the role gate in place.

Whenever Bob enters a P4P-enabled online shop the merchant’s system might ask or remember whether Bob is a role-gate user. In this case the shop can apply one of Bob’s role-gate keys to request the current role, its properties, associated preferences,

and the transaction history from the role gate. This information is used by the shop to generate a role-specific shop presence. Not all information will be disclosed. Depending on the level of trust and the usage of the profile specification proposed by the merchant, evaluation criteria, for instance, may not be revealed.

To the shops Bob will 'appear', for instance, as a teenage girl with a preference for yellow clothes and horses, although he actually is a middle-aged purchasing agent. We borrow the metaphor of skinnable user interfaces (see MP3 players, Netscape 6 etc.) to express that the user is wearing a role-specific skin for the shopping trip.

The role representation stored in the role gate is not static but subject to permanent feedback. If the seller wants to ask Bob for additional preferences (e.g. 'are you interested in Arabian horses?'), the merchant may submit additional questions (which is also supported to some extent through the role gate server, see below) and may decide to add the newly elicited preference definitions to the current role representation in the role gate. If transactions (e.g. the consumption of streamed music or a micropayment for news feeds) take place, it is also possible to add the logged data to the role history.

2.2 Skin hopping and cascading

The role gate also provides the functionality of sharing a set of roles or role elements such as preferences among role-gate users. Let us assume a scenario in which so far it was Bob who used to buy books for Alice but one day his wife urgently needs a present for their daughter. In this case Bob could share this already fine-tuned shopping role (e.g. 'parent of a teenage girl') with his wife, who could then use this skin for a Christmas shopping trip.

To model the plausible real-world scenario that Bob enters a shop together with Alice requires a different functionality – skin cascading. In the role representation, Bob may use the preferences of Alice regarding essential attributes but could override some attributes (e.g. the preferred price range) or evaluation criteria (e.g. emphasising quality). In the role gate this is performed through a cascade of roles in which Bob's preferences overlay Alice's preferences.

3 Prototype overview

The primary requirement for the operation of the role gate will be a network of content providers or e-Commerce shops supporting the Web-role specification data format and the role-gate interaction protocol. To support acceptance of the data format and the protocol, both should be based on open and accepted standards to the greatest extent possible, thereby also facilitating implementation. The representation for the role specification also has to be rich enough to capture the most relevant elements of a Web role, but still needs to provide clearly defined semantics and formalisms to support structured automated processing on the operator's side.

As a result of these requirements, the technical components or our proposed P4P framework are based on a number of emerging W3 standards such as the platform for

privacy preferences (P3P, [9]) and XML Schema [10], as well latest Internet technologies such as Web services [10] and peer-to-peer (P2P) computing [20].

P3P is an addition to the HTTP protocol for the exchange of privacy information between an HTTP server (e.g. an e-Commerce shop) and an HTTP client (e.g. a buyer's Web browser). The main focus of P3P is to define a protocol that allows a client to specify which privacy guarantees or server certificates are required for supplying a server with a requested set of personal data, such as the birth date or a credit card number.

P3P already includes the abstract concept of a user having multiple 'personae', which implies that P3P profiles can hold information about multiple roles and might reveal information about different personae to different servers [4]. However, P3P does not specify how these personae can be managed (including issues such as sharing etc.), and how the personal data is actually structured and transferred. Therefore our role-gate prototype complements the P3P framework with additional personae or role management functions, a format for the structure of personal data, and an extended role-data interaction protocol.

XML Schemata specify classes of XML instance documents by describing the document structure in a much richer way than is possible on the basis of document type definitions (DTD) [5]. One of the primary advantages of using XML schemata compared to the DTD mechanism is that it is possible to express hierarchies of data types, which is used in our prototype for the representation of ontology concepts in the role-data definition (see Section 3.1).

The following sections describe how these two standards are used in the implementation of the role-gate prototype, which comprises the role-gate server, the Web-role representation, and the role-gate protocol. The *role-gate server* interacts with content providers or online shops through a Web services interface. From the perspective of these *role operators*, our role-gate server offers several Web services for the retrieval and update of Web-role specifications. The role-gate server includes an implementation of a P3P user agent, which is required for the execution of the interaction protocol (see Section 3.2).

