Personalising the Editorial Mix for a Digital Newspaper using Constraint Programming

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Abstract

Resumé

Preface

Lyngby, June 2012

Michael Lunøe

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Chapter 1

Introduction

1.1 Problem description

1.1.1 Title

Personalising the Editorial Mix for a Digital Newspaper using Constraint Programming

1.1.2 Danish Title

Personalisering af den Redaktionelle Sammensætning i en Digital Avis med brug af Constraint Programmering

1.1.3 Time Frame

Project start 6/2-2012, delivery 3/8-2012.

1.1.4 General Project Objectives

The overall objective of the project is to make the student familiar with personalisation and the concept of modelling user preferences in digital solutions. A specific personalisation problem is analysed and relevant design proposals are discussed. A chosen design is implemented and solved using Constraint Programming. The project provides a conceptual basis for the use of Constraint Programming in the context of developing personalised digital solutions. Finally, the project attempts to make personalisation more accessible for developers with the introduction of Constraint Programming to the field.

1.1.5 Learning Objectives

Explore existing literature and summarise it.

Analyse the applicability of personalisation in a given domain and derive features of the problem to be personalised.

Identify features in the domain that can be solved using Constraint Programming.

Model the identified features as constraints and solve them using Constraint Programming.

Refine the identified features into general guidelines for the use of Constraint Programming in the context of personalisation.

Evaluate Constraint Programming as a tool for personalisation problems and compare the solution to existing solutions.

Describe and discuss the project in a report and present it orally.

The overall idea is to determine the use of Constraint Programming (CP) as a tool to make the personalisation of digital solutions more accessible.

? Footnote: definition of CP and definition of personalisation

The project will be divided into two main areas; i.e. an assessment of the use of CP in the context of personalisation and a direct application of this in the form of a personal digital news paper, where CP is used to personalise the content and composition of a digital newspaper.

1.1.6 Personalisation Challenges

In an attempt to personalise the content of a newspaper, the report will try to analyse which preferences the users will have with respect to the content and composition of relevant articles. It will describe the search for articles to fit the user needs as an Constraint Optimisation Problem and try to solve it. What makes a newspaper is not only the accumulated content of its articles, but the editorial mix of them. "Which articles should go where" is just as important and the composition of newspaper should therefore go through an equal solving process.

? Footnote: definition of COPs

1.1.7 Algorithmic Challenges

To be able to use and assess CP in the context of personalisation a full understanding must be acquired. Features that can be solved using CP will be modelled as a COP and solved. Furthermore, because the problem has a fixed budget for finding a solution, its algorithmic complexity will be analysed. The findings will be concluded in an evaluation of the applicability of personalisation problems in CP.

1.1.8 Existing solutions

Personalisation of digital solutions becomes more common everyday and users demand personalised solution to accommodate their needs. Many solutions to this problem already exists, but the role of CP within this domain has not been determined. This project seeks to explore CP as a tool to make the personalisation of digital solutions more accessible.

1.2 Motivation

The development of the Internet from a distributer of information to a library of digital applications has deeply integrated the users in every step of an applications lifetime. It has even become harder to distinguish between super users and developers, applications are branched and modified according to every need and authors can therefore no longer predict which use his or her application can be to another user - nor should he/she have to.

User preferences are very diverse and it is therefore hard to accommodate every individual in a single solution. A digital solution must be bound to a specific domain, but must also be open for novel use.

Constraint Programming offers a more natural way of defining problems, i.e. what should be solved (and not how). This makes the modelling of problems very intuitive, once setup, and can afterwards easily be extended and modified.

? reference to what - not how

? Something about introducing an automated editorial mix to the digital newspaper. Maybe about bringing rss-readers and digital newspapers closer together.

Chapter 2

Theory

2.1 Personalisation

"Personalization technology enables the dynamic insertion, customization or suggestion of content in any format that is relevant to the individual user, based on the user's implicit behaviour and preferences, and explicitly given details. This can be dissected as: 'Personalization technology enables the dynamic insertion, customization or suggestion of content' – personalization doesn't just have to be product recommendations: it can also include inserting any content like images or text (e.g. displaying a golf-orientated banner for a returning golf supplies buyer), or customizing content that is already there (e.g. 'Hi Joe, we've got some great movie suggestions for you!'). '$\cdots$ in any format' – it isn't restricted to the web. It can be implemented for any medium or touchpoint, such as emails, apps, instore kiosks, etc. '$\cdots$ that is relevant to the individual user, based on the user's implicit behaviour and preferences, and explicitly given details' – finally, the most important part. Personalization uses both implicit and explicit information, derived in two ways. Firstly, a visitor might explicitly declare some information, such as their gender or date of birth."

