MAI4CAREU

Master programmes in Artificial Intelligence 4 Careers in Europe

University of Cyprus

HUMAN-CENTERED INTELLIGENT USER INTERFACES - MAI648

Marios Belk

2022

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Adaptive User Interfaces

CONTENTS

- Overview
- Historical Perspective of Adaptive Interactive Systems
- High-level AIS Architecture
- Personalization Process
- User Modeling
- Types of Personalization
- Adaptation Mechanisms
- Adaptation Effects

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Learning Outcomes

- Understand the technical and design considerations for adapting content and functionality of intelligent user interfaces
- Explain the state-of-the-art adaptation and personalization technologies
- Assess the most relevant adaptation effects given the application domain and the human factors being modelled

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Overview

- Engineering interactive systems following UCD approaches does not always intuitively embed the users' characteristics and needs
- A challenge relates to dynamically adapting the content presentation and functionality of the system based on explicitly or implicitly retrieved information about the user

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Overview

- Adaptive user interfaces (Schneider-Hufschmidt et al., 1993; Brusilovsky, 2001) in interactive systems provide an alternative to the “one-size-fits-all” approach of static user interfaces by adapting the interactive system’s structure, terminology, functionalities and presentation of content to users’ perceptions, needs and preferences

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Historical Perspective of Adaptive Interactive Systems

Adaptive Hypertext and Hypermedia (early 1990s)

- Researchers from the hypertext and hypermedia community recognized the drawbacks of static hypermedia in a variety of application areas
- Explored ways to adapt content presentation and functionality of such systems to the needs of individual users

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Historical Perspective of Adaptive Interactive Systems

Adaptive Web (mid-1990s)

- Exponential increase of users and information on the World Wide Web
- Need to provide adapted and personalized content to the heterogeneous needs and preferences of users became

- The Adaptive Hypermedia community used the World Wide Web as an attractive and challenging platform for applying their research
- Since then, the majority of research on adaptive interactive systems has been applied on it

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Interdisciplinary Field

- *Early 1990s:* Hypertext and Hypermedia Community
- *Today:* Attracts many researchers from different communities
  - User modeling
  - Machine learning
  - Natural language generation
  - Information retrieval
  - Intelligent tutoring systems
  - Affective computing
  - Cognitive science
  - Web-based education

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Interdisciplinary Field

- Popular areas
  - *Information retrieval:* find documents that are most relevant to user interests and then to order them by the perceived relevance
  - *Intelligent tutoring systems:* select educational activities and deliver individual feedback that is most relevant to the user's level of knowledge