For a *role holder* (i.e. role-gate user), the role-gate server offers role management functionalities (e.g. for skin hopping or cascading) through a browser interface. Internally, the role-gate server features an SQL database with native XML extensions, which functions as a *role cabinet*. These central role management functionalities can be substituted by a local client application with personal Web-role storage[1]. The role holders also have the possibility of using this client application to privately share or even trade role data in a community with other role holders based on a P2P architecture, in which the role-gate server assumes the role of a central directory/indexing service comparable to a Napster server [14].

[1] The privacy discussions regarding the Passport initiative from Microsoft showed that some users prefer to keep their privacy data locally. Therefore we offer a local client application in the P4P framework as an alternative to the central role cabinet, and leave users the choice of which solution suits them best.

3.1 Web-role representation

Every role-gate user account can host one or more Web-role specifications (WRS). A WRS is organised into three main groups, each with a set of role elements. The WRS relates to the general P3P data categories in the following way:

- WRS properties element group – P3P demographic data (gender, age…).
- WRS preferences element group – P3P preference data (likes and dislikes…).
- WRS history group – P3P transaction data (logs of activity, purchases…).

A WRS is represented as an XML document. The structure of WRS XML documents is defined by a central *WRS schema* in the role-gate server, which defines the structure of the actual WRS instances as well as the structure of WRS proposals generated by role operators (see next section). For role holders, the schema also allows the expression of preferences regarding the disclosure of a WRS instance to role operators using the P3P preference exchange language (APPEL).

The declarations in the WRS schema are based on representations used in our previous work in the area of buyer decision-making [15]. Formalisms for likes and dislikes are expressed as unary and binary constraints, similar to the approach undertaken with CCL in the domain of software agent communication [19].

The second building block for the role representation is a *role-gate ontology*. Ontologies are formally specified models of knowledge, which can be used to share semantics within a community – in the role-gate scenario the members of this community are role holders (e.g. buyers) and role operators (e.g. merchants). The role-gate ontology defines a containment hierarchy of concepts (e.g. 'preferences' > 'likes' > 'taste') with attributes such as 'colour' and corresponding value domains ('yellow', 'green', etc.). The purpose of this ontology in the P4P framework is first to ensure that role operators send requests for WRS elements according to this ontology (thus creating syntactically and semantically correct requests), and second to guarantee that the Web roles defined by the role holders are 'understandable' for the role operators. The role-gate ontology is represented in XML Schema following the approach chosen in our work on buyer/seller negotiations (see [18] for details).

To assist the user in the definition of a Web role, interactive questioning on the basis of the adaptive interviewing framework [17] may be applied. An interview for the elicitation of preferences can be conducted through role operators who might retrieve standard question specifications for this purpose from the role-gate server. Comparable to the common ontology for Web role concepts, this central repository of questions serves the purpose that role operators and role holders speak 'one language.'

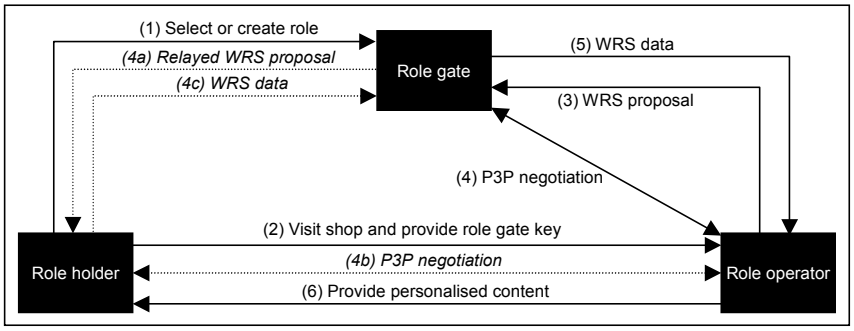
3.2 The role-gate protocol

The role-gate protocol manages the interaction between the role holder's client, the role-gate server, and the role operators' systems. From the perspective of a role holder, the protocol execution is transparent – i.e. the browsing activity is not affected by the role-gate intermediation except that the role holder has to provide role operators with role-gate keys.

Every role operator needs a *role-gate key* to access the role-gate server. The role-gate server can generate one or more role-gate keys[2], encoding in the key the usage policy for the key (e.g. its time validity) as defined by the role holder, and pass them to the role holder. After a role selection at the role-gate server, illustrated as step (1) in Figure 1, role holders navigate with their browser to the desired Web page in the same way as they would without the role gate. After receiving or retrieving the role holder's key (2), the role operator (e.g. the merchant) may invoke a Web service of the role-gate server with a WRS proposal for the role identified in the key (3). The *WRS proposal* specifies the WRS elements the merchant is interested in with empty value domains (placeholders). Technically this WRS proposal is an XML document instance conforming to the WRS schema, and can therefore be easily rendered in a Web service call, because Web services receive and return parameters natively in XML format.

