A Profile Ontology for Personalised Mobile Shopping Support

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Abstract. Personalisation is a desired functionality for applications within mobile environments. One approach to personalisation of mobile services is by the use of personal and contextual information. In this paper we describe a personal profile for this purpose that has been created using OWL DL implemented in Protégé. The developed profile ontology is based on, and evaluated relative to, personas and scenarios from the food shopping domain. The profile covers three levels of information; personal information, stable information and temporary interest. The main result is a profile ontology that is used to illustrate potential benefits by use of information about a person in the personalisation process, which can be extended to cover other areas of interests.

Keywords: Personal profile, ontologies, personalisation, food shopping.

1 Introduction

New types of networks and devices bring the Internet into everyday lives through wireless and mobile technologies. Users of mobile technologies are getting exposed to information and services, without being able to control the flow of services. The goal is to connect accessible and mobile devices collecting context and eventually provide service provisioning for the users through the sharing of information in a ubiquitous computing environment [1]. This change will involve technical, social and organisational challenges [2].

The vision for the next generation Web as the Semantic Web [3], is now often combined with Web 2.0 technology to predict Web 3.0. Information is accompanied by metadata about its interpretation, so that more intelligent and more accessible information-based services can be provided. With these new possibilities we need to increase users' abilities to express what information and services they need. For our personalisation we will use Semantic Web technology as the enabler. The core components in the Semantic Web and its applications will be the ontologies. An ontology can be seen as an explicit representation of a shared conceptualisation [4] that is formal [5].

Personalisation is needed to overcome information overflow and the traditional one size fits all approach. By knowing the user one can improve the quality of services delivered. Information about a user can be used to target services directly to a specific

user. One of the main challenges and potential for future contextualised and personalised support lies in the combination of public and private information and the combination of personalisation and contextualisation [6]. Research has been done on adapting information according to the context the user is in. However, little research has been done in focusing on offering the right services at the right time.

Here we focus on the personal profile. The developed case environment is related to food shopping, where users in some situations have to make non-trivial decisions. Mobile services within the food shopping domain is currently being investigated by the GS1 MobileCom [7]. We want the system to be able to decide what can be relevant in a particular situation. Depending on what the goal is for a specific user, varying parts of profile and context will assist in the personalisation process. Being on the move it is important for users to receive the right information at the right time, and at the same time being able to exchange and control information that is necessary to make this possible.

The rest of the paper is organised as follows. First, selected parts of our food shopping case are described. Then, the developed ontologies are described together with the necessary types of information about a person. Third, the overall architecture is presented. Related work is presented in section 5. Finally, conclusions are drawn.

2 Case Environment

The main sources of information for the creation of the profile are the personas and the scenarios. A persona describes users quite detailed, while the scenarios put the persona in a realistic situation.

2.1 Persona: Bill and his Family

A persona is a description about an imaginary user that explains who he is, his beliefs and goals etc. Such a description can therefore explain the decisions and choices he makes. Personas can be used as an interaction design technique with significant influence on development of new software [8]. They work as a shared basis for communication, and for engagement in the group that are going to use them [8, 9]. By understanding a fictitious user one is better prepared to be able to predict how a different person than himself would behave in a specific situation.

Our family personas consist of five persons; a mother, a father and three children, and they constitute a household. Family members have preferences and wants, and sometimes the preferences do not match. When there is a conflict, the parents have the last word. Here we focus on the father, Bill. These keywords describe Bill; 39 years old, conscious about contents of food, prefers healthy, non-harmful food, prefers ecologically produced food, small carbon footprint if possible, FairTrade is regarded positive, price is an issue, but not the most important one, have certain affinities, likes to have a preset shopping list and finds it difficult to adapt on the spot.

The shopping list of the day can be regarded as a temporary interest, while the preferences for certain makes and brands can be regarded as stable interest. Note that the temporary interest relative to today's shopping list is recurrent at different

intervals (e.g. if milk is bought today, it will typically turn up again the week after. Products that one does not get, might be replaced, or might stay on the list).

We understand that Bill and his family are interested in what they eat. When one is conscious about food, what it contains and how it is produced, it is important to easily find relevant information about products. However, it can often be challenging and time consuming to find this information manually on the declaration. Therefore assistance in the food shopping process is highly relevant for Bill.