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

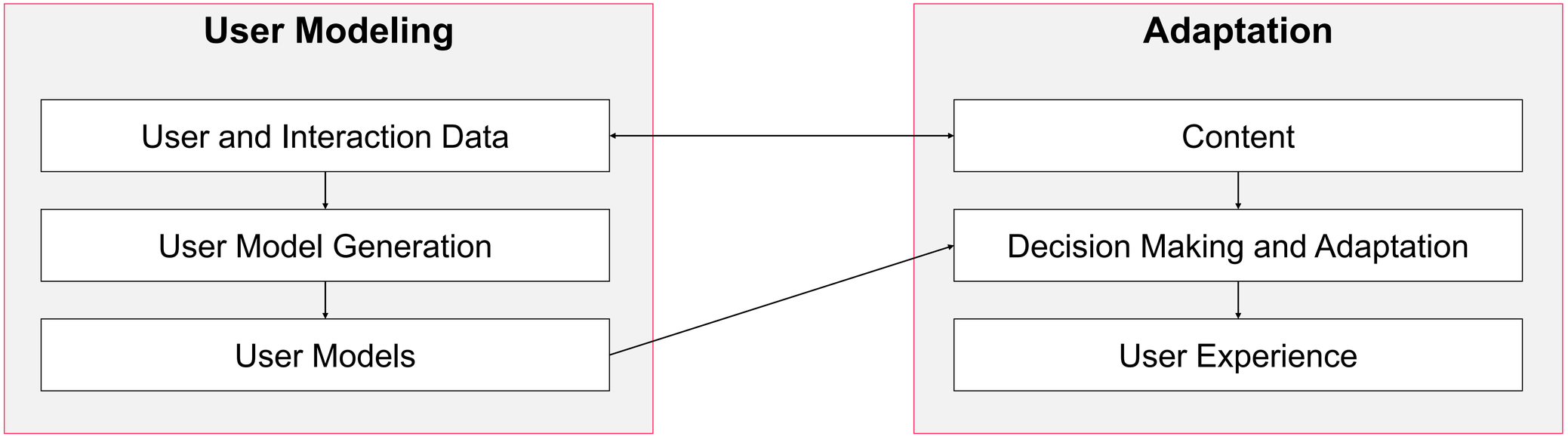
Other Technical Challenges

- Study and incorporate structures of meta-data (i.e., semantics) at the Web content provider's side, as well as propose the construction of a Web-based adaptation mechanism
- Semantic mark-up can contribute to the whole adaptation process with machine-understandable representation of Web content
- Machine-understandable data can be incorporated in the design of Web-based systems to inform the adaptation mechanism of the intention of specific sections and accordingly adapt them based on the user's characteristics and adaptation rules

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

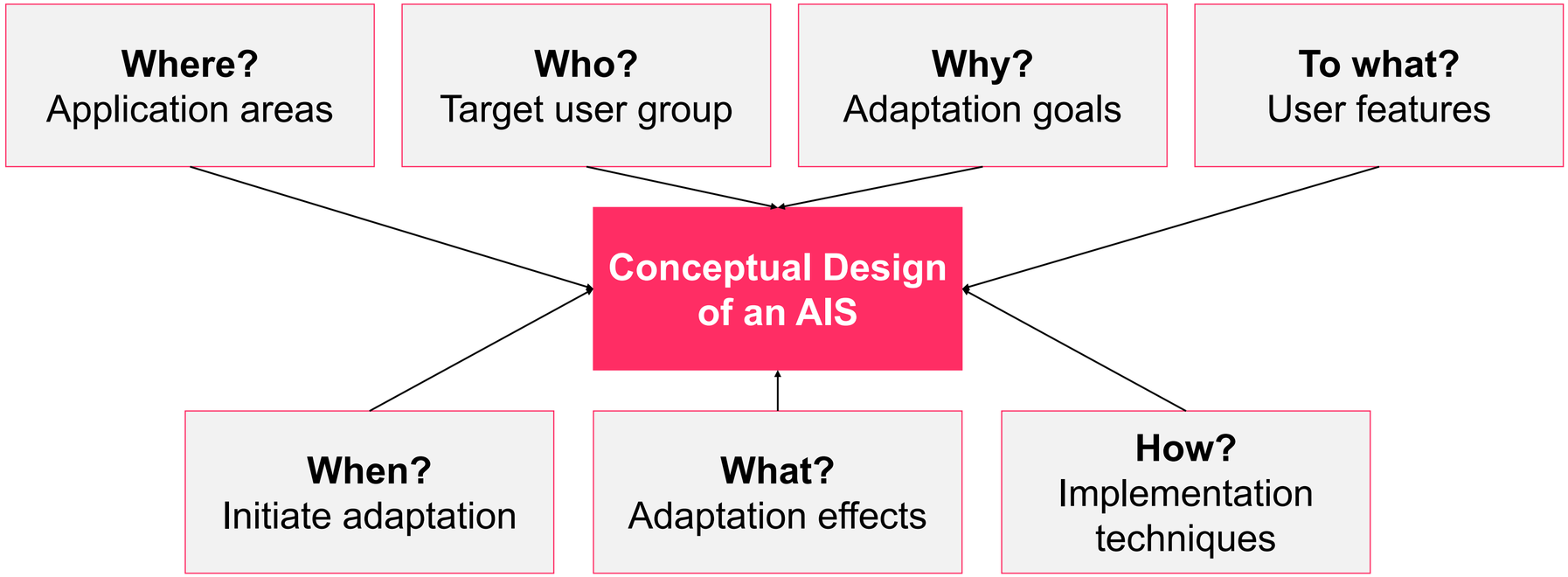
High-level Adaptive Interactive System Architecture



This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Conclusive Framework for Defining an AIS



Example
Where: Educational
Who: 1st year Students
Why: Learn effectively
To What: Knowledge
When: Recognize invalid user behavior
What: Additional explanations
How: Track progress of the user for user knowledge modeling and expand content explanations

