Regional Hosts for Global Round

1. China
2. Spain 1
3. Spain 2
4. Brazil
5. India
6. Ireland
7. United States of America
8. Japan
9. Turkey
10. Adlik/ZTE
Sponsors and Promotional Partners

Sponsorship

➢ Cisco Systems and ZTE

Challenge Promotion

❖ LF AI Foundation:
  ![LF AI Logo]

❖ SG Innovate (Singapore):
  ![SG Innovate Logo]

❖ Next Generation Mobile Networks Alliance:
  ![NGMN Logo]
We have more than 400 Registrations

Over 50 countries

- Professionals: 45%
- Students: 55%
The Grand Challenge Finale

Tentative Schedule: To take place in mid-December (15 – 17 Dec, 2020)

<table>
<thead>
<tr>
<th>15 Dec, 2020</th>
<th>16 Dec, 2020</th>
<th>17 Dec, 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening Ceremony</td>
<td>Sponsor Session</td>
<td>Invited Talk</td>
</tr>
<tr>
<td>Sponsor Session</td>
<td>Finals Presentation</td>
<td>Sponsor Session</td>
</tr>
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<td>Sponsor Session</td>
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<tr>
<td>Finals Presentation</td>
<td>Invited Talk</td>
<td>Prize Presentation</td>
</tr>
<tr>
<td>Invited Talk</td>
<td>Finals Presentation</td>
<td>Closing Ceremony</td>
</tr>
</tbody>
</table>

**Finals Presentation**: Participants or teams that are invited to take part in the final conference and compete for the ITU Challenge Prizes. 10 - 15 minutes presentation including Q&A.
Participants/Teams across different problem statements will compete for the following titles and prizes:

- **1st prize:** “ITU AI/ML in 5G Challenge Gold Champion”: 5,000 CHF
- **2nd prize:** “ITU AI/ML in 5G Challenge Silver Champion”: 3,000 CHF
- **3rd prize:** “ITU AI/ML in 5G Challenge Bronze Champion”: 2,000 CHF

3 Runners up will receive 1,000 CHF each
ITU Prizes

Host 1
- Team-1
- Team-2
- Team-3
  ...
- Team-N

Host N
- Team-1
- Team-2
- Team-3
  ...
- Team-N

Judges filter

Final event

Judges filter

Internship/collaboration /job offer.....