2.2 Scenario: Bill Shopping Food

In this selected scenario, Bill is out shopping on a Tuesday evening. The shopping list was prepared in advance, and consists of items for the whole family. Bill finds it difficult to adapt on the spot, and consequently he prefers a complete shopping list in advance. The scenes are illustrated in Figure 1. Bill has strawberry jam on the list, but the type they usually buy is sold out. On the shelf there are many alternatives, and Bill does not know which one to choose. A jam has typically more than ten different types of information related to it. Since Bill has specific concerns regarding the contents of food, it is important for him to avoid certain ingredients. Instead of reading the declaration of contents for all the available strawberry jams, he provides a query for alternatives, a request, to the personalisation system (e.g. scanning the bar code of an available jam and select alternative product). The result of the request is a response from the system, which is a prioritised list of jams according to his preferences and the knowledge about the different jams (and of the jam that is originally preferred).

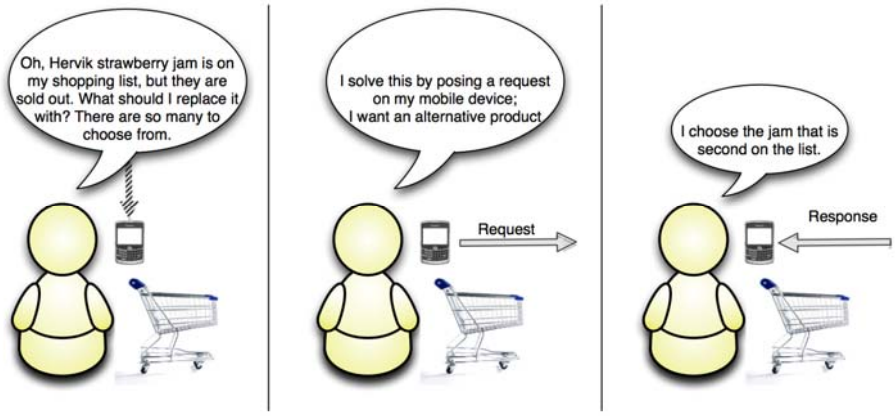

Fig. 1. Scenes from scenario – Request for alternative product

The result is delivered to Bill's device, and gives Bill information enough to make a well-founded choice. The rest of the alternatives have been excluded due to low relevance. Bill chooses the second alternative because he does not mind the additive potassium sorbate. The reason several alternatives are given is that the preferences only give an indication for what the system thinks can be most relevant, and there is not necessarily one correct answer. Presenting only one result could eliminate other

relevant products. By presenting the most relevant ones and providing information about them, it is up to the user to make a final decision.

3 The Personal Profile and Food Ontology

Before we describe the ontology we will shortly describe the background for the process and how we have proceeded with the creation of the profile ontology.

3.1 Profile Information and the Process

Characteristics described in the personas are partly used for structuring. They give indications for necessary properties and classes, particularly with regards to personal information and stable interests. We also use the scenarios to extract information that is necessary or useful to achieve the personalisation we propose. To do this, the scenarios have been analysed in more detail with regards to the personalisation process. The scenarios also tell much about the stable and temporary interests.

Since the goal is not to create a complete profile, we focus on general concepts that make it possible to achieve the successful personalisation we aim for. Therefore, the profile will only consist of a portion of the information that should be part of a complete profile. The contents will be constrained by our scenarios, but could be extended to cover other areas and more details. Since many of terms that need to be modelled are more abstract than physical, effort to decide how to model it has been needed. This has also been an issue as to which classes that needs to be included and how they are to be related and modelled in relation to other classes.

Since we focus on mobile food shopping support we have limited the scope for the rest of the world that is modelled. We look at the food domain that can be related to local supermarkets in our neighbourhood. Figure 2 illustrates the top level of classes in the ontology, while Figure 3 illustrates top level relations. Some of these will be referred to in the examples. Many of the defined classes will not be mentioned since they are included for reasoning purposes related to useful classifications used in the personalisation process by the mediator. We focus on the classes that are relevant for the described persona and scenario in section 2, and which are used to define a person and related parts of the food domain.

The information in the personal profile can be divided in three main parts. The first category is termed personal information. Personal information consists of categories of information that is common for all users. Personal information is useful to identify the demographic properties of users. Many of these can be derived from the persona description. They change very seldom and typical examples are name, birth date and address. This type of information is particularly useful when connecting to a new service provider who is interested to know who you are and where you live or what your phone number is etc.