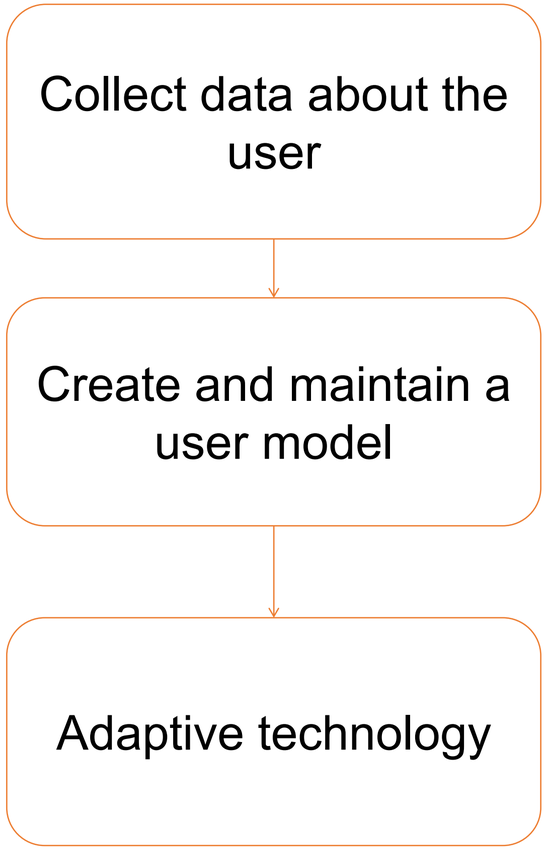
This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

Personalization Process Paradigm

Name: Anna
Gender: Female
Age: 19
Profession: 1st year CS student
Bought: Matrix Revolutions Movie
Navigation behaviour data (e.g., time spent on pages, ratings on products)

Interests: Like Sci-fi movies
Individual traits: Imager cognitive style

Content level adaptation
Provide more images
Link level adaptation
Recommend new Sci-fi movies



user modeling

deals with what information represents the user in a particular context and how to learn and represent this information

adaptation

deals with what adaptation types and mechanisms need to be performed and how to communicate them to the adaptive user interface

improve its usability and user experience

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Modeling

- User Modeling Factors
  - Knowledge
  - Interests
  - Goals
  - Traits
  - Context of use
    - Platform
    - Location
- User Data Collection Methods
- User Model Generation

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Model

- The user model is a representation of information about an individual user that is essential for an AIS to provide the adaptation effects

- Dynamicity factors
  - Static models vs. Dynamic models

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Knowledge

- Indicates the level of expertise a user has on a specific subject
- Application Areas
  - Educational (most common) e.g., expert on Databases
  - Commercial, Medical, …

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Knowledge

- Dynamicity feature
  - Domain dynamicity, e.g., expert on ERDs, novice in SQL
  - Time dynamicity, e.g., now expert, In 10 years N/A
- Different modelling approaches
  - Scalar model
- Structural model
  - Overlay model
  - Bug model

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Scalar Model

- Self evaluation or objective testing

- Indicates level of user's domain knowledge
- - Quantitative [0-5]
- - Qualitative [Poor, Good]

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Overlay Model

- Model expertise for each domain fragment
- Domain is divided in fragments
- Indicates level of user's knowledge of a domain fragment

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Bug Model

- Model misconceptions of domain fragment

- Track the user and recognize invalid behavior

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Interests

- Indicates a person's attention or curiosity towards various domain concepts
- Application Areas
  - Information retrieval and filtering systems
  - Web recommender systems

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Interests

- Dynamicity feature
  - Time dynamicity, e.g., short-term interests or long-term interests

- Different modelling approaches
  - Keyword-level
  - Concept-level

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Interest Modelling Approaches

Keyword-level Models

- Weighed-vector of keywords: Process pages to obtain keyword vectors. Automatic document processing
- Open-corpus systems (i.e., expandable corpus of documents)
- Example: News system

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Interest Modelling Approaches

Concept-level Models

- Weighed overlay of a domain model: Documents are assigned to a concept at creation time
- Closed-corpus systems (i.e., discrete corpus of documents)
  - Example: Museum guides

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Interest Modelling Approaches

