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An Intelligent Recommender System for E-learning Process Personalization

A Case Study in Maritime Education

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Presenter's Resume

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  - Post-doctoral Researcher (Athens University of Economics and Business)
    - Title of postdoctoral research: "Advanced data analytics and knowledge discovery for e-service customization"

- Education
  - PhD in Information Systems (National Technical University of Athens)
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Outline

- Introduction
- Research Methodology
- Results
- Conclusions & Future Work

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Motivation

- The pandemic of COVID-19 caused the closing of classrooms all over the world and forced 1.5 billion students and 63 million educators to suddenly modify their face-to-face academic practices.

- **Higher education institutions** were forced to shift rapidly to **distance and online learning**.
  - On the one hand, this fact revealed the **weaknesses of adoption and utilization of e-learning strategies** and technologies as well as inequalities.
  - On the other hand, it resulted in a **digital revolution of education**.

- **E-learning personalization** is emerged as a major challenge, especially in today's fast adoption of this alternative way of learning.

- Despite the large amount of research works dealing with **learning profiles** in physical classrooms, these models should be further investigated and validated in the **virtual classrooms**.

Research Objective

- The complete transformation of the physical learning process to a virtual one pose the **challenge of personalization according to different learning profiles**, a research area rather underexplored.

- The **objective** of the current paper is to develop an **intelligent recommender system** for supporting the professors in higher education understanding their students' needs so that they **adapt the e-learning process** accordingly.

- In addition, the proposed recommender system is able to **classify new records (i.e. students) to the appropriate learning profiles**, e.g., in order to support the organization of the class groups.

- The proposed approach was applied to a **maritime educational institution**.

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The Proposed Methodology

- The proposed methodology consists of the following steps:
  - Data Collection and Learning Profile Model Selection
  - Classification for Structuring the Learning Profiles
  - Modelling the Relationships between Learning Profiles and E-learning Preferences
  - Predicting the Class Attribute of E-learning Impact

Data Collection and Learning Profile Model Selection

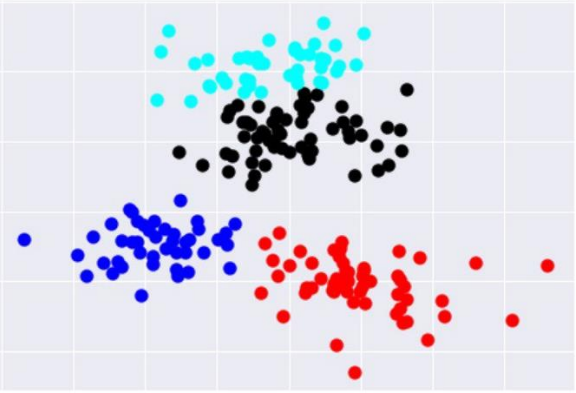
- The data was collected in the form of an online questionnaire addressed to students of higher educational institution.

- 80 questions in a Likert scalescale
  - (1: Strongly Disagree – 5: Strongly Agree)

- Each question was related to one out of the **4 learning styles** as defined by the **Honey and Mumford Model**:
  - **Activist:** *active involvement in the learning activity*
  - **Reflector:** *watching and thinking about what is happening*
  - **Pragmatist:** *learning activities where there is time to observe, reflect and think*
  - **Theorist:** *understanding the theory behind the action*

Classification for Structuring the Learning Profiles

- The classification of students to learning profiles is not straightforward since they may have characteristics of more than one profile.

