Asian Regional Workshop on SciTinyML: Scientific Use of Machine Learning on Low-Power Devices

6-10 June 2022
Online

Further information:
https://tinyML.edu.org/SciTinyML
edu@tinyML.org
### Challenges

#### Future of Jobs

**Human-machine frontier**
Proportion of tasks completed by humans vs machines

<table>
<thead>
<tr>
<th>Year</th>
<th>Machine</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>34%</td>
<td>66%</td>
</tr>
<tr>
<td>2027</td>
<td>43%</td>
<td>57%</td>
</tr>
</tbody>
</table>


#### Future of Jobs

**Skills and talent gaps block industry transformation**
Percent of respondents rating this as a main barrier

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills gaps in the local labour market</td>
<td>60%</td>
</tr>
<tr>
<td>Inability to attract talent</td>
<td>53%</td>
</tr>
<tr>
<td>Outdated or inflexible regulatory framework</td>
<td>42%</td>
</tr>
<tr>
<td>Skills gaps among the organization's leadership</td>
<td>37%</td>
</tr>
<tr>
<td>Shortage of investments capital</td>
<td>37%</td>
</tr>
</tbody>
</table>

# Fastest growing vs. fastest declining jobs

## Top 10 fastest growing jobs

1. AI and Machine Learning Specialists
2. Sustainability Specialists
3. Business Intelligence Analysts
4. Information Security Analysts
5. Fintech Engineers
6. Data Analysts and Scientists
7. Robotics Engineers
8. Big Data Specialists
9. Agricultural Equipment Operators
10. Digital Transformation Specialists

## Top 10 fastest declining jobs

1. Bank Tellers and Related Clerks
2. Postal Service Clerks
3. Cashiers and ticket Clerks
4. Data Entry Clerks
5. Administrative and Executive Secretaries
6. Material-Recording and Stock-Keeping Clerks
7. Accounting, Bookkeeping and Payroll Clerks
8. Legislators and Officials
9. Statistical, Finance and Insurance Clerks
10. Door-To-Door Sales Workers, News and Street Vendors, and Related Workers

**Source**


**Note**

The jobs which survey respondents expect to grow most quickly from 2023 to 2027 as a fraction of present employment figures.
## Businesses’ top 10 skill priorities for 2027

<table>
<thead>
<tr>
<th>Rank</th>
<th>Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analytical thinking</td>
</tr>
<tr>
<td>2</td>
<td>Creative thinking</td>
</tr>
<tr>
<td>3</td>
<td>AI and big data</td>
</tr>
<tr>
<td>4</td>
<td>Leadership and social influence</td>
</tr>
<tr>
<td>5</td>
<td>Resilience, flexibility and agility</td>
</tr>
<tr>
<td>6</td>
<td>Curiosity and lifelong learning</td>
</tr>
<tr>
<td>7</td>
<td>Technological literacy</td>
</tr>
<tr>
<td>8</td>
<td>Design and user experience</td>
</tr>
<tr>
<td>9</td>
<td>Motivation and self-awareness</td>
</tr>
<tr>
<td>10</td>
<td>Empathy and active listening</td>
</tr>
</tbody>
</table>

### Type of skill
- Cognitive skills
- Self-efficacy
- Technology skills
- Working with others

### Source

### Note
The skills which organizations will prioritize in workforce development initiatives from 2023 to 2027.
**Figure 1**

Most employees say their health worsened or stayed the same last year, but more than 3 out of 4 executives believe their workforce’s health improved.