The second category is termed stable interests. It is called stable because the type of information does not change frequently, due to importance and relevance. Once a user has an interest, he is likely to have this interest for a longer time span, e.g. favour

a specific producer of jam. The interest for this producer is the same from one week to another.

Sometimes it is useful to be able to specify interests or activities that do not last over a longer time span. Therefore, the third category is termed temporary interests. For a shorter time period a user could be interested in for example buying a new digital compact camera. In our case the daily shopping list represent the temporary interests. As soon as the goal is fulfilled, it is no longer part of the personal profile.

Fig. 2. Protégé class hierarchy

3.2 Describing Personal Information

The profile is centred around the *Person* class, which will be the main part with regards to representing an actual person. Bill will be represented as an instance of the *Person* class. The properties we have included to describe who a person is, are his name, his family relations etc. Some of the datatype properties included are *hasName* (type String), *hasAge* (type int), *hasBirthday* (type date) and the object properties *hasGender*, *hasFamilyRelations* with subpropeties *isMarriedTo* and *hasChild*. We have included properties for both age and birthday, so that we do not have to compute age. A person can be either a *Man* or a *Woman* (not both), and are connected through the *hasGender* relation. Many of the relations related to personal information correspond to relationships also modelled in GUMO+UbisWorld [10] and SUMO [11]. We have not used these unabrighted though, since an earlier analysis [12] has shown that existing ontologies in this area are not directly reusable.

The personal information part has not been very important in our scenarios, and therefore we only include basic personal information. This part can be extended as it in many situations is useful to exchange detailed and extensive personal information (address, account information, phone number etc.) in an easy and controllable way. Personal information is used in many situations, and in the connection to new service providers controlled exchange or shared access of personal information can be useful.

3.3 Describing Interests

Stable interests are the most important type of information as to being able to find out the relevance of a specific service or information, and to target services to individual users. All the different preferences for a person belong to this group.

Long-term interests are important, and from the persona and scenario we see that it is useful to be able to indicate relative interest. As we can se from the persona Bill, we want to be able to specify to what degree he prefers for example ecologically produced food and fair trade food. Many of such preferences of a person are regarding how good or how bad he prefers or likes something or not. Such value partitions in our model are intended to indicate that a specific relation can have different levels of intensity or degree. We have chosen to select levels corresponding to high, medium and low for the different gradings. We have modelled this as value partitions that later can be further subdivided if necessary. Our value partitions belong to the class *Modifiers*, and all the different modifiers are modelled as disjoint classes which exhaustively partition the parent class representing the feature. The class *Modifiers* has the subclasses *ADHDAdditiveAffinity*, *EcoAffinity*, *FairTadeAffinity* and *PriceSensitivity*. Class *EcoAffinity* is divided into subclasses *HighEcoAffinity*, *MediumEcoAffinity* and *LowEcoAffinity* and similar for the other affinities except *ADHDAdditiveAffinity*. *ADHDAdditiveAffinity* is a class that is included for being able to say that one avoids additives with a certain effect with regards to the medical diagnosis ADHD. Each modifier can be connected to the *Person* class through object properties *hasEcoAffinity* and similar for the other affinities. All affinity properties are subproperties of *hasAffintiy*. The combination of different affinities makes it possible to use them together in different ways in the search for relevant services, and this is done by the mediator during the personalisation process. A person having a high affinity for ecological products, would typically value products that are ecologically produced very positive. Someone not interested in ecological food would not indicate any interest related to ecological food, and hence the fact that a product is ecologically produced or not would not affect any possible rankings.

