Group coursework worth 100% of your final mark.
LI Software Engineering and Professional Practice & Building Usable Software (34257, 34208, 34258, 34210, 34206, 36987)
School of Computer Science, University of Birmingham, UK, and Dubai
Deadline: Dec 5, 2022, 5:00 p.m. (Firm)

I.   **Challenge Description: Pick <u>ONLY ONE</u> of the below challenges.**

Challenge 1 (brief description): Software Engineering for/with Metaverse: How the Metaverse Could Change our Workplace and Day-to-Day Computing?

The workplace of the 2020s already looks vastly different from what we could have imagined just a couple of years ago. Now, the metaverse promises to bring new levels of social connectedness, mobility, and collaboration to a world of virtual work. The metaverse is poised to reshape the world of work in at least four major ways: new immersive forms of team collaboration; the emergence of new digital, AI-enabled colleagues; the acceleration of learning and skills acquisition through virtualization and gamified technologies; and the eventual rise of a metaverse economy with completely new enterprises and work roles. The metaverse also opens up new possibilities to rethink the office and work environment, introducing elements of adventure, spontaneity, and surprise. A virtual office doesn't have to be a drab, uniform corporate environment downtown: why not a beach location, an ocean cruise, or even another world? Our work colleagues in the metaverse will not be limited to the avatars of our real-world colleagues. Increasingly, we will be joined by an array of digital colleagues — highly realistic, AI-powered, human-like bots. The metaverse could also revolutionize training and skills development, drastically compressing the time needed to develop and acquire new skills. While still in its early stages, the emergent metaverse provides an opportunity for enterprises to reset the balance in hybrid and remote work, to recapture the spontaneity, interactivity, and fun of team-based working and learning, while maintaining the flexibility, productivity, and convenience of working from home.

We are seeking innovative suggestions for applications of your choice: these could be of direct use or of futuristic nature. *The scope is open and can be related to any application you can envision.*

Examples of applications for Challenge 1 may include, but are not limited to:
- Metaverse gaming applications that allow players to interact with other participants within a single interoperable environment.
- Metaverse digital offices/business meetings applications where employees can be trained using a simulated experience.
- Metaverse learning spaces/virtual classrooms applications that enable students to watch live experiments with more intensive and high-quality knowledge resources.
- Metaverse healthcare applications where patients and doctors can interact in virtual 3D clinics.
- Metaverse virtual transport/travelling applications for users who cannot travel long distances.
- Metaverse virtual concerts/entertainment applications.
- Metaverse for mental health.

- Metaverse for supporting children in need.
- Metaverse for promoting sustainability and/or peace in the world.
- Metaverse to support software engineers in their workplace.
- Metaverse social network applications.
- Metaverse applications for promoting equality, diversity, and inclusion.
- Metaverse applications in medicine.
- Metaverse applications for the elderly.
- Real-estate applications that enable prospective buyers to take a tour and explore all possible options in real-time.
- Other applications of societal, economical or entertainment need.

References that relate to Challenge 1 are as follows.
Ref 1. https://hbsp.harvard.edu/product/H06YV3-PDF-ENG?Ntt=metaverse
Ref 2. What is the metaverse? - BBC News (Duration: 3:08) -
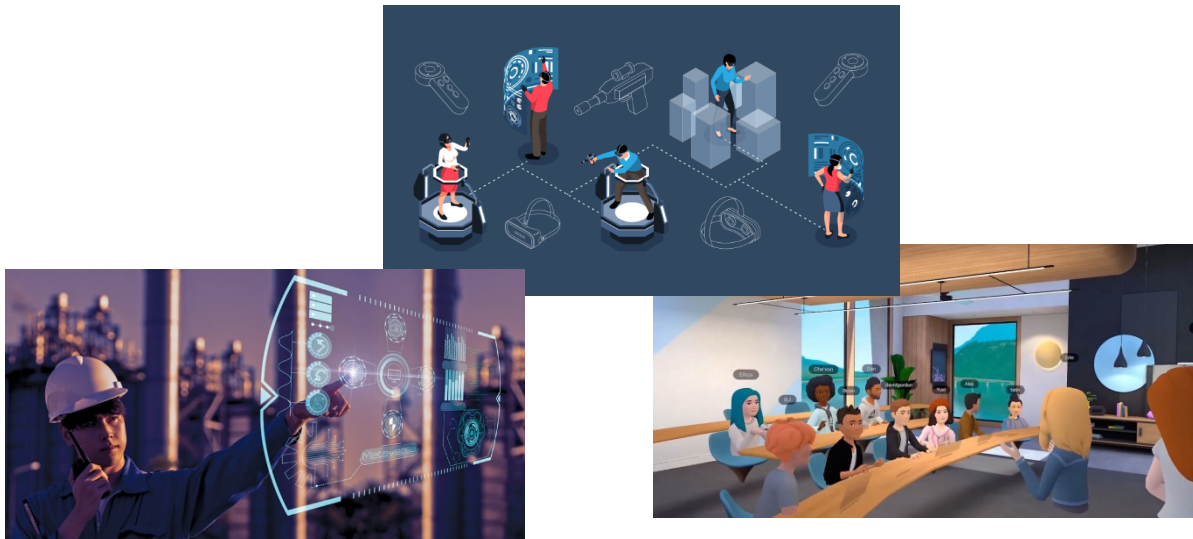https://www.youtube.com/watch?v=V6VsxcVpBVY