<table>
<thead>
<tr>
<th></th>
<th>Improved</th>
<th>No change</th>
<th>Worsened</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employee perspective on how their well-being changed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical well-being</td>
<td>36%</td>
<td>41%</td>
<td>23%</td>
</tr>
<tr>
<td>Mental well-being</td>
<td>33%</td>
<td>42%</td>
<td>25%</td>
</tr>
<tr>
<td>Financial well-being</td>
<td>30%</td>
<td>33%</td>
<td>37%</td>
</tr>
<tr>
<td>Social well-being</td>
<td>27%</td>
<td>55%</td>
<td>17%</td>
</tr>
<tr>
<td><strong>C-suite perspective on how employee well-being changed</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical well-being</td>
<td>80%</td>
<td>17%</td>
<td>3%</td>
</tr>
<tr>
<td>Mental well-being</td>
<td>77%</td>
<td>20%</td>
<td>3%</td>
</tr>
<tr>
<td>Financial well-being</td>
<td>76%</td>
<td>19%</td>
<td>5%</td>
</tr>
<tr>
<td>Social well-being</td>
<td>77%</td>
<td>20%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Source: Deloitte 2023 Well-being at work survey.
• Rate of automation in industry is growing rapidly, while future engineers across the globe encounter mental health issues; raise potential risks towards engineering safety practices
• 12% of workers in Malaysia experienced serious mental health in the past 2 years.
• To increase safety of engineers and reliability of engineering system designs based on the needs and principles of the Industrial Revolution 4.0.
Boosting Engineering Safety And Reliability for IR 4.0: Integrated Approach of Soft and Hard Skills (BESTARI4.0)
There are two critical challenges in enhancing the safety of engineers and engineering systems in the IR 4.0 era. The first challenge is the lack of new technical skills for designing, operating and maintaining future intelligent engineering systems. The second challenge is the engineering community's lack of familiarity with soft skills. To address the challenges, we aim to develop both soft and hard skills of engineers in a single multi-disciplinary module.
Objectives

1. To develop a hybrid module to enhance the safety of engineers, by integrating soft and hard skills, based on the need and direction of IR 4.0.
2. To deliver modules by holding a series of national-level workshops for the final year students, fresh graduates, and early career engineers.
3. To develop a micro-credential course based on the developed module.

Expected Outcomes

Two micro-credential modules for both soft and hard skills. The modules should demonstrate suitable assessment methods and reporting in a user-friendly manner. The micro-credential should be shareable across multiple platforms including social media, email, blogs, and resumes.

Current Status

40% progress (developing hard skills materials)
Core Team

Marco Zennaro
Lead Investigator (ICTP)

Prof. Ir. Dr. Rosdiadee Bin Nordin
Project Leader (UKM)

Ts. Noor Mohd Helmi Bin Nong Hadzmi
Lead Investigator (IX Telekom)

Prof. Madya Dr. Nor Fadzilah Binti Abdullah
Wireless Communications

Dr. Asma binti Abu Samah

Dr. Rozita Binti Ibrahim
Social Scientist

Dr. Mehran Behjati
Machine Learning

Ili Hazwani binti Zakaria
Research Officer

Dr. Nasrudin Subhi
Social Scientist
<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Module Development (10/22 – 3/23)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>Module materials</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>Development of hard, soft, and integrated skills teaching materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>First trial/test module delivery (4/23 – 6/23)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>Alpha version of the module</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>Delivering test module and identifying downsides of the developed module</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 3</th>
<th>Module improvement and module delivery preparation (7/23 – 9/23)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>Beta version of the module and teaching platforms and facilities</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>Improving module and preparing online and physical teaching materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 4</th>
<th>Module Delivery (10/23 – 3/24)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>6 workshops in hybrid mode</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>IP and Delivering one-year workshop</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 5</th>
<th>Micro credential development (4/24 – 8/24)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>Micro-credential module</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>Development of micro-credential module</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 6</th>
<th>Project closure (9/24)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deliverable:</strong></td>
<td>Technical report</td>
</tr>
<tr>
<td><strong>Milestone:</strong></td>
<td>Providing progress evaluation and technical report</td>
</tr>
<tr>
<td></td>
<td>MODULES</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td><strong>Introduction to Machine Learning</strong></td>
</tr>
<tr>
<td></td>
<td>What is machine learning</td>
</tr>
<tr>
<td></td>
<td>Machine Learning Ethics</td>
</tr>
<tr>
<td></td>
<td>ML Systems Learning Style and Algorithms</td>
</tr>
<tr>
<td></td>
<td>Types of ML Outputs</td>
</tr>
<tr>
<td></td>
<td>Machine Learning Microcontroller</td>
</tr>
<tr>
<td></td>
<td>Deep Learning</td>
</tr>
<tr>
<td>2</td>
<td><strong>Embedded Devices</strong></td>
</tr>
<tr>
<td></td>
<td>Embedded System Design</td>
</tr>
<tr>
<td></td>
<td>Real Time Operating System</td>
</tr>
<tr>
<td></td>
<td>Arduino as Microcontroller</td>
</tr>
<tr>
<td></td>
<td>Benefits of Combining ML and Embedded Systems</td>
</tr>
<tr>
<td>3</td>
<td><strong>TinyML with Edge Impulse</strong></td>
</tr>
<tr>
<td></td>
<td>Edge Impulse with the Nano 33 BLE Sense</td>
</tr>
<tr>
<td></td>
<td>Setting Up Edge Impulse</td>
</tr>
<tr>
<td></td>
<td>Creating Datasets and Program</td>
</tr>
<tr>
<td></td>
<td>Train the ML Model</td>
</tr>
<tr>
<td>4</td>
<td><strong>Examples for IoT</strong></td>
</tr>
<tr>
<td></td>
<td>Building machine learning model</td>
</tr>
<tr>
<td></td>
<td>Security of ML</td>
</tr>
<tr>
<td></td>
<td>Deploy ML on cloud, edge and devices</td>
</tr>
<tr>
<td>5</td>
<td><strong>Assignment &amp; Evaluation</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Relevant Tools for TinyML Micro-credential Course

