Finding Interest in the Stream

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ABSTRACT
Interest, the curious emotion, plays a crucial role as an intrinsic motivator to encounter new things. It also plays a role in the establishment of longer term interests that people develop. Providing *support* for the experience of interest, and *managing* the development of enduring interests has potential to augment the effectiveness of information streaming applications. This poster briefly surveys 'interest' and considers the implications of a hypothetical Interest Machine that is able to measure interest and model interests.

Keywords
Information Behaviour, Encountering, Streaming, Emotion, Affect, Interest.

INTRODUCTION
Information streams are increasingly common features of our current information eco-system. News feeds, social media feeds, photos feeds, etc. all keep us informed and up-to-date. They allow us to be peripherally aware of a broad range of topics (e.g. global events), whilst also focusing on topics that are of most interest to us (e.g. a friend's latest photo or a colleague's opinion).

However, developing stream-based applications that provide an engaging, enjoyable and informative experience poses a number of challenges. Firstly they can place increased demands upon our time, effort and attention, all of which are limited, valuable resources. Secondly, simply trying to filter/reduce items in our streams to make better use of our limited resources upsets the balance of peripheral awareness and focal interest. It also removes the serendipitous joy of stumbling upon something that is unexpectedly relevant. Thirdly, manual curation of feeds often fails as we find ourselves in a state of information hoarding, unable to eliminate feeds that 'just might be useful one day', whilst encountering new feeds that we want to include into our information horizon (Sonnewald 1999).

As information streams have become more pervasive and important in our lives in recent times, an ongoing area of increasingly relevant research has been affective computing (Picard 1997); building systems that are aware of more than just our explicit user interaction, but also able to observe, interpret and respond to our emotional, cognitive and physiological responses. The application of affective computing to better understand and support our information behaviour has been recognised by information scientists (Nahl 2007). Whilst detecting primary emotional categories (love, joy, surprise, anger, sadness and fear) and monitoring attention through eye-tracking and gaze patterns are important advances in understanding the user experience of information systems, this poster considers specifically the affect of *interest*, and the implications it may have for stream-based applications.

Interest is a term that is easily applied in many situations, often used quite casually and descriptively, such as "X was interesting". Despite this, interest has crucial importance to furthering our understanding of human information behaviour (Spink 2007) and accounting for the intrinsic motivation we have to specifically seek out (Wilson 2000) and also incidentally encounter information (Erdelez 1996). In the context of stream-based applications, awareness of the user experience of *interest as an emotional state* and a model of the lifecycle of our *enduring interests* may help in addressing the three problems stated above, and provide a more effective, engaging and ultimately enjoyable information streaming experience.

The next section provides a brief overview of the history and current theory of interest as a distinct emotion, and how enduring interests develop. This is followed by a discussion of a hypothetical system, the Interest Machine, that is aware of our expression of interest as it occurs and also maintains a model of our ongoing interests over time. The paper concludes with future directions and the wider issues of integrating interest into stream-based applications.

UNDERSTANDING INTEREST
Interest is of particular importance to the study of information behaviour, as it serves as a vital source of intrinsic motivation to explore, encounter and experience new and unfamiliar things. The study of interest has a long history and has crossed many fields from psychology to education (Silva 2006). As far back as the 1800's Darwin (1872/1998) studied the emotions linked with exploring,

learning and thinking, whilst Dewey (1913) had written about interest and effort, and their importance in education. More recently, Berlyne (1960) studied interest, producing several theories about curiosity and attempted to identify the objective properties of what made an event potentially interesting to people.

He proposed several collative variables which accounted for an event's intrinsic levels of interest, including novelty, complexity, uncertainty and conflict (Berlyne 1960). This contribution had profound effects on the study of curiosity and interest for the following decades. Intuitively, the idea that events have intrinsic levels of universal interest would seem to make sense; breaking news and themes of sex, violence and death are universally attention grabbing, but on closer inspection, there is large variation between and within people in terms of what they find interesting.

Theories based on objective properties of interest have given way more recently to *appraisal theories* that consider how individuals subjectively appraise events (Silva 2006). Essentially, when a person encounters an event, they appraise its meaning; these appraisals evoke emotions; emotions are thus caused by how the person appraises an event, not by what is actually happening. When it comes to interest, people make two appraisals (Silva 2005). Initially they appraise the *novelty—complexity* of the event, whether it is new, complex, unexpected, surprising etc. This initial appraisal is then moderated by a second appraisal, the *comprehensibility* of the event, or how well a person can understand the event (i.e. their coping potential, such as prior skills, knowledge and resources).

Therefore, finding something understandable can be seen as the turning point between finding the event interesting or confusing and uninteresting, which helps to prevent a person from finding every single new event indiscriminately interesting. This subjective approach to the experience of interest helps to account for why one person might respond to an event positively and find it interesting, whilst another may respond negatively and find it uninteresting.