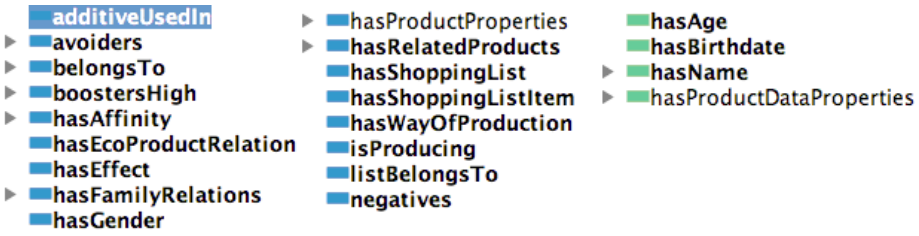

Fig. 3. Protégé top level object and data type property hierarchy

While many of the persona characteristics indicate what the personal information and the stable interests are, the shopping list indicates the father's and the household's temporary interests. Temporary interests are important to understand the particular situation the user is in and his needs at the moment. To make it possible for Bill to specify which items are on the shopping list, there is a class *ShoppingList*, where Bill's list can be registered. It can for example be the individual *BillsShoppingList*,

which is a type of *ShoppingList*, that can be related to particular food and food products (e.g. Hervik Ecological strawberry jam) through the *shoppingListItem* property. When we know some characteristics of a person, it is possible to use this information to define new classes (e.g. class *EcoConcerenedPerson* which are all instances that are persons and have the affinity high for ecologically produced food).

3.4 Food and Related Concepts

In addition to representing people, there are classes that have been included to describe concepts about the food domain. For this we have used a public food taxonomy [13] for information about existing processed food and commodities. It seems that there is currently no complete overview of products and list of contents of products online. Therefore, the information about jams and its ingredients has been manually collected from the products' list of contents out in actual supermarkets. Due to the political focus on food-safety, it is not unlikely that such information will be made publically available in a digital form in the future. What we then need is to connect the information we have about food and the actual persons that are modelled in the *Person* class.

The main classes are *Food, FoodInformation* and *NonFood*. The class *Food* has been separated in *Commodity* and *ProcessedFood.* Class *Additives* is a subclass of *NonFood*. The class *Jam* is a subclass of *ProcessedFood*, which is a subclass of *Food*. The jam that Bill is looking for is typically an instance of one of *Jam's* subclasses *StrawberryJam*. We have named the instance *HervikStrawberryJam*.

FoodInformation has subclasses *Producer* and *QualityMark*. The class *Producer* represents all the different kinds of producers, e.g. like the ones producing jam in the scenario; *Nora*, *Ica* and *Hervik*. These are represented as individuals. Food can only be marked as E*cological* or *FairTrade*, which are the instances of *QualityMark*. Types of *Food* are connected to *Producer* through the properties *hasProducer*. Whether a product is ecologically produced or not, is specified through the property *hasQualityMark* (which is a subproperty of *hasProductProperties*). All products that have the quality mark ecological are considered ecologically produced food.

4 Overall Personalisation Architecture

Here we present the personal profile in relation to the other necessary components. The *mediator* is responsible for the personalisation and connects the right users with the right services. To do this, the mediator is provided the necessary parts of the profiles, information about the domain and devices etc. These sources of information are used in the different steps in the personalisation process. All the service agreements and searches for services (providers) are done through the mediator.

The process is initiated by the expression of a request which represents the user's goal in a particular situation (by user or service provider). The user poses such a request from his mobile device. The request starts the personalisation process performed by the mediator. The profile, which should be stored at a trusted third party, will be available in the process providing the mediator with relevant profile

information. This profile information will be used together with the information about the domain, which in our case is about food and food products. The preferences in the profile are defined in relation to what information that is to be found about food, e.g. is a person's concern in ecological produced food related to the way the a particular product is produced. The main steps of the mediator as the matchmaker are pre-processing of goals, find services, compose services, adapt result to device and delivery. Several sources of available information are involved in the personalisation. External knowledge represents information sources that the mediator has access to, but not necessarily owns and administers. Where these sources of information are physically stored is not the focus of the current paper. The important thing here is the use of information, and the benefits gained in the personalisation in the form of relevant services. The real world is observed by sensors, and parts of it can be perceived and interpreted as context information. Context information can for example be a user's location, location of other users, the weather and time of the day.