Hybrid Models

- Concept-level modeling with automatic document processing
- Assign concept on an existing domain model (e.g., ACM topic ontology)

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Goals

- Indicates the user's objective and intention in a system
- Application Areas
  - Information retrieval (e.g., search goal in an electronic encyclopaedia, a commercial electronic shop)
  - Educational (e.g., learning objective in electronic learning system)
  - Application systems (e.g., task in electronic performance support system)

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Goals

- Dynamicity feature
  - Domain dynamicity, e.g., tasks change from session to session
  - Time dynamicity, e.g., primary goal changes within session

- Popular modelling approach
  - Overlay model on a list of available goals the system can recognize

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Goal Recognition Process

- Explicit goal specification
  - User chooses current goal from a predefined list of possible goals
  - User can also specify a new user goal to the list
- Probabilistic Overlay Model
  - Model the user current goal as a probabilistic overlay of the goal catalogue. Each goal of the system maintains the probability that this goals is the current goal
  - Infer the goal through user's interaction. For example, by noting the amount of time a user spends on a topic, the current goal could be inferred through a weighted topic-goal association matrix

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Traits

- Indicate features that define a user as an individual, e.g., personality traits, cognitive factors
  - Application Areas
  - Educational (most popular), commercial

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Traits

- Dynamicity feature
  - No dynamicity

- Traditionally extracted utilizing specially designed psychometric tests

- Widely used traits in Adaptive Hypermedia Systems
  - Cognitive Factors
  - Learning Styles

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Cognitive Styles

- Indicates an individually preferred and habitual approach to organizing and representing information
- Popular theories of individual styles applied in Information Technologies
  - Witkin's Learning Styles
  - Baddeley Working Memory Span
  - Felder/Silverman Index of Learning Styles (ILS)
  - Riding Cognitive Style Analysis (CSA)
  - Kolb's Learning Styles

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Modelling User Context

- Indicates features of the user's working context
  - Application Areas
  - Mobile and ubiquitous systems
- Popular User Context Features
  - User platform
  - User location
- Modeling approach
  - Raw Model, i.e., a set of <name-value> pairs (e.g., <OS, "Android">

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Modeling Mechanisms

- User information collection
  - Explicitly
    - e.g., direct input via Web forms
    - online questionnaires
    - psychometric tests
  - Implicitly
    - e.g., infer information (e.g., interests) about the user through his/her browsing activity

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Model Generation

- Extract knowledge from the navigation behaviour of users on the Web with specific data analysis techniques

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Pattern Discovery Techniques

- **Classification**
- Derive meaning from complicated or imprecise data, extract patterns
- Map a data item to a predefined class

- Used to understand existing data as well as predict how new instances will behave
- High training time causes problems when user models need to be created in real-time

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Pattern Discovery Techniques

Clustering

- Group users with similar characteristics (e.g., common browsing activity)
- Treat clusters as a classification problem

- Recommend purchased or positively rated products from other users in the same cluster
- Users cannot be part of more than one cluster
  - Solution: Fuzzy Clustering

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Classification

- Under machine learning
- Supervised learning
- Learn from past data, classify new data
- The output variable is categorical in nature

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Classification Methodology

- Split data into 2 exclusive sets for training (70%) and testing (30%)

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Clustering

- Identification of natural groupings of things
- Under machine learning
- Unsupervised learning
- No output variable

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Clustering

- Based on past data it assign the data points into clusters
- Cluster number often based on heuristics
- Distance measure to calculate how close the data points are from each other, e.g., based on Euclidian distance
- Methods of analysis
  - Statistical methods such as k-means
  - Neural networks
  - Fuzzy logic

