Norwegian University of Science and Technology

Master's thesis, spring 2014

Personalizing anonymous video conferencing systems

Author:
Jonas Myrlund

Supervisors:
Prof. Heri Ramampiaro
Prof. Helge Langseth

February 2014

"I definitely need to find a timely quotation for my Master's thesis."

Jonas Myrlund, February 2014

NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Abstract

Faculty of Information Technology, Mathematics and Electrical Engineering
Department of Computer and Information Science

Master of Science in Computer Science

Personalizing anonymous video conferencing systems

by Jonas Myrlund

Identifying the different ways in which users use a product can be useful on several levels. In this project we will look at how identifying user classes allows for simple personalization of the product, and to what extent simple personalized treatments can alter user behavior.

It is often the case that some identified user classes are more desirable than others. Either because its associated users generate more revenue, use the product more, invite their friends, or similar. This project describes a system capable of not only identifying user classes, but more importantly a framework for identifying the most effective ways of driving users toward more desirable user classes.

More specifically, given a set of identified user classes and a set of predefined treatments, we want to find out how each treatment affects each user class. Although the project implementation will specifically target the video conferencing service appear.in, a major research question will be to what extent the results generalize.

We find that ...

Acknowledgements

I would like to thank my supervisors, Heri Ramampiaro and Helge Langseth, for lots of good advice, while at the same time allowing me a great extent of freedom in planning and executing this project.

My supervisor at Telenor Digital AS – Svein Yngvar Willassen.

Contents

Abstract ii

Acknowledgements iii

Contents iv

List of Figures vi

List of Tables vii

Abbreviations viii

1 Introduction 1
- 1.1 Background and motivation . . . 1
  - 1.1.1 Usage patterns . . . 2
  - 1.1.2 Anonymity and privacy . . . 2
  - 1.1.3 Visualisation of clustering . . . 3
- 1.2 Problem specification . . . 3
- 1.3 Organisation of the thesis . . . 4

2 Survey 5
- 2.1 The case study: `appear.in` . . . 5
  - 2.1.1 Anonymity and privacy . . . 5
  - 2.1.2 Differentiating the product . . . 5
  - 2.1.3 Similar products . . . 5
- 2.2 A survey of the available data . . . 5
- 2.3 Similar applications . . . 5

3 Design 6
- 3.1 System overview . . . 6
- 3.2 Adaptation component . . . 6
- 3.3 Differentiating product features . . . 6
- 3.4 Evolving the user models . . . 6
  - 3.4.1 Multi-arm bandits . . . 6
  - 3.4.2 Tracking individual treatment . . . 6
- 3.5 Visualisation requirements (?) . . . 6

4 Implementation **7**

5 Problem approach **8**
5.1 Data ingestion and preprocessing 8
5.2 User modeling and clustering 8
5.3 Evaluation metrics 8
5.3.1 How to measure a positive user experience 8
5.4 Applying the personalized feature set 8
5.5 Tracking user treatments 8
5.6 Visualizing effects 8

6 Conclusion **9**
6.1 Results 9
6.2 Generalising the system 9
6.3 Suggestions for further work 9

A Evaluation Results **10**

Bibliography **11**

List of Figures

List of Tables

Abbreviations

Chapter 1

Introduction

1.1 Background and motivation

My motivation for doing a personalisation project related to anonymous online video conferencing is comprised of two important factors. To understand how they are related and why they both are of equally big interest, some background on both the technological landscape of the web and the application case is needed.

For a long time, developing video conferencing services was an extremely challenging discipline, and as a result the market has consisted of a correspondingly low number of actors. However, this trend is currently in the process of being shaken and turned on its head with the introduction of HTML5; more specifically, with the introduction of the WebRTC[1] specification.

As the name implies, WebRTC handles real-time communication, but an important aspect of the technology is that it is designed to do so peer-to-peer. Although it per design is a protocol for exchanging arbitrary data between peers, it is especially geared towards multimedia streams. For instance, the traditionally cumbersome task of setting up a two-way audiovisual connection is now a matter of dropping around 40 lines of Javascript into a web page[2].

[1] Web Real-Time Communication.

[2] For an excellent introduction, see: http://www.html5rocks.com/en/tutorials/webrtc/basics/.

Although the WebRTC specification is still officially a *working draft* in the W3C[3], several large browser vendors have already implemented it, and applications previously unseen on the web pop up every week.