As with other emotions, certain components should be identifiable to verify the presence of interest as an emotional experience. Components include physiological changes, facial expressions, patterns of cognitive appraisal and a subjective feeling (Lazarus 1991). In particular, Reeve (1993) discovered that interest is characterised by five upper facial behaviours (eyes closed, number of eye glances, duration of eye glances, eyelid widening, exposed eyeball surface), one lower facial behaviour (lips part), and two general head movements (head turns, head stillness) as interest-associated facial movements.

Following on from interest as a distinct emotion, is the development of interests that people have, which may appear, grow and abate over time. Previous theories have tended to focus upon association, repetition and unconscious motivation in the formation of interests.

However, with a better understanding of interest as an emotion, recent theories provide improved insights into the development of enduring interests.

Most people can give a list of their interests if asked. But few will have been asked how any one particular interest emerged. Most likely, an initial spark of interest influenced the development of enduring interests. The *emotion-attribution theory* of interest outlines the process by which interests can emerge. Because we can reason about our emotions (Russell 2003), we have the ability to make causal attributions. These attributions are not perfect and can be manipulated or misattributed. Attributions for the experience of interest help us understand why we felt interest, and what made us feel interested. This then let's us form expectations on what will make us feel interested in the future.

However, the experience of interest alone only encourages us to encounter new things, and it does not account for why we revisit an activity over time (after all, it is no longer novel). Happiness works together with the experience of interest, ensuring that we maintain and revisit experiences that previously led to a positive affect. In contrast, although we may find interest initially in something, e.g. in learning to play a musical instrument, if we cannot cope with its complexity and make satisfactory progress, then a negative affect, such as frustration, helps it to die away.

Given the recent renaissance in the study and understanding of interest, and the development of interests, it seems appropriate to consider how this might influence and improve the experience of using stream-based applications that present a flow of information competing for our attention and attempting to stimulate our interest. The next section considers the implications of an interest(s)-aware system.

IMPLICATIONS FOR INFORMATION STREAMS

Understanding interest, and the development of enduring interests, has useful contributions to the study of information behaviour. In particular, for stream-based applications where information is ever-flowing, and there is a trade-off between maintaining one's peripheral awareness and finding interesting nuggets that are relevant to and contribute towards the advancement of an ongoing interest.

We are not yet at the stage where we can accurately detect interest (although the previous section highlighted the features that are expressed during the experience). Nor can we accurately model the subtle and dynamic lifecycle of our interests (taking into account our past experiences, our level of comprehension and receptiveness to more information with a particular topic of interest).

However, it is enlightening to consider a hypothetical system, the Interest Machine (IM), that is aware of our emotional experience of interest, and manages an evolving model of our past, current and longer term interests. The IM is not in itself a stream-based application, rather a

service other applications can interact with. It's purpose is to connect the user activity, goals and responses to the stream-based interaction, helping to improve the experience across multiple streams and applications. This section outlines the implications for such a system by considering its technical requirements and its the benefits and drawbacks for the user.

What are the requirements for building the IM? The IM is dependent upon feedback; observing, measuring and detecting the implicit feedback the user generates i.e. physiological response and interaction activity, and also complementing this objective data with the subjective reporting of interest that users may explicitly provide, i.e. liking, bookmarking, sharing something. This nexus of feedback is not necessarily novel, but neither is it trivial to interpret, especially in the context of modelling and predicting interest. As noted, the causal misattributions people make for the experience of an emotion are just as likely to be present within the IM; was the content of something the cause of interest, or was it simply a prior-state of boredom leading to a heightened state of curiosity that provoked interest? A key challenge is to accurately identify interest as it occurs, yet place it within the wider context of the interaction and user interests to make better predictions.

Given more accurate predictions of the items from the stream that a person finds interesting, the next requirement is to select the appropriate system response: does this event combine with prior events to provide evidence that an interest is emerging in a particular topic, and what are the implications of this. A dynamic model of user interests should represent the various states of individual topics, and the intensity or patterns associated with them, such as topics that appear suddenly, spike in activity, yet fall-off rapidly (e.g. news of an earthquake), or slower burning and cyclical patterns that are not sustained by such intensive activity. The challenge here is to model the subtle dynamics of our individual interests such that a user can be better supported in encountering information, reminded if they missed something, and ensuring the flow of information provides a satisfying experience in terms of their focal and peripheral interests, without blocking information that could serendipitously lead to new interests.