? definition from elsewhere than wikipedia

2.2 Contraint Programming

2.2.1 Why Constraint Programming?

2.2.2 Constraint Programming In The Context Of Personalisation

Hard constraints and soft constraints

Wiki: "A constraint optimization problem can be defined as a regular constraint satisfaction problem in which constraints are weighted and the goal is to find a solution maximizing the weight of satisfied constraints. Alternatively, a constraint optimization problem can be defined as a regular constraint satisfaction problem augmented with a number of 'local' cost functions. The aim of constraint optimization is to find a solution to the problem whose cost, evaluated as the sum of the cost functions, is maximized or minimized."

? Find reference that is not from wikipedia

Chapter 3

Analysis

This section analyses the user preferences and identifies with features should be modelled as personalisation constraints. I also seeks to define the default setting that consists the general model for a good digital newspaper.

The focus of automatically generating the editorial mix introduces circumstances about the similarities between articles. These will consist the content constraints of the system along with those determined by user preferences. Therefore the constraints that belongs to composition conditions must be presented/defined.

prerequisites:

- 14.732x20.828cm [Ihlström *et al.*, 2004, p. 1]
- A5 (A4 if reducible) [Ovesson and Wikström, 2005, p. 6-7]
- reader knows about constraints
- relevance feedback introduced (click on article, time spend reading it and scroll)
- argument that transparency of the general model is enough for the user to provide settings [de Buenaga Rodríguez *et al.*, 2004, p. 7]

3.1 User Needs

This section will define the user needs for the application.

3.1.1 Business Case

3.1.1.1 Need

User value: personal quality and up-to-date stories enriched with quality images. This means that content providers should be chosen/verified. Same navigation as actual newspapers, but faster and with endless more content. Instantly up-to-date. Adaptive layout. Adjustable user profile.

3.1.1.2 Approach

personalised content + composition.

Constraint Programming: fast computation - good for optimal solutions, describes the generic solution in stead of how to solve or find it, very easy to tailor the problem definition of the solution and adjust it and even let users make the adjustments - transparency.

Content providers can get to know their readers preferences better and improve the provided content.

3.1.1.3 Benefit Per Cost

Revenue flow: Content providers are paid. Income from advertisers (scattered [Ovesson and Wikström, 2005, p. 6-7]) and users. Income from selling user behaviour patterns and targeted commercials.

3.1.1.4 Competition

Flip board, Wired magazine, zite and app with actual editors affiliated.

? Which design choices to focus on?

- "open, turn pages, chose article, read and return" [Ihlström *et al.*, 2004, p. 6]
- both general and personal news (collaborate filtering solves that some news are not received, but are universally interesting [Díaz and Gervs, 2005])
- full screen display of article
- images + video? adjustable
- graphical/textual content ratio
- opens in front page view (summery of newspaper 8 articles) [Ovesson and Wikström, 2005, p. 8]
- put in personalised sections
- back page, funnies?
- section headline [Ovesson and Wikström, 2005, p. 6-7]
- article headlines
- article summaries / extracts [Díaz and Gervs, 2005]
- menu w. section headlines [Ovesson and Wikström, 2005, p. 8]
- page numbers [Ovesson and Wikström, 2005, p. 6-7]
- page turn
- press "like" or key word based user profile (mark self or highlighted? right click to add): positive + negative list (keywords+categories [Abuzir and Vandamme, 2002], [Díaz and Gervs, 2005] and [de Buenaga Rodríguez *et al.*, 2004])
- adjust variables
- share social network
- share directly (grey out the ones who have read it)
- comment
- see friends comments

