ADAPTING VET EDUCATION TO LABOR MARKET NEEDS WITH FOCUS ON ARTIFICIAL INTELLIGENCE AND COMPUTER VISION

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Abstract There is an obvious lack of focus on Artificial Intelligence (AI) in multiple levels of education. The paper presents and is a part of the ongoing EU project AIM@VET (Artificial Intelligence Modules for Vocational Education and Training) that covers the development of learning modules aimed at adapting Vocational Education and Training to the needs of the labor market with a focus on AI. There are six partners from Spain, Portugal and Slovenia, where in the Slovenian branch, the University of Ljubljana (UL) and School Center Velenje (SCV) serve as contributing partners, focusing on computer vision aspect of AI. The topics include capturing and curating unbiased data, detection and segmentation, and tracking and recognition. The development process mainly involves UL preparing the content and the SCV teachers transferring the content to students, with both students and teachers providing feedback. The importance of VET education in AI and the significance of ensuring unbiased and fair algorithms are especially emphasized throughout the project.

Keywords: EU project AIM@VET, computer vision, artificial intelligence, vocational education and training, education

University of Maribor Press

DOI https://doi.org/10.18690/um.feri.4.2023.8
ISBN 978-961-286-720-1

PRILAGAJANJE POKLICNEGA IZOBRAŽEVANJA IN USPOSABLJANJA POTREBAM TRGA DELA Z OSREDOTOČANJEM NA UMETNO INTELIGENCO IN RAČUNALNIŠKI VID

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Sinopsis Na večih nivojih izobraževanja je očitno pomanjkanje poudarka na umetni inteligenci (UI). Članek predstavlja zasnovo EU projekta AIM@VET (moduli umetne inteligence za poklicno izobraževanje in usposabljanje) v teku, ki zajema razvoj učnih modulov z namenom prilagajanja poklicnega izobraževanja potrebam trga dela z osredotočenostjo na UI. Projekt vključuje šest partnerjev iz Španije, Portugalske in Slovenije, pri čemer slovenski del predstavljata Univerza v Ljubljani (UL) in Šolski center Velenje (ŠCV), ki se osredotočata na računalniški vid kot delu UI. Teme vključujejo: zajem in urejanje nepristranskih podatkov, detekcijo in segmentacijo ter sledenje in prepoznavanje. Razvojni proces vključuje predvsem pripravo vsebine s strani UL in prenos vsebine s strani učiteljev ŠCV na dijake, pri čemer tako dijaki kot učitelji podajo povratne informacije. Pomen poklicnega izobraževanja na področju UI in pomen zagotavljanja nepristranskih in pravičnih algoritmov sta še posebej izpostavljena skozi projekt.

Ključne besede: EU projekt AIM@VET, računalniški vid, umetna inteligenca, poklicno usposabljanje, izobraževanje

https://doi.org/10.18690/um.feri.4.2023.8 DOI
978-961-286-720-1 ISBN

Univerzitetna založba Univerze v Mariboru

1 Introduction

The main goal of the project is to address the high need for AI-qualified people in the EU by developing AI teaching units for vocational students. Furthermore, the EU's Digital Education Plan 2021 – 2027 emphasizes that in order to support competitiveness, we need people with the latest digital skills [1]. To face this lack of AI understanding in the educational systems, different initiatives are arising worldwide to develop specific curriculum and literacy for AI, mainly at pre-university level, to prepare students in this field in a formal way [2]. The curriculum will therefore focus on advanced digital topics such as AI and aim to provide the students with up-to-date knowledge and skills that companies are looking for. To achieve this, the VET teachers will be for the delivery and feedback of the teaching units and the focus will be on specific AI topics that are relevant to the market.

The target groups of the project are VET schools, VET teachers, VET students, and technological companies in Spain, Portugal, and Slovenia. The project aims to provide support and training to VET schools, teachers and students in Europe to increase their digital skills and knowledge in advanced digital topics like Artificial Intelligence (AI). The goals are to adapt the curricula and courses to labor market needs, improve the digital skills of teachers and students, and provide practical training in areas like computer vision, robotics, and ambient intelligence. Additionally, the project also aims to increase the interest of VET schools and teachers towards innovation in education and provide better prepared professionals to technological companies in Spain, Portugal, and Slovenia to help them compete in the global digital market. A study [3] reports that by the end of the decade 70% of the companies will have some level of AI integration.