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

K-means Clustering

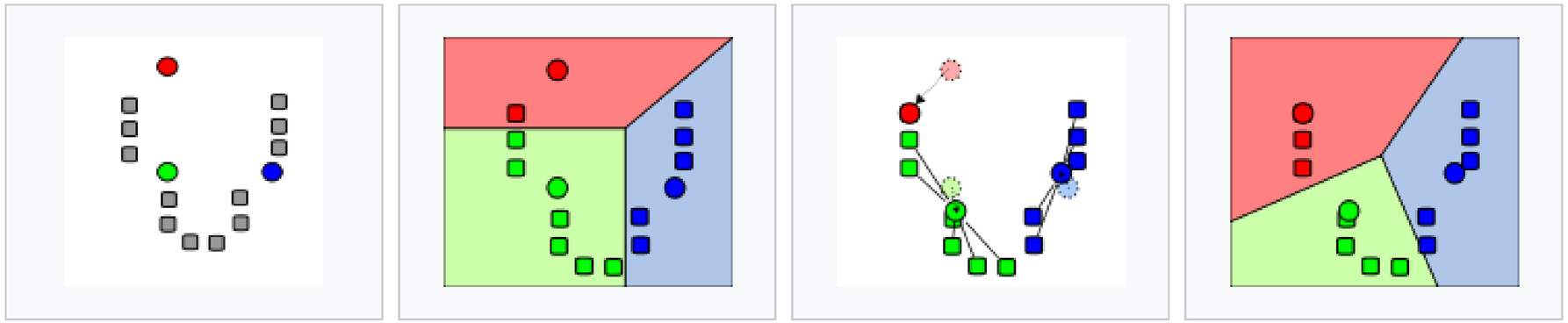
- *k*: Number of clusters
- Step 1: Randomly generate *k* points (=3 in this example) as initial cluster centers
- Step 2: *k* clusters are created by associating every observation (data point) with the nearest mean
- Step 3: Re-compute new cluster centers; the centroid of each of the *k* clusters becomes the new mean
- Steps 2 and 3 are repeated until convergence has been reached, e.g., until assignment of data points becomes stable

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

K-means Clustering



Source: https://en.wikipedia.org/wiki/K-means_clustering

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Association Rules

- Finds relationships between variables
- Under machine learning
- Unsupervised learning
- No output variable
- Also popular in business, known as market basket analysis
  - Famous “relationship between diapers and beers!”

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Association Rule Example

- Input: user interaction and transaction data in an E-Commerce site
- Output: Frequent relationship between items
- Example:
  - “Users who bought smartphone Y also bought the smartphone case Z 80 percent of the time"
- This information can be used to recommend new products to users belonging to the same group of interests

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Adaptation and Personalization

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Types of Personalization

- Link personalization
- Content personalization
- Personalized search
- Context personalization
- Authorized personalization
- Humanized personalization

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Link Personalization

- Adaptation and personalization of the structure and presentation of hyperlinks in an interactive system
- Achieved by selecting the links that are more relevant to the user (e.g., based on interests, preferences), changing the original navigation space by reducing or improving the relationships between nodes, and adapting the presentation of links
- Popular in
  - E-Commerce
  - Educational Hypermedia Systems

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Content Personalization

- Adapting and personalizing the content of the user interface
- Categories
  - Node structure personalization entails filtering the content that is relevant to the users, illustrating sections and information in which the users may be interested
  - Node content personalization is finer grained than structure personalization and involves adapting the information of the same node to various users

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Personalized Search

- The process of tailoring and personalizing the search results to an individual's interests by taking into consideration information about the individual beyond the query provided
- Implemented on the server side as part of a search engine's methods or on the client side on the user's computer (e.g., as a plugin on the Web browser).
- Two general approaches to personalize the Web search results
  - By modifying the user's query
  - By re-ranking search results

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Personalized Search

- Modeling users' information for personalized Web search. This can be achieved through the following techniques:
  - Personalized search based on content analysis in which the system compares and checks the content similarity between Web-pages and user models
  - Personalized search based on hyperlink analysis in which the system computes the personalized importance of Web documents for each user
  - Personalized search based on collaborative approaches in which the system presents similar search results to users with similar user models

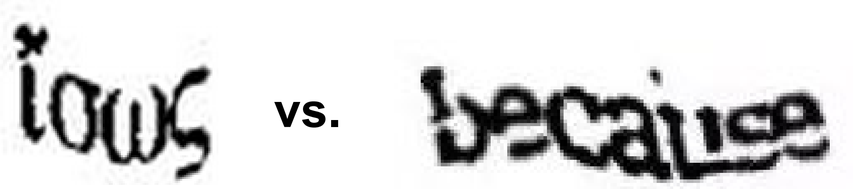
Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Context Personalization