Upon reception of a WRS proposal, the role-gate server verifies the authentication data and, if successful, investigates for which purposes the WRS will be used by the merchant (P3P lists purposes such as 'customisation of site to individuals' or 'contacting visitors for marketing of services or products'). To obtain this information the role-gate server downloads the P3P policy file with the P3P statements issued by the merchant, and relates it to the preferences of the role-gate user stated in the APPEL section of the WRS (4). This negotiation is part of the standard P3P protocol. If the buyer's privacy preferences are fulfilled (P3P acceptance), the role-gate server replaces the WRS proposal placeholders with the appropriate WRS instance, which is then returned as a result of the initial Web service invocation (5).

Receiving the return values, the merchant is enabled to use the WRS as input for personalisation measures, e.g. shop layout customisation, recommendations, or promotions (6) – compliant with the usage statements committed in the shop's P3P policy.



[2] The role holder will use multiple keys if she wants to prevent role operators from linking their traces of a browsing session with a specific role. If this is not critical, one key can be used for multiple role operators.

Fig. 1. Role-gate protocol.

An extension of this interaction protocol is necessary if the role holder prefers to run the local role-gate client application with personal Web-role storage. In this case the user has to select the active role on the client, and the application maintains an open TCP/IP connection to the role-gate server similar to other P2P architectures with a central indexing service. Upon reception and successful authentication of a WRS proposal, the role-gate server will notice that the role data is not available centrally and use its directory to locate the open connection to the client application of the appropriate role holder. On the basis of this connection, the WRS proposal is relayed to the client application (4a). The client application now may perform the P3P negotiation (4b) and, if successful, generate the WRS instance. This instance is then transmitted to the role-gate server (4c), which renders it into the return data of the initial Web service invocation. The rationale underlying this mechanism is that for the role operator it should be transparent whether the role data is stored centrally on the role-gate server or locally on the role holder's client. The real P2P character of the overall architecture is only exploited when role-gate users search for or exchange roles among peers similar to the activities on file-sharing networks.

The role-gate protocol features two other optional extensions. The first extension can be used if a merchant learns something about the role of the buyer and intends to feed this information back into the central WRS. Often buyers will not immediately buy one of the products offered in the first view, and instead navigate the shop for a while, possibly answering additional questions about their needs and stating preferences for certain product features. As a result, the merchant will learn more about the buyer, and thereby is able to expand the role specification. A corresponding WRS update Web service is available to role operators anytime. By default, all incoming WRS updates are first cached in the role-gate server and require a confirmation from the role holder, before they are merged into the WRS.

The merchant system can at anytime answer the page request of a role-gate user with a new WRS proposal to the role-gate server, asking, for instance, for additional preferences. The role-gate server tries to serve this request with the available role specification. If the requested data is not available, one or more standardised questions including pre-defined answer sets may be returned by the role-gate server, which thereby recommends to the merchant to ask these standardised questions in order to receive the requested preferences from the role holder. The goal of this mechanism is to ensure that new preferences are elicited in compliance to the general role-gate ontology, and therefore are syntactically and semantically correct for other role operators as well.

4 Discussion

This paper demonstrates how Web users themselves can reveal their current role to one or more content providers or e-Commerce shops in a managed and efficient way. The goal of the proposed solution, the P4P framework, is to avoid irrelevant or badly-targeted personalisation measures, such as recommending children books on horses to

40-year-old accountants because they once bought such a book for their daughter. To demonstrate our approach in more detail, we presented framework components such as the role-gate server, a role representation format, and a protocol that controls the interaction between role holders and role operators. In this final section, our approach is evaluated and compared with related efforts.

4.1 Evaluation

The primary contribution of the P4P framework from a content provider's or merchant's perspective is that the proposed solution provides a finer-grained and more accurate foundation for Web intelligence mechanisms. In a shopping context, the merchant may already upon first contact receive a rich buyer specification including demographic data, preferences, and a transaction history. Furthermore, this specification represents the actual shopping background – the role selected by the buyer, which may vary from visit to visit and therefore is a critical input for personalisation measures. The advantage for role holders such as buyers is first that they can create and maintain shopping role specifications through one single point of access rather than having distributed profiles at several merchants. Second, they can explicitly reveal their current shopping background to a merchant, thus avoiding, for instance, irrelevant recommendations due to profile information situated in the wrong context. Third, buyers can obtain pre-defined profiles or profile elements from other role holders. Fourth, profiles are either stored locally or managed by a trustworthy party, which can also sanction the misuse of disclosed profile information to some extent.