The specific objective is to create 3 learning modules and 12 teaching units for each of the three branches (work packages) of the project, namely computer vision, robotics, and ambient intelligence, where each work package will be covered by two institutions from each country:

- Slovenian work island: University of Ljubljana (UL) and School center Velenje (SCV). Focused on the computer vision module.
- Spanish work island: University of Coruña and Integrated Professional Training Center Rodolfo Ucha Piñeiro. Focused on the robotics module.

- Portuguese work island: University of Minho and Caldas das Taipas Secondary School. Focused on the ambient intelligence module.

Each work package will consist of approximately 140 teaching hours, teacher guides, student guides, programming exercises, and additional materials. The teaching methodology emphasizes hands-on, project-based learning, using standard software libraries and real-world tasks. Open simulation environments and real devices will be used to support online and blended learning. The teachers at partner VET schools will play a crucial role in the design and implementation of the learning modules.

2 Computer Vision

The goal of this work package is to develop teaching units and resources in the field of computer vision for VET students and will be covered by the Slovenian group – UL and SCV.

Computer vision is a crucial aspect of artificial intelligence and ranks fourth among all world publications according to Google Scholar metrics for the IEEE/CVF Conference on Computer Vision and Pattern Recognition publication. It utilizes images as input and extracts information from them to make decisions based on their content. Understanding the concepts, methods, and applications of computer vision is vital for future generations to effectively use and adapt them in daily life.

Today, and even more so in the future, cameras are used in a variety of settings, such as industry facilities, smart homes, autonomous vehicles, surveillance, and entertainment systems. The specific objectives are related to these scenarios and cover topics such as the importance of unbiased image data curation, object detection and segmentation, and tracking and recognition. The teaching units will encompass classical and deep learning solutions, with a focus on different learning techniques, knowledge distillation for lightweight modeling, and explainable decisions.

The teaching units will be hands-on and interconnected, providing examples of real-world applications. Most of the solutions will be based on deep learning and will address the challenges of supervised learning, including a lack of data and labeling, as well as introduce semi- and unsupervised learning and knowledge distillation for

embedded systems such as IoT and robotics. The teaching units will be based on tools such as Python, PyTorch, OpenCV and related tools, with the possible use of real cameras to capture and manipulate real-time video streams and split into the following learning modules (LMs).

2.1 Learning Module 1: Capturing and Curing Unbiased and Properly Distributed Data

In recent years, the topic of bias and fairness in algorithms has become increasingly important due to the potential for automated decision-making models to make unfair decisions with significant societal, legal, and ethical implications. These learning modules will address this crucial issue by presenting a comprehensive protocol for collecting, organizing, labelling, and maintaining image datasets that ensures a balanced distribution of samples and eliminates any potential biases. This will be achieved through teaching units designed to educate students on the proper techniques and methodologies for capturing and curating data in a manner that promotes fairness unbiased decision-making and is within the rules of the General Data Protection Regulation (GDPR).

A case incorporating this will be data for recognition scenario and demonstration of failure/success of the recognition model based on the severe bias present/absent in the training data [4, 5].

2.2 Learning Module 2: Detection and Segmentation

The first step in most Computer Vision systems is object or subject detection, where bounding boxes are used to identify the location of the desired object or subject within an image [6]. However, this technique is limited in that it only provides a rough estimate of the object's location [7]. To overcome this limitation, a more detailed technique called segmentation is also used, which labels each individual pixel as being a part of the object or the background. This learning module will build upon the data obtained in Learning Module 1 and cover both object detection and segmentation in detail, providing students with a comprehensive understanding of these fundamental steps in computer vision systems.

A case incorporating this will include data annotation, which will then be fed into a CNN-based model to locate objects in images. Students will observe the importance of not only raw model capabilities but also the importance of training data.

2.3 Learning Module 3: Tracking and Recognition

While processing a single image is a crucial starting point, many real-world applications require a series of images to be processed within a video, providing an additional temporal component. This learning module will show students how to utilize this extra information in a tracking scenario [10] and demonstrate how it can be used to track objects and subjects over time. The goal of a computer vision system is often recognition, which can be used for a variety of purposes, including the recognition of people, objects, soft-biometrics modalities, gestures, etc. [8, 9] This learning module will provide students with an in-depth understanding of recognition techniques and how they can be applied to real-world problems. By the end of this module, students will have a comprehensive understanding of tracking and recognition techniques and be well-equipped to implement these techniques in their own projects.

