## The problem formulation

At TU/e, the adaptive hypermedia engine called GALE (GRAPPLE Adaptive Learning Engine) is used for teaching and creating adaptive hypermedia. GALE is a highly dynamic engine with which a wide variety of adaptation techniques can be realized.

A big problem in the creation of adaptive hypermedia applications, often called authoring, lies in its complexity. Authoring adaptive applications is often times tricky to get into as a non-expert or novice GALE developer. On top of that, repeatedly defining adaptive behavior is tedious and often times involves a lot of repetitive work. Authoring tools are used in order to solve these problems and to provide support when authoring GALE applications. The tool which is currently for authoring applications in GALE is called GAT (GRAPPLE Authoring Tool). This tool, in its current state, does not meet the desired requirements. The tool has been developed by a number of different parties, leading to some unfortunate design decisions and usability problems. The solution to this problem is to design and create a new authoring tool for GALE.

The goal of this project is to create a new Authoring environment for GALE with a low barrier of entry and a high usability for novice GALE users. It should be a generic and extensible platform which can be used for numerous adaptive hypermedia application types.

## An introduction to adaptivity

Many items we use on a daily basis are tailored to our personal needs and desires. Furniture and clothing are examples of this: The height of many office chairs are adaptable, for example and a tall person might need bigger clothes as opposed to a shorter person. Over the years this phenomenon has made its way to the digital world as well. The reason for this is that people have their own preferred learning style, their own interests and their own approach to problem solving. In the past few years especially, personalization and adaptation has showed up in fields such as advertisement, shopping recommendations and on-demand television. Even though the digital applications of adaptivity have grown over the years there are still some areas in which adaptive hypermedia could make a big difference. The area of e-learning is a prime example of this, though the institutions are slowly realizing a one-size-fits-all program is not the ideal way of teaching.

The field of adaptive hypermedia systems (AHS) focuses on developing platforms and techniques which further explore and exploit the possibilities in digital personalization and adaptation. It does this by adding adaptive behavior to hypermedia content. The term hypermedia is an encapsulating term which covers audio, video, plain text, hyperlinks and other visual media. In this case hypermedia is typically viewed in an internet browser. The adaptive behavior is based on environmental factors as well as the user browsing behavior and history.

The concept of adaptive hypermedia was first elaborately described by [BrLe93] in 1993. Soon after, pioneering ITEs (Intelligent Tutoring Environment) containing adaptation functionalities such as ELM-ART [BrEl96] were created. Since then a multitude of adaptive hypermedia platforms have been developed over the years. The adaptive hypermedia platform this thesis covers is called GALE.

## Adaptivity and GALE

GALE [SmBr11] (Generic Adaptation Language & Engine) is a strong generic platform for adaptation. It acts as a web server in that it serves web content to the client, but it also handles adaptation rules and expressions. Almost every adaptation technique can be applied in GALE, which makes it a truly generic platform.

GALE has been developed as a part of the GRAPPLE [BrAl13] (Generic Responsive Adaptive Personalized Learning Environment) project. It has been developed as an EU FP7 STREP[[1]](#footnote-1) project that lasted from 2008 until 2011. In this project academic and industrial partners collaborated to develop a generic adaptive learning environment and to integrate this with several learning management systems.

The main three types of adaptation found in GALE are content adaptation, navigation adaptation and presentation adaptation. Content adaptation is used to personalize the content of hypermedia pages based on the user. This is done by extracting information from a user model, which contains information about the current user.   
Navigation adaptation involves the adaptation on the availability of hyperlinks, thus influencing the users’ path of navigation through the available hypermedia pages. Lastly, presentation adaptation changes the way the page information is displayed rather than the information itself. This could result in different text sizes or fonts, but it could also go as far as to display a different kind of media to represent information altogether (video instead of text, for example).

Figure 1. 1: A snippet from the Milkyway demo.

For content to be presented through GALE it needs to be created first. The format in which content needs to be presented to GALE is HTML combined with some specific GALE tags for further customization. These HTML pages are linked to parts of a domain and adaptation model which also have to be presented to GALE. Both of these models are represented by a single GAM (Gale Adaptation Model) file. This file is written in a textual format which is aimed to be readable by humans and which describes a domain and its associated adaptation. However, it is difficult for non-expert users to create this file without extensive knowledge on GALE. Designing and creating such a GAM file containing the adaptive application content is also known as “authoring”.

