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Erasmus+ Programme
of the European Union

Research Methodology and Practice Course (RMPC)

Term: Spring 2022
Class meetings: Once a week and special meetings with individual groups on request
Class size: up to six groups of students (2 - 4 people) per group
Instructors: Martin Lukac, Vitaly Levashenko, etc.…
Pre-requisite courses: Python programming, system programming, preferable previous experience with AI and related technologies

Description

The Research Methodology Course (RMC) is a graduate level course with the aim to teach young researchers the methodology of performing research, leading group projects, achieving given results and presenting the results on an international level. The course is a problem-driven teaching approach to research: a set of research problems are given to students that will form several groups, each solving one particular problem. The course will be organized as a set of discussion sessions with the instructor where problems related to advancing the group projects will be addressed.

Skills and competencies

	Academic Skills
1	Read Scientific Literature
2	Learn through problem solving
3	Make Presentations on the level of International Conferences
4	Solve Problems, Make Decision, Schedule Activities
5	Experience of study via Flipped Classroom and Blended Learning

	Subject-Specific Skills
1	Use of python, pytorch and other python libraries for developing Artificial Intelligence based systems

2	Use python and libraries to understand in depth data science projects and data manipulation
3	Use python and libraries for the implementation of high speed information processing system
4	Learn how to present, communicate and develop research ideas.
5	Learn how to write research papers, work in team and achieve results in research and software development.

At the end of this course the students will gain the following skills:

1. Ability to write scientific papers
2. Ability to work on research projects
3. Understand the research process including topic finding, literature search, perform research activities and deducing significant results

Structure and Organization

The students will be organized in groups. Each group will be working on a single project throughout the length of the course. Each project will be supervised by an adviser or the course instructor. Each group will be submitting an intermediary report as indicated in the class schedule. In addition the students will be presenting intermediary and final presentations as a presentation of current results, problems and achievements.

The class will meet once a week for a brainstorming and instruction session. During these sessions individual groups will be solving problems and ask for guidance from the instructor. All sessions are mandatory to attend by all course members. Several of the sessions will be organized as student group presentations.

For all the groups projects several criteria must be fulfilled. Each group must provide the following items to be properly evaluated:

1. A weekly log file of activities of each member of the team. This log of activities will be used as a part of evaluation in the Attendance grade category.
2. A github repository that will store each group's code. The repository, organization and content will be used to evaluate the Final Project Report.
3. Presentations of the progress with raised problems and provided solutions. These presentations will be used to assess the progress in the Assignments and Interim Presentations category. The final presentation will bear the highest weight in grade terms.
4. A latex based report that will be turned in the final paper (independent of whether it will or won't be published). The paper and its content will be used to evaluate the Final Project Report category.
5. A demonstration of the working code as a part of final assessment. The demonstration of the working code will be used to evaluate the final project.
6. Proper documentation of the developed final product. The documentation of the working code will be used to evaluate the final project.

Class outcomes

Active Verb	What will be done/produced	How this learning outcome will be achieved
Design	After the course completion the students will be able to design a group project with clear task separation, time plan and expected outcomes	Students will create a group project in one of the available project topics.
Modify	After the course completion students will be able to analyse previously implemented code for artificial intelligence application	Students will be working on existing platform where they will be replacing subcomponents of processing and observing the results
Write	After the course completion students will be able to write scientific papers	Students will write a paper on their achievements during the term in a continuous manner
Present	After the course completion students will be able to present their work on a level of international conference	Students will present their work and results in a presentation format equivalent to an international conference.

Class Schedule

The expected class is 15 weeks.

Week	Learning topic	Assignment	Deliverables
1	Literature search	Create groups, select projects	
2	Motivation and Problem specification	Assign roles and prepare work separation, project plan	Bibliography
3	Presentation iteration 1		Presentation
4	Writing Introduction	Write Introduction of the final paper	
5	Research Project Iteration 1		Draft Paper 1
6	Presentation iteration 2		Presentation

7	Writing Previous Work	Write the previous work section	
8	Research Project Iteration 2		Draft Paper 2
9	Writing Background	Write the background or methodology section	
10	Presentation iteration 3		Presentation, Draft Paper 3
11			
12	Presentation iteration 4		Draft Paper 4
13	Writing Experiments and Results	Write the experiments and results section	
14	Writing Conclusion	Write the conclusion	Draft Paper 5
15	Final Presentation		Presentation, Final Paper

Grading

Participation: 10%
Assignments and Interim Presentations: 40%
Final Project Report 30%
Final Project Presentation 20%

The larger outcomes

All students attending the class will be provided with advertising material such as pens and block notes with the ACeSYRI logo as a basic gift for participation in the project class.