Figure 1: Example of Python Jupyter script within the learning module for feature extraction, which can then be used for image recognition.

Source: own.

A case incorporating this will include developing various feature extraction techniques, as shown in Figure 2, and comparing them to some of the shallower CNN-based architectures. The goal is for students to see that even simple feature extraction techniques work to some extent and can be very useful even with little programming.

3 Expected Results

The University of Ljubljana (UL) and School Center Velenje (SCV) will work together to develop the teaching units (TUs) with a focus on computer vision to contribute to the adaptation of VET education to the labor market needs. The following sequence of tasks will be followed in the development of TUs, as also illustrated in Figure 2:

- UL, in collaboration with SCV, will conduct an initial analysis of the content and the most appropriate means for practical learning.
- UL will implement the TUs for the different learning modules in a sequential manner. On average, each TU will take around 2 months for the UL team to deliver.
- SCV teachers will implement the TUs with their student group as they are received from UL. The implementation time will depend on the VET school's dedication, but a minimum of 2 hours per week is expected.
- SCV teachers and UL team will have on-demand development meetings to clarify any issues and make improvements to the TUs.
- SCV students and teachers will provide feedback on the implemented TUs.
- UL will integrate agreed modifications and deliver the final version of the TUs.

Both partners will work in parallel throughout the project, with a permanent communication channel to ensure a fluid collaboration. The UL team has the technical responsibility, utilizing their expertise in computer vision research and teaching, while SCV has the educational responsibility, bringing their expertise in VET education requirements.

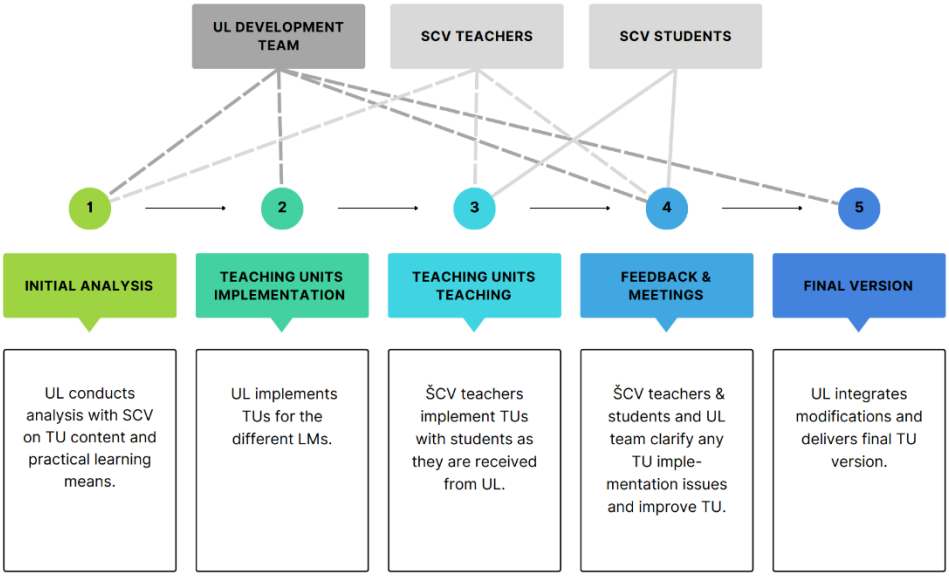

Figure 2: Implementation pipeline.
Source: own.

4 Conclusion

The partnership between, not only the University of Ljubljana and School Center Velenje, but also Spanish and Portuguese partners, presents a unique opportunity to bridge the gap between academia and industry by adapting vocational education and training to meet the needs of the labor market with a focus on AI. We hope that the collaboration will provide students with practical and hands-on experience in capturing, curating, utilizing data, and understanding computer vision algorithms through a series of teaching units. The focus on eliminating biases and promoting fair algorithms is especially important given the potential societal and ethical implications of these systems. The provision of feedback and on-demand development meetings ensures that the teaching units are continuously improved to meet the evolving needs of the field. This innovative approach to education highlights the crucial role that education plays in ensuring that the development and deployment of AI is ethical and responsible.

Acknowledgement

This work was supported in part by the EU Erasmus+ project KA220-VET and ARRS project P2-0214 (B) Computer Vision.

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