- Adaptation of information that is accessed in different contexts of use
  - User's location
  - Interaction device
  - Physical environment or social context
- Example
  - Text-recognition CAPTCHA mechanism may localize the text-based challenge by presenting characters personalized to the users' localized information



This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Authorized Personalization

- Applied when an interactive system provides different access of information and action permission to users with different roles in the system.
- Role-based access control: access rights in particular sections of a system are categorized under a role name. Most widely known approach
- Team-based Access Control: collaborative team work and incorporates context information (i.e., the members of a team and the object instances) that is associated with collaborative tasks and accordingly applies this context information for access control

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Humanized Personalization

- Aims at creating personalized user interfaces based on intrinsic human factors
  - Emotional factors (anxiety, stress)
  - Personality traits
  - Cognitive styles
  - Learning styles
  - Visual attention
  - Elementary cognitive processing abilities, etc.
- Given the highly complex and multi-dimensional character of these factors, personalizing content and functionality of interactive systems based on such human factors is still at its infancy and not yet widely applied in commercial interactive systems

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Adaptation Mechanisms

- Implementation mechanisms to provide adaptation effects on the user interface based on the user model
- Main adaptation mechanisms
  - User Customization
  - Rule-based mechanisms
  - Content-based mechanisms
  - Collaborative-based mechanisms
  - Web mining
  - Demographic-based filtering

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

User Customization

- The system provides an interface that allows users to construct a representation of their own interests
- System is not considered adaptive but rather adaptable
  - But still this mechanism provides personalized content to the user

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Rule-based Mechanisms

- System has rules to adapt content and functionality based on the user model characteristics
- Online Banking System
  - [USER].logged == False AND [USER].loginattempts.count > 2
  - [UIOBJECT.LiveSupport.show=True]

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Content-based Mechanisms

- Suggest the user links to a specified page by analyzing page content

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Collaborative-based Mechanisms

- Based on the assumption that if users X and Y rate n items similarly, or have similar behaviors (e.g., buying, watching), and hence will have similar interests

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Web Mining

- Web mining includes data mining techniques with the aim to identify patterns from Web systems
- Main categories
  - Web content mining which aims at the extraction and integration of data and knowledge from Web-page content
  - Web-structure mining which aims at the analysis of node and connection structure of a Web-site
  - Web usage mining which aims at extracting useful information from server logs about the interaction activity of users, e.g., discover what users are looking for in a Web-page

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Web Mining

- Applies statistical and data mining techniques on server log data, resulting in a set of useful patterns that indicate users' navigational behavior. Given the site map structure and usage logs, a Web usage miner provides results regarding usage patterns, user behavior, session and user clusters, clickstream information, etc.

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Web Mining

- Data mining methods employed
  - Association rule mining
  - Sequential pattern discovery
  - Clustering
  - Classification
- Web Mining process
  - Pre-processing and data preparation, including data cleaning, filtering, and transaction identification, resulting in a user transaction file
  - Data mining step in which usage patterns are discovered via specific usage mining techniques

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Demographic-based Filtering

- Complements other adaptation mechanisms such as rule-based and collaborative filtering, aiming to refine the personalization result
- Utilizes demographic information of users (e.g., age, gender, profession, etc.) to infer users' interests and accordingly recommend particular objects
- This method uses demographic information to identify the types of users that prefer a certain object and to identify one of the several pre-existing clusters to which a user belongs aiming to tailor recommendations based on information about others in this cluster