One of these applications is called appear.in, and like many others it concerns itself with video conferencing. The idea is simple enough: a conversation happens between users who are in the same room at the same time. The central idea, though, is that the room is identified solely by the URL in use, not in any way by the peers connecting. In that way, if any two users are visiting, say, `https://appear.in/ntnu` at the same time, they can start chatting away without any more call setup or configuration.

1.1.1 Usage patterns

Until the arrival of WebRTC, this way of thinking about conversations for anything but textual conversations hasn't been a big thing. However, the simplicity of the room concept opens the service up for a wide variety of uses[4]. These wildly varied use cases are where the motivation for this project stems from:

1. If the users' behaviors are quantified, will any clear and distinct usage patterns emerge?
2. If so, can the different uses be better served by dynamically adapting the product to fit each of them?

1.1.2 Anonymity and privacy

appear.in is an anonymous communication service. No personal information is ever collected about the users, and not even IP-addresses or geolocational data is logged on an individual level. By tracking individual *browsers* using cookies, then logging behavioral events along with a cookie identifier, we can measure user behavior over time.

This all opens a wide series of questions bordering to sociological aspects of web usage:

[3]The latest specification can be found here: `http://dev.w3.org/2011/webrtc/editor/webrtc.html`.

[4]In addition to traditional video calls, we've already seen it used for everything from virtual offices and team meeting rooms to baby monitoring and remote tutoring, just to name a few.

1. To what extent can an anonymous web service be personalised? Is user behavior enough to provide a satisfactory personalised user experience?
2. Will a personalised user experience go against the users' expectations of appear.in as an anonymous web service?
3. How can we measure any of this?

@TODO: More on how personalisation in a service anonymous by design is analogous to a authenticated service with strict privacy concerns. Challenges from lack of demographics.

1.1.3 Visualisation of clustering

@TODO: What is the state of the art regarding visualisation of spacio-temporal clusters. (Dimensionality reduction etc.)

Package into clustering tool to improve business intelligence. Challenges from lack of demographics.

1.2 Problem specification

Main research question: Can users of anonymous video conferencing services be clearly divided into user classes based on their behavior, and if so, to what effect can personalisation improve their activity level?

1. Are users of video conferencing services such as appear.in clearly dividable into separate groups based only on their behavior within the service? Do these patterns reflect those seen elsewhere – in other types of internet services or even in real life?
2. Is it feasable to personalize treatments to these user classes? Does it stimulate users into becoming more active users?
   (a) Is this something these users want?
   (b) Do the inferred preferences of the detected user classes significantly differ from each other?

(c) Can the personalized treatments be devised in such a way as to stimulate the moving of users in the direction of any desired user class?

3. How can a toolkit be devised to handle the following?

   (a) User classification based on behavior.

   (b) Product personalization based on a relevant user's class.

   (c) Tracking of each treatment's effect on each user class.

   (d) Prioritize using the most effective treaments without introducing statistical bias (see multi-armed bandit).

   (e) Allow product developers to easily access results to improve future feature prioritization.

1.3 Organisation of the thesis

This paper is organised as follows.

Chapter 2 surveys relevant literature, similar applications, provides an in-depth analysis of the available data. Chapter 3 describes the system design and the reasoning behind central design choices. In chapter **??** we'll look at the execution results, and see how they evaluate. Chapter 6 summarises the most important takeaways, and suggests further work.

Chapter 2

Survey

2.1 The case study: appear.in

2.1.1 Anonymity and privacy

2.1.2 Differentiating the product

2.1.3 Similar products

2.2 A survey of the available data

2.3 Similar applications

Chapter 3

Design

This chapter will describe the system in a top-down manner. After explaining the initial design requirements, the system viewed as a whole will be described, then the large logical modules and their relationships.

Implementation specific details are deferred to chapter 5.

3.1 System overview

3.2 Adaptation component

3.3 Differentiating product features

3.4 Evolving the user models

3.4.1 Multi-arm bandits

3.4.2 Tracking individual treatment

3.5 Visualisation requirements (?)

Chapter 4

Implementation

Chapter 5

Problem approach

5.1 Data ingestion and preprocessing

5.2 User modeling and clustering

5.3 Evaluation metrics

5.3.1 How to measure a positive user experience

5.4 Applying the personalized feature set

Description of the FlagService model.

5.5 Tracking user treatments

5.6 Visualizing effects

Chapter 6

Conclusion

6.1 Results

6.2 Generalising the system

6.3 Suggestions for further work

Appendix A

Evaluation Results

Bibliography