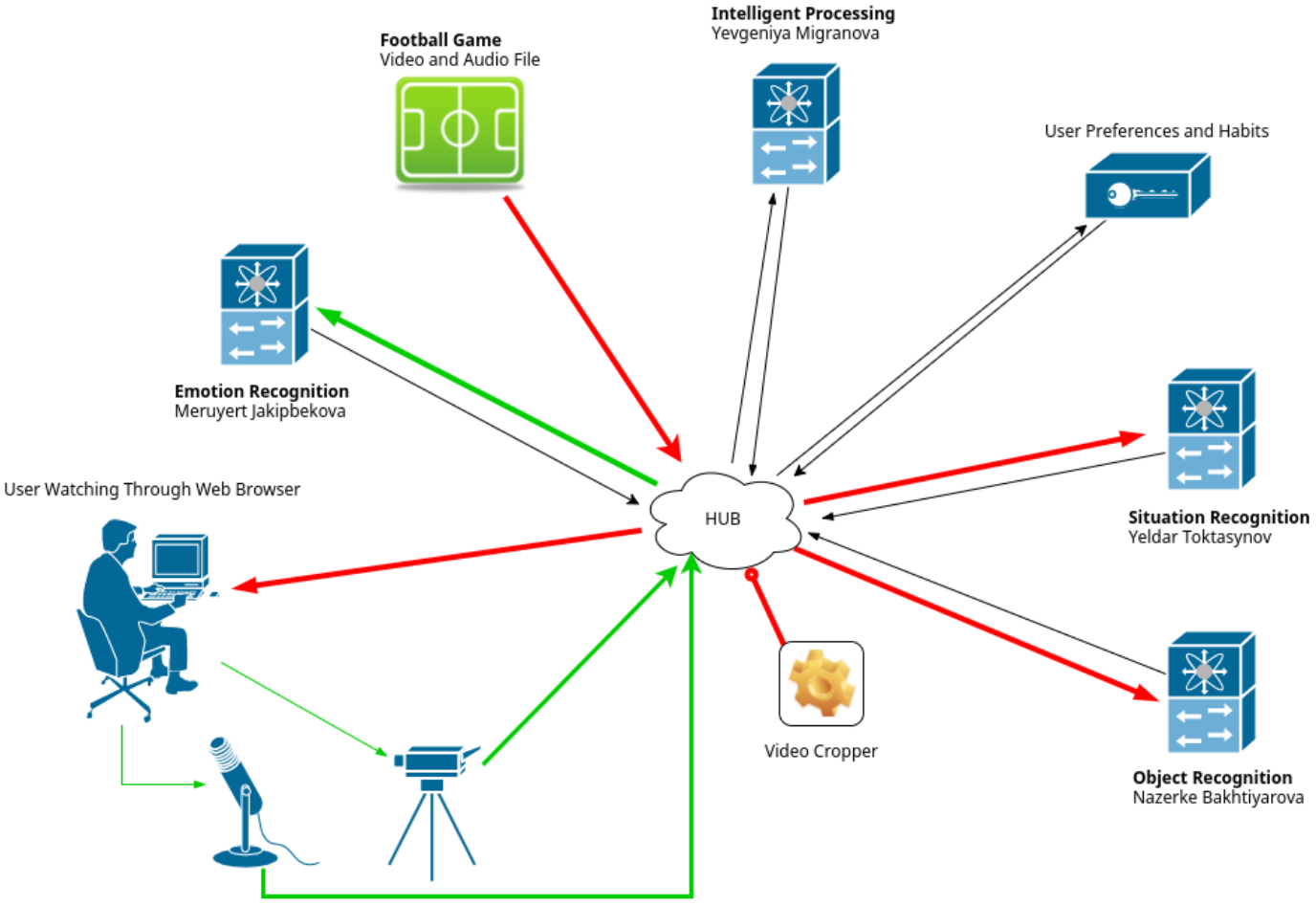
In addition to the standard class structure and due to the involvement of the ACeSYRI CBHE+ Erasmus grant there is expectation that the best group of students will be rewarded in various possible approaches:

1. A few days visit to Zilina, Poland or France to the PI/Co-PI institution of the ACeSYRI initiative for the most successful students of the class. Currently NU can support two students for up to three days in Zilina. Additional students can be supported from the mobility finances of the partners. (It is not clear if only students from Partner universities can be eligible for this)
2. Possibility to publish paper with significant achievements in Scopus indexed journal. Default journal is CERES journal. Submission to a conference is welcome as well.