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

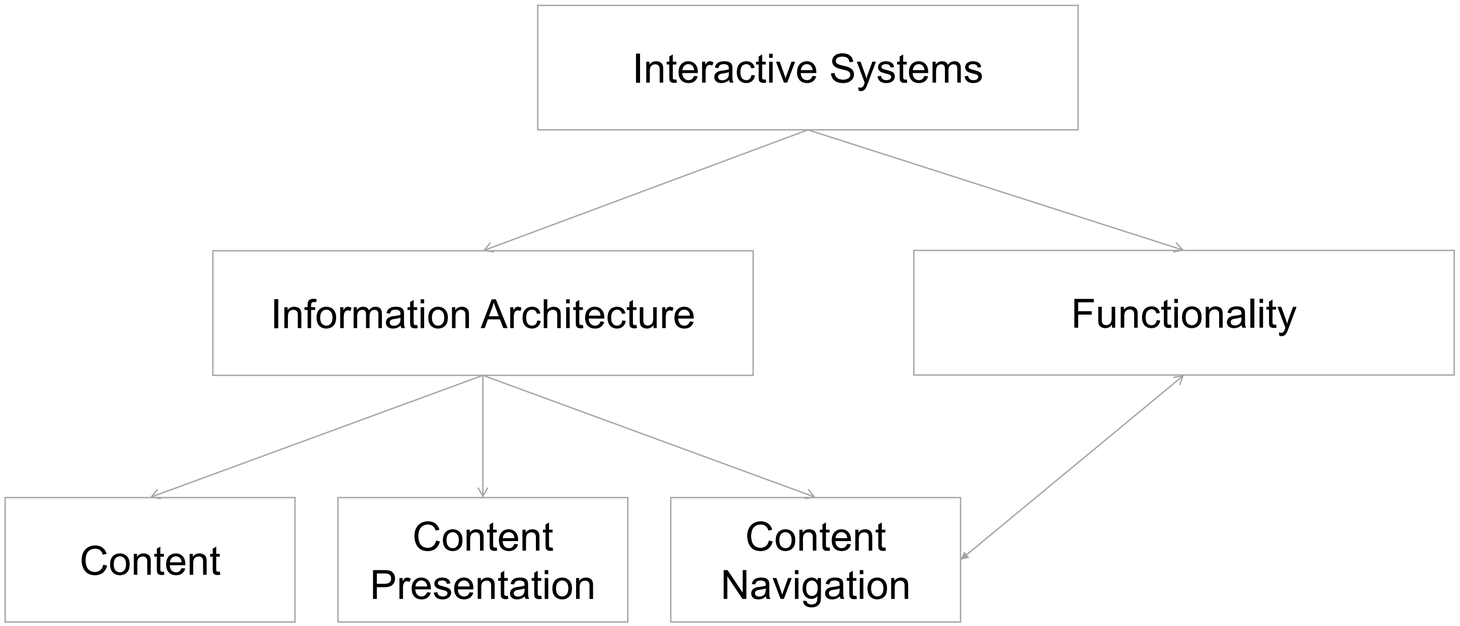
CONTENT 6

Adaptation Effects

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Interactive System Architecture - What to Adapt?



This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

What to Adapt?

- An important adaptation issue is which visible features of the system can be adapted by a particular technique
- Two main classes of adaptation technologies
  - content-level adaptation, called adaptive content presentation
  - link-level adaptation, called adaptive navigation support
- *Adaptive presentation* relates to the adaptation of hypermedia elements inside nodes
- *Adaptive content navigation support* relates to the adaptation of links inside nodes, indexes and maps

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Adaptation Effects in UIs

- Content-level adaptation
  - Adapt the hypermedia elements (or content fragments) of a node
- Link-level adaptation
  - Adapt the presentation of hyperlinks within a node in order to support user navigation in the hyperspace

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Content-level Adaptation

- Inserting/removing fragments
- Expanding/Collapsing fragments
- Altering fragments
- Sorting fragments

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Link-level Adaptation

- Direct Guidance
  - “Guide” the user by suggesting the “next best” node to visit
  - Emphasize existing hyperlinks or generate a new “next” hyperlink
- Link Ordering
  - Prioritize all hyperlinks of a node that are relevant to the user to the top
- Link Hiding
  - Restrict navigation space by hiding hyperlinks to irrelevant nodes
  - Variations
    - Remove
    - Hide
    - Disable

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 6

Link-level Adaptation

- Link Annotation
  - Augment the hyperlink with additional information about the node behind the annotated hyperlink, with some form of annotation
- Link Generation
  - Dynamically create new, non-authored hyperlinks on a Web-page

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action
No 2020-EU-IA-0087, co-financed by the EU CEF Telecom
under GA nr. INEA/CEF/ICT/A2020/2267423

CONTENT 4

Sources and further readings

- Germanakos, P., Belk, M. (2016). Human-Centred Web Adaptation and Personalization - From Theory to Practice. Human-Computer Interaction Series, Springer, doi: 10.1007/978-3-319-28050-9

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

MAI4CAREU

Master programmes in Artificial Intelligence 4 Careers in Europe

Thank you.

Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423