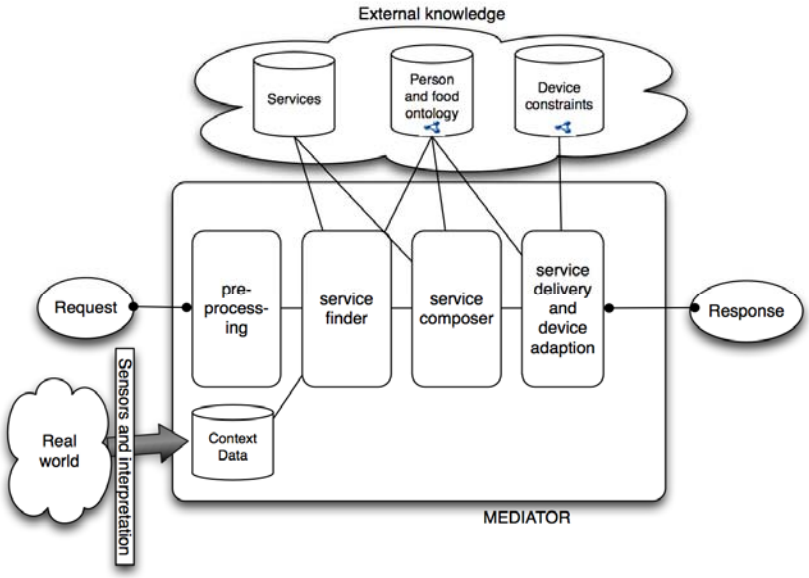

Fig. 4. Overall personalisation architecture

A user request represents an explicit need or goal of the user, and corresponds to pull services as the user is the active part. Requests are sent directly to the mediator which is responsible for the matching. In addition to explicit requests posed by users, it is also possible for the mediator to support users' implicit goals. Trying to satisfy a user's implicit goal correspond to push services, where the user is a passive part. In such cases the mediator is able to find matches between available services and users' profiles that match a particular service or group of people the provider is interested in. For both types of requests it is important that the response provides a result that is relevant for the user. In the presented scenario, Bill proposes an explicit request.

While the user perceives the personalisation process as one step with one input and one output, the mediator actually performs a set of steps to be able to return a response to the user according to the initial request. Hence, from the user's side, the

communication with the mediator in the scenario will be perceived as a simple service that retrieves an alternative product based on the request he poses. Figure 4 illustrates the main steps in the personalisation process. However, in the steps of the personalisation process to produce relevant results for the user, the mediator in many cases executes more than one service to produce the result that is to be delivered. Non-functional requirements (performance, throughput, response time etc.) are also important, but our focus has been on the functionality that is to provide relevant services to the user.

When the mediator receives the request it has to do some pre-processing before the request can be handled. This depends on how the requests are expressed, and how they are going to be used in the search for alternative services. If several services are needed to fulfil the request, then the request needs to be split up in separate parts so that smaller services can be found. These parts will be called sub-requests. A request or sub-requests should make it possible to find services that imply the possibility of delivery of relevant results to the user.

After the request has been transformed, it will be used to search for services that can satisfy the request. It is necessary for the success of the personalisation that the services retrieved, which will lead to the delivered response, are relevant for the user. If more than one service can be considered relevant, the most relevant service should be selected. Services can be relevant at two levels. At the first level of the matching we are concerned with finding relevant services according to the request. In this matter a relevant service is a service that can satisfy the request fully or partially. On the next level we speak about the relevance of the result of the execution of a service. This is particularly useful when the service delivers multiple results. In cases where a service gives several results, it is necessary to chose one or more that are relevant to the user. To do this, personal information is an important factor to be able to decide what is relevant and how relevant it is. In this step, sorting of the information is important. Like in the presented scenario, several smaller services are necessary to produce a prioritised list of alternative jams, e.g. find all alternative products, find out to which degree a specific jam satisfy a user's preferences, sort alternatives by relevance.

When a service (or several services) has been found, it will be used to find or reason over information in the knowledge base. The selection of which information to be chosen to be a part of the result is influenced by this information. In some cases retrieved information needs to be ranked. Then the most relevant information should be selected to be a part of the delivery of the response. In the presented scenario the system actually finds ten different alternatives, but only presents a selection of the four most relevant results. Since devices have different abilities, the result should be adapted according to device specification. When the result has been set according to the user's device, it should be delivered to the user.

5 Related Work

The need for systems to adapt to their users has been recognised in many application areas. So far much focus has been with regards to applications intended for stationary

computers. Personalisation for mobile systems has a different focus, where services and the control and automatic selection of services are important. For a mobile user it is essential to be in charge of the flow of information and services. Exactly what personalisation will mean for future mobile services and how it should be done is still more open. However, personalisation is a compelling feature for mobile communication systems for both end users and service providers. I the busy life of mobile users relevant services are important.