Example Projects

1. Build a high throughput pipeline for the Live-Feeling Communication Project

In this project the students will have a task to build a high-throughput, multi-computer system. The system target is to transmit a large amount of video data. The schema of the system is shown in Figure below.



The function of the system is to do the following operations:

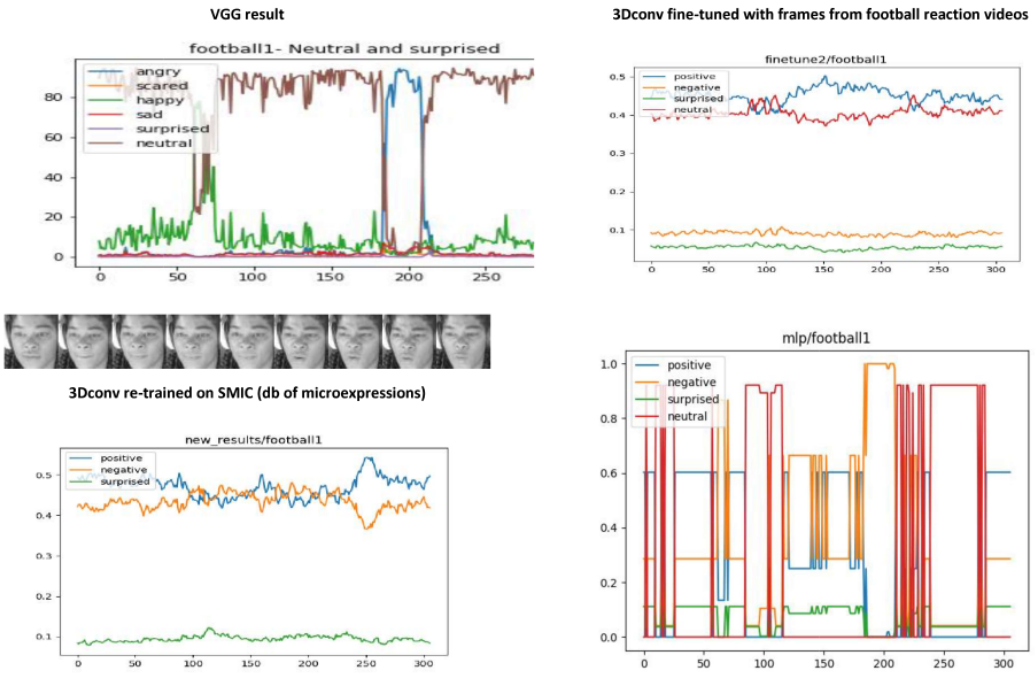
a. Send real time stream of user's video and audio (stream A, green arrow) to the Hub
b. Send one or more real-time streams of a football game audio and video (Stream B, red arrow) to the Hub
c. Send the Stream B to a Situation recognition and Object Recognition and Tracking modules
d. Send the Stream A to an real-time emotion recognition module
e. Return the result of processing Stream A and Stream B to the Hub.
f. Process the results on the Hub (or other networked machine), modify the football stream accordingly
g. Send to the user a modified real time football video game from the Hub

The aim of this project is to determine the best solution for this approach. This would require evaluation of various pieces of software for the load on each remote machine and determine the optimal solution. For instance should the emotion recognition be on the HUB machine or should the football stream processing be on the Hub or should it be on another machine. While such solutions can provide a computational load reduction they will also require the HUB to be very heavily overloaded with networking traffic.

2. Build reliable emotion recognition system for unposed multi-person audience

In this project the students will be confronted with the problem of real-time emotion recognition in a natural environment. The recognition model will be provided but the students will have to solve several unsolved problems:

a. Emotion recognition of occluded faces
b. Emotion recognition of partial faces
c. Emotion recognition from interrupted sequence of emotional recognition
d. Emotion recognition under strains of environmental changes: distance from camera, lightning, image quality etc



3. Build a football action predictor

In this project the students will be confronted with the problem of noise football game object recognition. The general idea is to find the best model to recognize and track the elements of the football game such as players, ball, referees, audience, etc.

For this the students will have to solve the following problems:

a. Find existing CNN models for players and ball detection
b. Evaluate their accuracy and time complexity
c. Implement extrapolation or alternative method of tracking such as detect and track instead of per image detection

4. Build a pipeline for ligand-protein binding prediction