3.1.2 Technical Requirements

- "the clear overview of content, including a beginning and an end, the ease of use, typography and design" [Ihlström *et al.*, 2004, p. 7]
- familiarity in design from printed paper [Ihlström *et al.*, 2004, p. 7]
- "news valuation, e.g. positioning of lead story" [Ihlström *et al.*, 2004, p. 7]
- mobility [Ihlström *et al.*, 2004, p. 7]
- continuous updates [Ihlström *et al.*, 2004, p. 7]
- ability to search [Ihlström *et al.*, 2004, p. 7]
- "easy and intuitive navigation" [Ihlström *et al.*, 2004, p. 7]
- add video and sound [Ihlström *et al.*, 2004, p. 7]
- Landscape + portrait [Ovesson and Wikström, 2005, p. 6-7]
- touch screen interaction [Ovesson and Wikström, 2005, p. 6-7]
- Design+layout from printed newspaper [Åkesson *et al.*, 2005]
- Functionality from online newspaper [Åkesson *et al.*, 2005]
- Name of columnist [de Buenaga Rodríguez *et al.*, 2004, p. 4]
- Transparency of implicit relevance feedback (see/modify current weights of categories) [de Buenaga Rodríguez *et al.*, 2004, p. 7]
- dynamic short-term + static long-term user profile [Abuzir and Vandamme, 2002], [Díaz and Gervs, 2005] and [de Buenaga Rodríguez *et al.*, 2004]
- relevance feedback [Abuzir and Vandamme, 2002], [Díaz and Gervs, 2005] and [de Buenaga Rodríguez *et al.*, 2004]

In which period of time is an article relevant to a user? Maybe if it is still available, then it is still interesting - new approaches or discussion about the subject might arise. How do we control that a news item is not missed? Keep index of what has been viewed in addition to what has been read.

3.2 Interface

3.2.1 Typeface

"How users read the web: They don't. They scan the page, picking out individual words and sentences",

? Jakob Nielsen cite

Colour scheme: `http://colorschemedesigner.com/#0042b1Tw0w0w0`

Figure 3.1: Colour scheme of the interface [Stanicek, 2010]

? colorschemedesigner.com cite

3.3 Test

3.4 Constraints

The constraints can be divided into groups: layout-/content-based, global/-topic/neighbouring,

Technical argumentation for choices. Business case argumentation for choices (user needs). Reference to written articles about design choices - navigation: sections + headlines,

3.4.1 Layout Constraints

first focus: layout + one sections

3? columns images/no image base layout

3.4.2 Content Constraints

Content similarity relationships: article vs. neighbouring articles article vs. containing section/topic article vs. whole newspaper

"[...] it was found that the best eight-item mix within an issue was not necessarily composed of the eight highest-readership items in that issue." [Haskins, 1965] (maximum audience coverage, which is no longer an issue due to personalisation)

$$\mathcal{C} = \left\{ \begin{array}{c} \texttt{all\_different}(a_i), \\ \texttt{sim}(a_i, a_{i+1}, 0.7, 0.9), \\ \texttt{sim}(a_i, a_{i-1}, 0.7, 0.9), \\ \texttt{sim}(a_i, a_j, 0.3, 0.9) tempo_i < tempo_{i+1} + 10 \wedge tempo_i < tempo_{i-1} + 10 \wedge \\ tempo_i > tempo_{i-1} - 10 \wedge tempo_i > tempo_{i+1} - 10, \end{array} \right\}$$

? AIRussel p. 207 preference constraints. can often be encoded as costs on individual variable assignments. Solved either path-based or local. p. 216 Minimum-remaining-values, p. 217 Least-constraining-value.

3.5 Test Results

long layout

Stumbleupon - Collaborate filtering for recommendation

Chapter 4

Implementation

? css: conditional styling

4.1 Server

using hash of url as ids.

looking for images and videos in the article.

4.1.1 Word tagging

tagging: maxent_treebank_pos_tagger, Treebank Part of Speech Tagger (Maximum entropy) - sikkert upenn corpus.

alternativt: Treebank Part of Speech Tagger (HHM)

wordnet_enrich: "W-kmeans: Clustering News Articles Using WordNet", 116262780379.pdf

wordnet sammensatte ord

cite "Text Classification Using WordNet Hypernyms.pdf" hypen density. This is better in 116262780379.pdf

using nouns and adjectives NOT nouns and verbs as in "Text Classification Using WordNet Hypernyms.pdf"

tagging på feeds er givet fra feedets navn. Kan bruges til at verificere min classification.

Opbygge en database med articler og bruge det som basis for similarity queries. wordnet_ic Information Content: Load an information content file from the wordnet_ic corpus.

```
>>> from nltk.corpus import wordnet_ic
>>> brown_ic = wordnet_ic.ic('ic-brown.dat')
>>> semcor_ic = wordnet_ic.ic('ic-semcor.dat')
>>> dog.res_similarity(cat, brown_ic)
7.9116665090365768
>>> dog.res_similarity(cat, genesis_ic)
7.1388833044805002
```

Listing 4.1: cap

4.2 Client Side

worker.js to create a background worker to perform the constriant programming.