The MC will leverage a combination of SW & HW tools.

Participants will gain proficiency in using Edge Impulse, Google Colab, and Arduino IDE to develop and deploy ML models on microcontrollers.

By utilizing basic sensors and the Arduino Nano, learners will acquire practical skills in implementing TinyML applications.

Additional tools like Raspberry Pi and TensorFlow Lite expand the possibilities for advanced projects.
### Comparison of BESTARI4.0 with Coursera & EDX

<table>
<thead>
<tr>
<th>Modules</th>
<th>BESTARI4.0</th>
<th>Coursera (Edge Impulse)</th>
<th>EDX (Harvard)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mode of Delivery</strong></td>
<td>Online (early development phase with physical workshop)</td>
<td>online</td>
<td>online</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Max. 40 hours (to fulfil notional hours)</td>
<td>Est. 4 hours videos, 4 hours self reading</td>
<td>Not more than 40 hours (overview for the duration of every videos and reading materials are not shown before launching the lesson)</td>
</tr>
<tr>
<td><strong>Each Video Duration</strong></td>
<td>Under development</td>
<td>Minimum - 2 mins, Maximum - 15 mins</td>
<td>Average 5 mins</td>
</tr>
<tr>
<td><strong>Overview of each subtopics</strong></td>
<td>Depends on the selected microcredential platform to launch the course</td>
<td>Available. Duration for every video, slides and assessment can be viewed before learning time</td>
<td>Not available. Have to launch and join in every modules to view the layout of every subtopic.</td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
<td>at the end of every modules</td>
<td>at the end of every modules</td>
<td>at the end of every modules</td>
</tr>
<tr>
<td><strong>Participant/Instruction Interaction</strong></td>
<td>Both cohort and independent learning</td>
<td>Independent learning</td>
<td>Independent learning</td>
</tr>
<tr>
<td><strong>Pace of Learning</strong></td>
<td>Hybrid (fixed for physical course or self paced for online course)</td>
<td>Self paced</td>
<td>Self paced</td>
</tr>
<tr>
<td><strong>Total modules</strong></td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Indicator of achievement</strong></td>
<td>Handout Project on the last day of the course</td>
<td>Project to be submitted at every module</td>
<td>Project to be submitted at every module</td>
</tr>
</tbody>
</table>
Recruitment of Research Assistant for the soft-skills development

Identifying a suitable micro-credentials platform for the final deliverable

Developing website for visibility

Finalizing hard-skill materials (Machine Learning) for trial/pilot workshop

Construction on hard skills module layout (learning objectives, outcomes and quizzes)

FGD with industry partners (IX Telekom and Aerodyne) and final year students
Focus Group Discussion (FGD)

- To gather data and information on investigating the caused of mental health among engineers in workplace. The survey only done among selected young engineers from IX Telekom on 3rd February 2023.
Moving Forward

Challenges

• So many micro credentials platform to choose!
• Creating a unique content that can differentiate our micro credential course with existing ML courses
• Ensure the learner consistency while pursuing micro-credential – add active learnings?
• Sustainability of the platform; to engage with wider/specific audience

Opportunities

• Integrate into existing degree course on Machine Learning (tech) and social science (soft-skills)
• Recognition & certification of the short course
• Collaboration with a production team to create interesting contents for the short course
• Provide a flexible form of learning
Thank You!

Email: adee@ukm.edu.my
Visit: https://www.ukm.my/bestari40