The IM aims to support and improve the efficacy and experience of the user, helping them find their flow in the stream of information. Counter-intuitively, attention tends to decrease during interesting tasks, but is higher than for uninteresting tasks (Shirey 1988); whilst for tasks that people find difficult or boring, more focused attention is required to achieve the goal, often resulting in ad-hoc strategies to artificially increase interest. Within a stream-based application, processing incoming information is the task, and ensuring that it is not overwhelming is a key role for the IM to play. Drawing attention to items of interest would support the user, whilst allowing them to skip over items deemed to be less interesting, but nevertheless should

still appear in the stream. While remembering past items that are now relevant to a new topic might be worth reintroducing into the stream despite the break in chronological order, supporting re-finding. Over time the model of interests would also help to make better judgements about the level of interest of new incoming items. This would ensure that users encounter enough interesting information within their stream, without being overwhelmed by lots of uninteresting items.
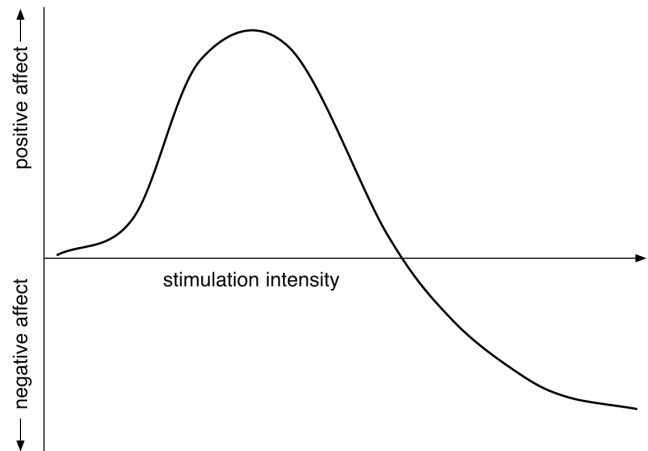

Figure 1: The Wundt curve, or inverted-U relationship between stimulation and affect.

But too much of something can be a bad thing. Being overwhelmed by uninteresting information is highly likely to induce a boring experience, whilst being overwhelmed by interesting information may lead to a sense of frustration in not having the resources to cope with the overload. Whilst stimulation initially will have a positive affect, eventually the resources of user to cope are exhausted. Then, a dampening effect occurs where the user takes measures to avoid the stimulation. This situation is represented by the *inverted-U*, or Wundt curve that describes the relationship between stimulation and affect (Walker 1981), see Fig 1.

The drawbacks of an IM would be the creation of a situation where too much interesting information may be presented to the user, and they neither have the time nor the attention to devote to processing all the incoming information. Instead of a feeling of boredom of not having anything interesting to encounter, they would be left with a sense of frustration that they do not have the slightest chance of engaging with all of their interests. Worse still, instead of frustration, addiction could emerge, preventing the user from getting on with more productive activities in other parts of their life.

It may well be possible that the uninteresting items in a stream actually play an important role, much like musical pauses, and help to mediate the levels of stimulation in preparation for something interesting further down the stream. The challenge here for the IM is supporting the user's own coping potential and ensure that over-stimulation

does not occur despite the best intentions to satisfy the user's interests, whilst avoiding a state of boredom.

There are also wider issues beyond the IM itself. Serious concerns may arise over privacy. While, users may be happy to make certain interests publics, there are also those interests that they would rather keep to themselves. Also, the responses and interactions of users needs to be treated with respect as users are "trusting" the IM with highly sensitive information. Furthermore, when the IM identifies and highlights highly interesting items in a stream, it needs to consider the context and timing of presenting the information. So the contextual factors that exist outside of the IM must also be taken into account. However, there is also an opportunity to better improve the user experience of engaging with information streams through an IM that can take advantage of the changing levels of interest given the context and prior stimulation.

FUTURE DIRECTIONS

The IM does not exist yet. However, the concept of an IM has provided a useful construct for discussing the implications of incorporating an understanding of interest and interests into a hypothetical system. Doing so reveals the potential benefits along with some of the challenges faced by stream-based applications.

Firstly, the demands on our time, effort and attention can be better managed if systems are aware of, and can make predictions about, our interests. It is not so much matching and recommending similar items to those that we have been interested in before, but discovering and building a model that is sensitive to our highly individual preferences and assists us in progressing with our interest without overwhelming us. Secondly, the system response must be more sophisticated than simply trying to increase or decrease what we have to process within our streams. Qualitative affect (such as usefulness and enjoyment) may be more appropriate measures of system effectiveness than by quantitative means (such as time or effort). Thirdly, the manual effort in finding, following and forgetting feeds is increasing as ever more feeds become available to us. A system informed by our interests is better placed to be more responsive to our needs and provides sophisticated support for these tasks.

With the increase of interest in affective computing, crucial components have already being developed to detect emotional, cognitive and physiological states of interest, which could contribute towards the construction of the IM. However, this will only be a first step, and the complexity of creating appropriate models of interest and interests for information systems is still an unmet challenge.

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