## The structure of GALE applications

All concepts contained in a GALE application are contained within their own separate entities. These entities consist out of a set of attributes and parameters amongst which the concept name and web resource (used when the concept is accessed and displayed within the browser). These concepts can be connected to each other by means of labeled relations. Many standard layouts for GALE, such as the “*static-tree-view”* [REF] make use of parent-child relations in order to create a default concept hierarchy. These labeled relations can also be used to create dynamic behavior on concept pages by listing all objects that are related by the current object through a specific labeled connection. An example of this is the milkyway demo [SmBr11] in which an “*isMoonOf*” relation is used to list all moons rotating around a specific planet. A snippet of the concept “Jupiter” with such a list is displayed in *figure 1.1*. These relations do not have any specific adaptive behavior attached to them and are often referred to as “non-pedagogical relations”.  
The set of all concepts together with the relations they share amongst each other will be referred to as a “Domain model”.

Because the domain model is only responsible for the structure and data of the GALE application a second model is necessary in order to take define the adaptation. This is called the adaptation model. This model has been called the “Achilles heel of adaptive application design” [BrSm12] due to the increase in complexity as more flexibility in adaptivity is introduced. This model consists out of a set of adaptation rules which are responsible for the adaptive behavior of the resulting GALE application. These adaptation rules can also involve multiple concepts, forming pedagogical relations.

These models are brought together in the resulting GAM file. In this file all concepts are declared together with their specific attributes, parameters and GAM-expressions representing the adaptive behavior defined in the adaptation model. This file, named “*concepts.gam”* can be deployed on the GALE-server where it will then be automatically detected and deployed by GALE.

An authoring environment is used to create domain and adaptation models and deploy these into GALE applications. The goal of this is to make the authoring process less complex while trying to retain the flexibility that GALE allows.

## Authoring

The current authoring environment for GALE is called GAT. It has a graphic user interface which can be used to author adaptive applications. GAT tries to make the authoring process less complicated by visualizing the domain and adaptation model to an extent at which it is easy to create, understand and edit. However, time and use have proven that GAT does not have the desired functionality and usability of an authoring environment for GALE. An in-depth analysis of GAT is presented in *section 2*.

This calls for a new authoring environment in which lessons from GAT and other earlier projects can be learned and fresh ideas can be put to an implementation.

In order to get new ideas and inspiration a company called “De Roode Kikker” has been involved in this project. De Roode Kikker is a company which created and maintains an educational platform. They are looking into the possibility of using GALE in order to make their educational content adaptive. That means their goal is a specific platform which is aimed at authoring content within their existing platform. Their interest lies in adaptivity focused on the area of Adaptive Educational Systems (AES).

The new authoring environment desired for GALE should be a generic platform with which a multitude of adaptive hypermedia types can be authored.

This means there is a discrepancy in wishes and requirements between both parties involved (TU/e and “De Roode Kikker”. Yet, this does not hinder the collaboration in terms of exchanging inspiration and ideas as well as providing mutual technical support.

So the goal of this project is to create a generic platform which helps content authors to easily create adaptive hypermedia without extensive knowledge of GAM or the inner workings of GALE. In the ideal authoring environment the user will not have to deal with any kind of code at all. This platform needs to be generic in the sense that the adaptation must be adaptable and extendable. The material authored by the authoring environment must be field-independent.

ref:

[BrLe93] Brusilovsky, Peter, Leonid Pesin, and Mikhail Zyryanov. "Towards an adaptive hypermedia component for an intelligent learning environment." *Human-computer interaction*. Springer Berlin Heidelberg, 1993. 348-358.

[BrEl96] Brusilovsky, Peter, Elmar Schwarz, and Gerhard Weber. "ELM-ART: An intelligent tutoring system on World Wide Web." *Intelligent tutoring systems*. Springer Berlin Heidelberg, 1996.

[SmBr11] Smits, David, and Paul De Bra. "GALE: a highly extensible adaptive hypermedia engine." *Proceedings of the 22nd ACM conference on Hypertext and hypermedia*. ACM, 2011.

[BrAl13] De Bra, Paul, et al. "GRAPPLE: Learning management systems meet adaptive learning environments." *Intelligent and adaptive educational-learning systems*. Springer Berlin Heidelberg, 2013. 133-160.

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[BrSm12] De Bra, Paul, and David Smits. "A fully generic approach for realizing the adaptive web." SOFSEM 2012: Theory and Practice of Computer Science. Springer Berlin Heidelberg, 2012. 64-76.

1. Specific Targeted REsearch Project

   (http://cordis.europa.eu/fp7/ict/future-networks/funding-schemes\_en.html) [↑](#footnote-ref-1)