Figure 1. Example of existing applications

Challenge 2: Software Engineering for "Smart Cities and Smart Nations" in the Era of Big Data, AI, Blockchain and/or Emerging Technologies.
Data becomes an integral part of our digital economic opportunity leverage. "Smart cities" and "smart nations" are concepts which use big data, Artificial Intelligence (AI), and recently Blockchain technologies to deliver trustworthy, dependable, reliable, and secure smart services to citizens and mass public.

Among the many notable examples are Singapore, Dubai etc. Singapore, as an example, has most of the renowned "Smart City" rankings (e.g. 2020 IMD Smart City Index). Singapore is not trying to become a "smart city," but a "smart nation." Rather than simply optimizing generic urban processes like transportation, waste management, and energy systems, the city-state is pursuing a larger

ambition. It intends to deploy tech in every aspect of the residents' lives, to create a "digital economy," a "digital government," and a "digital society." Since initiating its "smart nation" strategy in 2014, Singapore has launched various "smart" projects (e.g. a digital identity program, e-payment in public transport, or e-health services such as the Moments of Life app). Behind all of these initiatives lies the GovTech agency, in charge of the operational implementation of the "Smart Nation" strategy.

During the Covid-19 crisis, the GovTech agency proved its capacity to quickly deploy digital solutions. In just a few weeks, the public authority was able to coordinate the development of a series of digital tools helping to follow and prevent the spread of the virus. Many of these solutions, like a WhatsApp channel to monitor the number of Covid cases daily, did not require sophisticated technologies. One of the smartest solutions was a simple online digital portal: Safe Distance @ Parks. A digital map showcasing the frequentation rate of every city. Easy to use, it aims at making people adapt their behavior by nudging them to avoid overcrowded parks. Such a fast development of new solutions in times of crisis demonstrates how its "smart nation" strategy has put Singapore at the forefront of both digital nations and connected cities.

We are seeking innovative suggestions for applications of your choice: these could be of direct use or of futuristic nature. *The scope is open and can be related to any application you can envision.*

Examples of applications for Challenge 2 may include, but are not limited to:
- Applications for smart waste management that optimize the efficiency of waste collection and reduce operational costs while better addressing any environmental issues associated with inefficient waste collection.
- Air quality management can capture pollution data in real-time and forecast emissions.
- Building and urban infrastructures planned in a 3D environment to maintain cultural heritage and careful growth into a modern and vibrant city.
- Smart lighting gives light when someone walks past smart lights in order to reduce the need for electrical power. In addition, the smart lighting system shall automatically set the brightness levels and trace daily use.
- A smart metering application that enables citizens to submit meter readings, view their bills and payment status and audit their home usage to manage water consumption.
- Sustainable smart cities and nations applications for CO2 monitoring and control.
- Smart education for providing education and support for the disadvantaged.
- Smart sharing of resources among public (e.g., sharing of unwanted and unused items) for community buildup.
- Smart nation for combating poverty and supporting homeless.
- Smart nations and cities for accessible and affordable homes.
- Metaverse applications (see the above) for smart nations and smart cities.