Model-View-Control using backbone.js

Paging: single page web apps + manipulation the browser history `https://developer.mozilla.org/en/DOM/Manipulating_the_browser_history`

Assignment from library in stead of arbitrary assignment? The latter is a more hypothetical approach. Providing the library as a constraint, where each variable assignment must have a unique combination from one of the possibilities of the constraint. (sim,breaking,chars,date,sections?,columns):list

Ranges can be optimised in space by converting them to integer ranges. This can be done by setting min = 0 and max = (b-a)/gap.

Furthermore each subdomain should be able to be represented by a set of ranges and atomic values. Propagating through values causes many iterations and a whole range may be discarded by looking at its maximum and minimum value. However, if the range holds a potential valid value (solution to a variable) it can be divided into smaller ranges and their minimum and maximum values may be examined. This divide-and-conquer technique may continue until the search reaches atomic values (determined by the gap value of the range). If some atomic values and ranges seems to fulfil the constraints they should be returned. And the subdomain now consists of both ranges and atomic values.

Optimal/promising fixed budget computation

The library could take any combination of constraints and then organise them into conjunctions of disjunctions, with the constraints taking fewer values first.

In the implementation this is done by hand, so the program takes conjunctions of disjunctions of constraints organised with constraints that takes fewer values first. Constraint weighing could also help organising the disjunctions and furthermore lead the search to concentrate on variables that is bound by these constraints. (p. 222 AIRussel).

Constraints should point to specific variables, this makes it somewhat rigid/ineffective because I have to write at global constraint that accounts for everything (ineffective in propagation - might also be a problem if it does not show progress in changing values, i.e. it is a hard constraints and not returning a cost of the set of values.) or divide it into smaller constraints separated by an 'or' (v). The latter is ineffective because there would should be a combination of constraints accounting for every situation, e.g. if the first variable is satisfying an unary constraint, the next say 3 variables (if the problem holds 4 variables) could satisfy three unary constraints, an unary and a binary (two combinations exists) or a constraint that takes three variables. This grows fast with the number of constraints.

? Does it make sense that a continuous range cannot have specific values removed? Should it be possible for it be divided into subranges if the user decides to remove a range of values in between its domain of [min;max]?

Chapter 5

Conclusion

Appendix A

User Needs

This section will define the user needs for the application.

A.1 Personas

- `student` 35%, `employeesself-employedfamilyworkers` 31%, unemployed, retired or other inactive
- `highformaleducation` 50%, medium formal education, no or low formal education
- `male` 55%, female
- `16-24` 34%, `25-54` 34%, 55-64, 65-74

A.1.1 Thomas: student medium formal education male 21

Thomas is 21 and a student at the Technical University of Denmark to be a bachelor of engineering in software. He is very interested in soccer and is therefore always updated on sports news. He reads about it online, newspapers and talks about it

with friends. With big events he even likes to post it on Facebook. As a soon-to-be software engineer he has a natural thirst for news about technology, and he mainly reads these at home at the dormitory. wired.com, newz.dk, engadget.com, facebook.com computer, Samsung Galaxy Tab

A.1.2 Laura: employed high formal education female 39

Laura is 39 and is employed as a key account manager. She likes to be updated on strategies and economical status of rivalling companies. She is also very interested in politics and likes to discuss this subject with her friends. She reads economical news and likes to be updated on the run. b.dk, borsen.dk, twitter.com iPhone, iPad

A.1.3 Marie: unemployed no or low formal education female 61

Marie is 61 and a currently unemployed housekeeper. She spends her day looking for a job and taking care of her pet cat until her husband comes home. She mostly looks for the gossip sections or news about crime or big disasters. She also spends some time reading through the travelling guides as she dreams of going away with her husband. ekstrabladet.dk, bt.dk, nyhederne.tv2.dk computer, Lenovo IdeaPad A1

A.1.4 Carl: retired or other inactive high formal education male 69

Carl is a retired professor in psychology. He likes to discuss human behaviour and relation with his acquaintances and is very interested in cultural events. Therefore he often seeks the cultural sections and discussion fora to see what is going on. politiken.dk, aok.dk, dr.dk computer, iPad