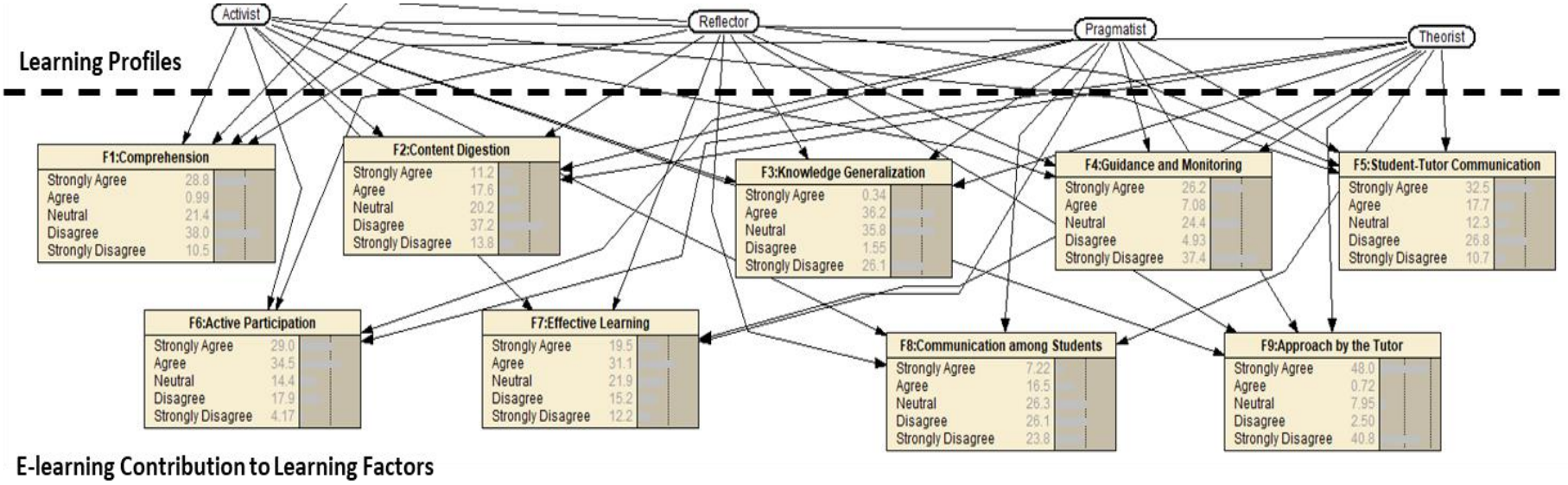


- According to the given answers, the **k-means clustering** algorithm was applied in order to assign the respondents to 4 clusters (k=4) matching to the aforementioned **learning profiles**.

Modelling the Relationships between Learning Profiles and E-learning Preferences

- Subsequently, the proposed approach models the **relationships between the learning profiles and e-learning contribution to learning factors**.

- To do this, a **Bayesian Network (BN)** is applied aiming at identifying these causal and uncertain relationships.



Predicting the Class Attribute of E-learning Impact

- At any time, the user of the recommender system is able to make queries in order to **investigate particular relationships** along with their associated Conditional Probabilities (CP).

- Moreover, the model incorporates a **Naïve Bayes classifier** for **predicting the class attribute of a learning profile** as soon as new records of students' responses are inserted.

- Prediction of the class attribute can be performed even if the questionnaire is not completely answered.

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Application in Maritime Education

- The proposed approach was applied on a **dataset of 268 students** of a **maritime higher educational institution in Greece**.
  - The learning process in **maritime education** faces additional **challenges** due to the structure of their programs, the tendency of undergraduate students to combine studies and work, the internationalization, specialization, and standardization.
  - These make maritime education an interesting case study for the validation of e-learning process personalization.
- The implementation and execution of the experiments were performed using the **sklearn.cluster** library of **Python** for the **k-means clustering** algorithm and the **BN functionalities of the pgmpy (Probabilistic Graphical Models using Python)** package.

Indicative Results

Highest and Lowest Conditional Probabilities (CP)

	E-learning contribution	Learning profile	CP
Highest CPs	F1={Neutral}, F2={Agree}, F3={Disagree}, F4={Agree}, F5={Strongly Disagree}, F6={Disagree}, F7={Neutral}, F8={Strongly Disagree}, F9={Agree}	Activist	0.386
	F1={Disagree}, F2={Disagree}, F3={Agree}, F4={Strongly Disagree}, F5={ Disagree}, F6={Agree}, F7={Neutral}, F8={Neutral}, F9={Disagree}	Theorist	0.295
Lowest CPs	F1={Stongly Agree}, F2={Disagree}, F3={Strongly Agree}, F4={Neutral}, F5={Disagree}, F6={Strongly Disagree}, F7={Neutral}, F8={Strongly Disagree}, F9={Disagree}	Reflector	0.081
	F1={Agree}, F2={Strongly Disagree}, F3={Agree}, F4={Strongly Disagree}, F5={Strongly Agree}, F6={Neutral}, F7={Agree}, F8={Agree}, F9={Strongly Disagree}	Activist	0.056

Classification Performance

	Predicted Positive	Predicted Negative
Actual Positive	TP = 31	FN = 6
Actual Negative	FP = 4	TN = 22

$$Precision = \frac{TP}{TP + FP} = \frac{31}{31 + 4} = 88.57\%$$

$$Recall = \frac{TP}{TP + FN} = \frac{31}{31 + 6} = 83.78\%$$

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Conclusions and Future Work

- In this paper, we proposed an **intelligent recommender system for e-learning process personalization**.
  - It identifies the **preferences of each learning profile** in order to support the selection of the appropriate **learning strategies**.
  - It is based on the **Honey and Mumford Model of learning profiles** and utilizes **k-means clustering** and **BNs**.

- The proposed approach was applied to a dataset of 268 students in **maritime education.**
  - We presented indicative examples of queries.
  - We validated the model in terms of its precision and recall.

- Regarding our **future work**, we plan to:
  - incorporate additional learning factors with respect to the e-learning impact
  - to apply more machine learning and data analytics methods, with an emphasis on fuzzy methods
  - to expand our research to various universities in order to obtain more generalized results.

Thank you!