Originally user modelling techniques were restricted to desktop systems on stationary computers. Lately there has been an increase in ubiquity of mobile and embedded devices. Hence, it has become apparent that in many cases the recognition and modelling of the user's external context is essential [14]. Ontology based user modelling is a direction where ontologies are used to structure user models [15]. There have been several proposals with regards to models of users using ontologies. Some ontologies are described as personal profiles and are publicly available (for viewing and editing) and referenced in papers (e.g. [11], [16]). However, there are also many ontologies only described in papers (e.g. [17],[18],[19],[20]). A common feature is that most of the ontologies are built from scratch.

The field of user modelling is said to contribute significantly to the enhancement of the effectiveness and usability of ubiquitous computing systems. On the other side, the field of ubiquitous computing is building the technological basis for these systems. This new technological basis offers the user modelling community opportunities to apply their methods to new kinds of systems. The combination of user modelling and the technological basis of ubiquitous computing can contribute to extending the methods themselves in the process [14].

The biggest change regarding personalisation is the focus on a person as one individual, and not a heterogeneous group. Focusing on individuals, other factors than earlier can be relevant for the personalisation process. When one says that personalisation is concerned with tailoring specifically to one individual user, other factors than just the user will be relevant, e.g. the result of personalisation in different settings or contexts should differ.

6 Conclusion and Future Work

A world where people have the possibility to be connected to the Internet everywhere and anytime poses new challenges as how to provide relevant information and services to mobile users. Today users have no way of controlling and providing necessary information that can improve the quality of services they receive. Personalisation by the use of personal and contextual information is what we propose to improve the situation and open up for new possibilities for users and service providers.

When mobile personalisation is successful, it can lead to several positive effects. Service providers can personalise services according to user needs and interests to reach the right customers, and users can receive services and information that actually is relevant. An effect of relevant services and information can be a wish to be loyal to the provider (lock-on). On the opposite we have lock-in, which can be characterised

as a situation where the effort of changing provider exceeds the advantages of the change of provider. Sharing of information between users and providers can lead to an increase of trust when the information leads to delivery of relevant services for the user.

Personas and scenarios have worked well in the process of visualising the personalisation process, and the use of the actual profile information. In addition to understanding the steps in the process, the personas and scenarios have been useful in the modelling of the profile. The information in the profile is an important factor when the personalisation is to rank different alternatives available and for exchanging personal information, for example when joining a new social community. From the simple scenario presented here we see the benefits the father achieves by having shared his profile information. He receives a list of relevant strawberry jams available, and can by himself make a choice of which one to buy.

In addition to physical concepts, it is necessary to also include abstract concepts that need to be modelled in a logical way. Therefore, building a personal profile was challenging. Several solutions of modelling a profile are possible. Since many different types of information about a person can be included, we have used personas and scenarios to limit the scope. The profile has been created to cover the areas of developed personas and scenarios. For the creation of the profile, the parts related to food and food products have been the easiest to model as they are physical concepts. Since many of the personal information relations are so similar in many areas, they were also ok to model, especially since we only included the most basic information. It was challenging to represent what we have termed stable and temporary interests, and decide how they were to be related to the actual food product so that relevance could be computed. Logical class names and names of relations are more troublesome to define, and at the same time one has to comply with the ontology language and tool. Several iterations have been necessary.

The ontology in OWL DL is used in a prototype which uses OWL API [21] and the reasoner Pellet [22] for inference, where the information in the ontology is used in the personalisation process. The overall goal is to show that successful personalisation can be enabled where the user is provided with relevant services that are targeted particularly for him that is suitable in the situation the user is in. We believe this can be achieved by the combination of personal and contextual information. The developed scenarios will be used for the evaluation of the personalisation proposed and its success. The implementation will be evaluated according to developed personas and scenarios. In addition, the personalisation concepts will be tested using mock-ups with test people through the RECORD Living Lab [23].

For future use, it can be feasible to combine manual maintenance of the personal profile with automatic building and adaption of profile information (e.g. through analysis of what a person or family actually buys, or through opinion mining finding identifying products with a lot of positive or negative mentionings). When other people’s opinions are to be considered, the opinions of like-minded people should be more valued than general opinions, and such are typically to find in communities with similarly disposed persons.

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