A.2 Scenarios

A.2.1 Thomas

Thomas comes home after a day at the study, picks up his tablet computer and opens Editor from the desktop. Editor opens and shows him the front page where all the

headlines stories are displayed. The main story is about a new version of the Android OS that has been released today and presses it to read more. The story opens in a full window display with quality images to match the articles. He reads the first section and feels satisfied with the amount of information, but wants to share the information on Facebook, so he clicks share button and writes a comment and posts it on his Facebook wall. He closes the article and returns to the front page. He sees a top story below the main story about Mr. Mærsk Mc-Kinney Møller who has died. It is not a story that falls into his key interests, but as the news is big he is satisfied that he got informed about it. Thomas feels like reading more about technology so he opens the menu and chooses the "Tech" section he has installed in the application. The section opens with a head line and a page number to let him know where in his paper he has navigated to and finds an article about a new multicore CPU technology. He has never been interested in CPU technology before, but finds this technology interesting after reading about it, so he opens the application settings and types in keywords about the technology under his "Tech" section to keep him updated about it. He also adjusts the ratio between general and personal news, to be less personal as he feels like he needs to broaden his horizon a bit with respect to news. He closes the settings menu and Editor immediately starts updating the articles. Some new articles about CPU technology has been included amongst the articles in the "Tech" section after paging through the section and reading some of the most interesting articles he closes the application.

It could be nice if the key words of a story could be or is already highlighted, so he can click it and add it to his positive or negative list.

"Define keywords and user preferences as rules (static and ageing, dynamic)" [Centeno *et al.*, 1999]

A.2.2 Laura

Laura is on the train on her way to a business meeting this morning and pulls out her tablet and sees she has one notification from Editor. She opens Editor to get updated on todays news. The front page is displayed and there are headlines from different top articles and a notification is shown in the corner. She presses the notification and the pages turns to show her the article, which opens in full screen. After reading it she wants to see todays headlines, so she presses the back button to return to the paper and presses the return to front page button and the paper turns pages to reach the front page. She scans the page to see if there is any big news about her rivalling companies. There is no breaking news, so she just turns the page to browse the content of todays paper. As she browses the "Politics" section of her paper she finds an article about the Prime Minister introducing a new bill about a toll ring around the capitol city. She chooses the article and it is shown in full screen. As she reaches

the bottom of the article she sees the comments about it where her friends and most others are against it. She decides to join the discussion and posts a comment on the article wall. She also sees one of her friends has not commented on the article wall and decides to share the article with her as she thinks she would agree with her opinion. She presses the share button and chooses the Editor logo. A list of her friends is shown, some of them who has already read the article is greyed out, but the one she was looking for is not. So she chooses her and a notification is sent to her.

A.2.3 Marie

It is morning and Marie wants to check the news with her coffee in the couch, so she opens Editor from her tablet to get updated. The front page is displayed with a collection of stories as highlights of the content of the paper. It mainly contains stories about celebrities and a big disaster that has happened in japan, but there is also a story about a big political change, that she does not find interesting. So she goes to the settings menu and types in "politics" to add to her negative list. She also adjusts the personal/general news ratio to contain only personal news as she wants only news that is directed to her. She returns to the front page which is now free of political stories. Her newspaper contains many images and videos as she has set her graphical/textual content ratio more towards graphical content.

A.2.4 Carl

Cultural, funnies

A.3 Business Case

A.3.1 Need

User value: personal quality fresh stories (content providers should be chosen!) enriched with quality images. Same navigation as actual newspapers, but faster. Instantly up-to-date. Adaptive layout. Adjustable user profile.

A.3.2 Approach

personalised content + layout.

Constraint Programming: fast computation - good for optimal solutions, describes the generic solution in stead of how to solve or find it, very easy to tailor the problem definition of the solution and adjust it and even let users make the adjustments, transparent.

Content providers can get to know their readers preferences better and improve the provided content.

A.3.3 Benefit Per Cost

revenue flow: Content providers are paid. Income from advertisers (scattered [Ovesson and Wikström, 2005, p. 6-7]) and users. Income from selling user behaviour. Free version w. commercials + paid (monthly) without.

A.3.4 Competition

Flip board, Wired magazine and app with actual editors affiliated.

? Which design choices to focus on?

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In which period of time is an article relevant to a user? Maybe if it is still available, then it is still interesting - new approaches or discussion about the subject might arise. How do we control that a news item is not missed? Keep index of what has been viewed in addition to what has been read.

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