References that relate to Challenge 2 are as follows.
Ref 1. https://creativeeconomies.com/wp-content/uploads/2022/05/Long-Live-the-Smart-Sustainable-and-Creative-City.pdf
Ref 2. https://cfds.fisipol.ugm.ac.id/wp-content/uploads/sites/1423/2021/02/63-CfDS-Case-Study-Singapore-from-Smart-City-to-Smart-Nation.pdf

Figure 2. Example of existing applications.

II.   Coursework Questions and Instructions – <u>All Challenges:</u>

You software solution has to deal with **<u>ONLY ONE focused application of interest that</u> <u>relate to</u> <u>ONLY ONE of above two challenges.</u>** We are seeking innovative suggestions of applications of your choice: these could be of direct use, of futuristic nature, to change behavior etc. The scope is open and can relate to any application you can envision.

The possibilities for Challenge 1 and Challenge 2 are endless and we are flexible. Your software solution may also aim at educating and engaging with the concerned individuals and/or public. Your application may wish to use AI, Big data and/or emerging technologies (e.g., virtual and augmented reality, gesture-control interactions, holograms, digital twins, and/or mobile apps among the others- as your group see it fit) for your chosen system. Please note that the University has been investing in Augmented and Virtual Reality technologies see that Collaborative engineering lab opposite to the new Engineering School) and you may wish to feature these in your solution.

We are open to *creative, novel ideas and useful applications of societal need.. We give you the freedom of choice and we do trust your taste!* We hope that your innovative solution will help us showcase the University of Birmingham as a cutting-edge institution in the use of software engineering for metaverse, mobile apps, data science and/or emerging technologies. We also hope to demonstrate the creativity and ability of our software engineering students to conceptualize innovative digital solutions and to demonstrate their technical skills in systematically engineering data science solutions, covering requirements, distributed architecture and design.

A.   Requirements Engineering (Unit 2):

A1. Describe your proposed system in 800 words (or less), stating your own assumptions on the scope of the system. Be precise, concise, and creative! Note, your scope should be reasonable and interesting enough to be handled by group members. **(2 points)**

A2. State the **functional and non-functional requirements** of your system. Use sensible phrasing, grouping and prioritisation as discussed in the sessions. **(2 points)**

B.   Software Specification, Analysis and Design with UML (Unit 3):
Use UML to document the analysis and design of your system to a professional level.

B1. Provide a comprehensive Use Case diagram for your system clearly indicating the

actors involved. Make sure you use stereotype relations such as <<extend>> and <<include>> in your modelling. **(2 points)**

B2. Choose FOUR non-trivial and most critical use cases from your Use Case Diagram described in B1. Provide meaningful documentation (i.e. use case specification) for the chosen Use Cases using pre/post conditions, flow of events. **(2 Points)**

B3. Describe FOUR non-trivial scenarios/stories for each of your chosen use cases in B2. **(2 points)**

B4. Provide an Activity Diagram for TWO non-trivial scenario of interest. It doesn't have to be the same one from previous questions. Make sure you use control nodes/cnditions/branching, swim lanes, and conditions. **(1 point)**

B5. Perform Class Analysis: **(2 point)**

a. Perform noun-verb analysis over your specification:
   Identify the potential classes and potential operations for these classes using what discussed in Lectures.
b. Derive your CRC cards for the identified classes from the last step.
c. Produce a First-Cut Class diagram to combine the consolidated results of using the above two techniques – i.e., noun-verb analysis and responsibility-driven analysis.
d. Detail your Class Diagram. This should provide details on attributes, operations, relationships, visibility, multiplicity, etc) (refer to the class notes).

B6. Provide an Object Diagram for ONE non-trivial scenario of interest. It doesn't have to be the same one from previous questions. **(1 point)**

B7. Provide TWO Sequence Diagrams, each describing a non-trivial scenario of interest. You may take the scenarios you have described in the above exercise, but they don't have to be the same ones. Make sure you use guard conditions, interaction frames (i.e. envelopes), etc. State any assumption you make. **(2 points)**

B8. Provide TWO State Machine Diagrams, each describing a non-trivial object state transitions or component of the system. Make sure you use guard conditions, parallel states etc. State any assumption you make. **(2 points)**

For the above questions that require modelling non-trivial scenarios, you may choose from those that were documented as part of the Use Case modelling (B1) and generated scenarios (B3) as this can simplify your work. Please ensure consistency with your description as much as possible.