An interesting question to discuss is whether role operators are willing to share elicited preferences with other content providers or merchants, e.g. by updating a WRS after a successful transaction. It is our belief that in many cases this will be the case because of the network effects (see for example [3] p. 522), which can be expected, once a critical mass of role holders uses the role gate. The more role operators cooperate, the greater the benefit for role holders, and vice versa. This will especially be the case if an active role-gate community can be established, for instance through the promotion of a large ISP.

Regarding this requirement of 'critical mass,' the advantage of the intermediary position of the role-gate server is that this approach does not require specialised browser technology or extensions on the client's side unless the role holder prefers to store role specifications locally. On the side of the role operator's system, however, several components are necessary to be 'P4P-enabled': Web services of the role-gate server have to be called and the WRS data format needs to be supported. Still, the P4P framework is based on open standards, such as XML Schema, Web Services and P3P, to allow seamless integration.

4.2 Related work

In our earlier work on the shopping gate [16] we compared our approach with existing eCommerce shopping sites that include a notion of roles such as smarterKids (an Internet shop for educational toys [8]), and concluded that the main benefit of our

proposed solution is the ability to store and share rich role specifications with centrally-controlled semantics in a way that is not proprietary to a specific application or site, but rather is based on open standards.

Given the broader focus on Web roles in general in this paper, a discussion of related work now also has to regard the main privacy/identity initiatives from Microsoft (Passport [6]) and Sun's Liberty Alliance [7]. The main focus of these initiatives is on a single sign-in for end users at multiple Web sites with (currently in Passport's case) additional support for express payment. For each individual, a single profile with demographic data (e.g. the billing address) is suggested. However, there is no notion of multiple roles, no possibility to express preferences such as likes and dislikes, and no support for sharing or exchanging role specifications. The vision of the Liberty Alliance is a 'federated commerce' in which a person's identity including buying habits and preferences is managed and distributed by the users themselves. Our P4P framework could be seen as a proposal on how to realise and extend key elements of this vision.

4.3 Future work

The most important task upon completion of the prototype is to evaluate the use of the P4P framework in an experiment with real role holders and operators. Beyond this main effort, one aspect that we want to address in the future is the notion of *role continuity* – how is a role affected by its temporal use by another user? Partial 'lifeless' might mean that transactions of another user do not contribute to the profile, but that changes to the profile initiated by the original owner of this role will still be reflected. In the extreme 'freeze' scenario, a profile that is given to another user will be frozen, or actually copied, and no longer linked to the original role. This aspect of role continuity can also be extended to a finer-grained typology of Web roles that is able to express, for instance, that one user is responsible for the selection of a product, another user donates the money, whereas a third user is entitled to receive a discount for this product.

The aspect of entitlements leads to other interesting options. The concept of roles is also discussed in the area of computer security as part of pseudonym systems (see for example [1]). Pseudonyms are used to guarantee anonymity (for instance during a shopping process) but can always be traced back to one unique identity. Our approach also assumes the existence of a unique user identity, which is associated with one or more Web roles. The concept of identity becomes critical if merchants offer, for instance, discounts or promotions for buyers that can be exercised either only once or, for example, only on the basis of demographic characteristics (e.g. age). If a role-gate user assumed the role of a student, a bookstore might offer special university discounts if the user presents an official proof of the student status. Such conditions could be modelled as an *entitlement credential*. Hence, we are currently investigating the use of different types of credentials (see for example [13]) in an extended role exchange/sharing process that also covers entitlements. In this scenario one role holder (the owner) might want to give one or more of her credentials to another role holder (the recipient).

1. *One-show credentials* may be used by a recipient to exercise an entitlement on behalf of the owner exactly one time.
2. *Multi-show credentials* would transfer an entitlement from one user to another user and allow a repeated execution of this right, such as receiving news from a certain premium service.
3. *Dedicated credentials* can only be used for the purpose defined by the owner, e.g. for the purchase of a specific textbook.
4. *Hidden credentials* do not reveal the nature of the encoded right to the recipient. The owner might, for instance, suffer a certain disability.

In general, we want to examine in this domain of future work how techniques from the field of security are used not only to make the P4P framework more secure, but also to enable new role-specific experiences in the Web, which are impossible in a non-virtual world.

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