C. **Software Architecture Style, Modelling and Evaluation (Unit 3 and Unit 4):** You are now a software architect and need to adopt a sensible architecture style for your system. Your group should work on evaluating two possible architecture candidate styles for your solution. Among the numerous possible tradeoffs, you may consider security, performance, scalability, availability, safety, and/or usability etc. once you evaluate your architecture choices and decisions.

C1. Consider two possible candidate architectures styles. Describe each using UML Components Diagrams **(2 points)**

C2. Provide Deployment Diagrams for each of your candidate architectures of question C1 **(2 Point)**

Your attempt for C1 and C2 should identify the potential components; specify their interfaces; compose the components; Model ports (if any) and subcomponents (if any).

C3. In no more than 400 words, compare and contrast your two chosen architectures and the tradeoffs. Your answer should provide a sensible conclusion on which of the two is your preferred option. **(2 Points)**

D. **Software Testing (Unit 5).**

Provide a testing plan of your system, covering SEVEN functional requirements and THREE non-functional. Your plan shall cover the Testing objectives, testing strategy (e.g. black box and white box); and the testing exit criteria. **(2 points)**

E. **Usability and Prototyping (Unit 6).**

E1. Provide an interactive prototype of your system including FIVE main screens, sketching and conceptualizing the main features of your system. You may use one of the selected tools that will be discussed and demonstrated in the class as part Unit 6; however, be free to use an alternative tools as you see it fit – we are flexible! **(2 points).**

E2. Video recording: Suppose that you have to showcase your prototype and project idea to the mass public and/or to seek funding for a startup opportunity. Provide 3- minutes video-demo of your system to showcase your system to non-experts. Use MP4 format. Be creative! **(2 Points)**

F. **Ethics and Professional Practice – (Unit 8) – self-reading:**
Your attempt should follow ethical and responsible design. Provide appraisal using the IEEE/ACM software engineering code of ethics. Your appraisal should not exceed 500 words. **(2 points)**

Quality, Consistency and Maturity. Follow a systematic design for all the above questions. Be consistent in using the naming across all your diagrams and their supporting documentations. Strive for a professional analysis and presentation. Make your own judgment on what to be modeled, documented, and presented **(1 point).**

Project Management and Moderation: This is a compulsory section. Failure to provide this section will risk delaying the marking of your coursework. In no more than 800 words, describe how your team had managed the project to meet the deadline. Describe the contribution of each member to the coursework (name, ID number and e-mail address). Briefly indicate the numbers of feedback session you have signed for. Make sure you carefully discuss and responsibly write this section with the presence of all your group members. We very trust you will be fair, ethical, responsible, and careful in writing this section. If a member has been absent or with no/very little contribution, it is important to explicitly mention this in your report (please highlight it in RED TEXT) to ease tracing when marking **(1 point).**

Submission requirements
- The report should be typed and presented in A4 paper format. The covering page should include your group number, ID numbers, and e-mails of all members in your group.
- Your diagrams should be produced using open source UML packages or Visio. Please be free to use any UML package you are comfortable with.
- Please, do work effectively in group towards meeting the requirements of this coursework. **We will leave it to you to decide on suitable communication platforms for your meeting (e.g., face-to-face/on-campus, Skype, Zoom, MS Team etc)**
- Please submit on Dec 5, 2022 5:00 p.m. to Canvas. Go the "Assignment" section in the canvas module, and select the "Group CWK". Only ONE member of your group needed to submit your group report and recorded video. The system will allow you to update your submission before the deadline. The report file type is limited to doc or pdf. The recorded video must be in mp4.
- Coursework mark computes to 34 points. For your overall mark out of 100, we will do the conversion.
- Additional Canvas submission information and moderation would follow separately– please keep watching the space for our announcements.
- We expect to provide virtual feedback support on your coursework (before submission). Please keep watching the Canvas announcements for any additional feedback and organizational support that you will get as part of the coursework.

Enjoyable Coursework and Good Luck!