Top 3 Challenge winning Teams
- 1st prize: 5kCHF
- 2nd prize: 3k
- 3rd prize: 2k

3 Challenge runners up
- 1k each

Honorable mention certificates

300 CHF for winner of each problem statement

Some regional hosts provide additional prizes. Please check their websites
<table>
<thead>
<tr>
<th>PS_#</th>
<th>Title</th>
<th>Current Deadline</th>
<th>Submission Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS-012</td>
<td>ML5G-PHY-Beam-Selection</td>
<td>Test dataset: Sep xxth Submission Deadline: <strong>Oct 15th</strong></td>
<td>upload files to a cloud storage server</td>
</tr>
<tr>
<td>PS-013</td>
<td>Improving the capacity of WLANs through ML</td>
<td>Test dataset: Sep xxth Submission Deadline: <strong>Oct 15th</strong></td>
<td>Email: francisco.wilhelmi[at]upf.edu</td>
</tr>
<tr>
<td>PS-014</td>
<td>Graph Neural Networking Challenge 2020</td>
<td>Test dataset: Sep 30th Score-based evaluation phase: <strong>Oct 1 - 15th</strong></td>
<td>gnnetchallenge &lt;at&gt; bnn.upc.edu</td>
</tr>
<tr>
<td>PS-018</td>
<td>Compression of Deep Learning models</td>
<td>Deadline: October 10th</td>
<td>create a private Github</td>
</tr>
<tr>
<td>PS-019</td>
<td>5G+AI (Smart Transportation)</td>
<td>Deadline: Sep 25th</td>
<td>Email: <a href="mailto:preranam.jnu@gmail.com">preranam.jnu@gmail.com</a></td>
</tr>
<tr>
<td>PS-020</td>
<td>Improving experience and enhancing immersiveness of Video conferencing and collaboration</td>
<td>Deadline: Sep 25th</td>
<td>Email: <a href="mailto:fauziyafarheen@gmail.com">fauziyafarheen@gmail.com</a>, <a href="mailto:amitg@dview.ai">amitg@dview.ai</a></td>
</tr>
<tr>
<td>PS-021</td>
<td>5G+ML/AI (Dynamic Spectrum Access)</td>
<td>Deadline: Sep 25th</td>
<td>Email: <a href="mailto:amit.oberoi@alumni.iitd.ac.in">amit.oberoi@alumni.iitd.ac.in</a></td>
</tr>
<tr>
<td>PS-022</td>
<td>Privacy Preserving AI/ML in 5G networks for healthcare applications</td>
<td>Deadline: Sep 25th</td>
<td>Email: <a href="mailto:prashantchugh1234@gmail.com">prashantchugh1234@gmail.com</a></td>
</tr>
<tr>
<td>PS-023</td>
<td>Shared Experience Using 5G+AI (3D Augmented + Virtual Reality)</td>
<td>Deadline: Sep 25th</td>
<td>Email: <a href="mailto:ankur@hike.in">ankur@hike.in</a>, <a href="mailto:neerajku@hike.in">neerajku@hike.in</a></td>
</tr>
<tr>
<td>PS-025</td>
<td>ML5G-PHY-Channel Estimation @NCSU:</td>
<td>Submission Deadline: <strong>Oct 15th</strong></td>
<td>Email: <a href="mailto:ml5gphy.ncsu@gmail.com">ml5gphy.ncsu@gmail.com</a></td>
</tr>
<tr>
<td>PS-031</td>
<td>Network State Estimation by Analyzing Raw Video Data</td>
<td>Submission deadline: September 20th</td>
<td>Email: <a href="mailto:5gc@nakao-lab.org">5gc@nakao-lab.org</a> or <a href="mailto:rising-itu-support@mail.ieice.org">rising-itu-support@mail.ieice.org</a></td>
</tr>
<tr>
<td>PS-032</td>
<td>Analysis on route information failure in IP core networks by NFV-based test environment.</td>
<td>Submission deadline: September 20th</td>
<td>Email: <a href="mailto:info_itu5G_jp@lists.cc1g.kddi-research.jp">info_itu5G_jp@lists.cc1g.kddi-research.jp</a></td>
</tr>
<tr>
<td>PS-036</td>
<td>Using weather info for radio link failure (RLF) prediction</td>
<td>Deadline: <strong>Oct 15th</strong></td>
<td>Email: aydin.cetin[at]turkcell.com.tr</td>
</tr>
</tbody>
</table>
ITU AI/ML in 5G Challenge: Submission

ITU recommends (or encourages) Open Source submissions for the Challenge solutions

- documentation
- code
- results
- etc

We have created a GitHub page - please submit your solutions using this platform


Each problem statement or challenge will have a Repo associated with it
Any Questions?

Email: ai5gchallenge@itu.int

Slack: join
ITU AI/ML in 5G Challenge Open House and Roundtable No. 2

19 August 2020

Prashant Chugh
Group Leader, C-DOT, New Delhi
and
Chair- IEEE Communication Society, Delhi Chapter
E-mail: prashant@cdot.in
prashantchugh1234@gmail.com
The next steps

Assumptions:

• Participant has gone through the problem statement description hosted on ITU web-site
• Participant has seen the video/ppt slides related to the problem, dated 27th July 2020 hosted on ITU web-site
• Participant has taken an overview of references mentioned with the problem statement description and the above mentioned presentation
• Participant has some experience in Deep Learning
The next steps

**Step 0:** (Expected Duration: 1 Wk)

- To identify a medical diagnostic problem for which deep learning has been applied in the past and sufficient data & deep learning models exist in literature. For example, this problem may be screening for tuberculosis.

- To run deep learning training and inference for the selected problem using models and open datasets in literature
ITU-ML5G-PS-022: The next steps

**Step 1:** (Expected Duration: 1 Week)
To study more and program simple examples about one or more of the following techniques:
➢ Homomorphic Encryption
➢ Federated Learning
➢ Differential Privacy
➢ Secure Multi Party Computation

**Hint:** Each of the above technique can be taken up by different team members as well

**Step 2** (Expected Duration: 1 Week)
Simulate Private Datasets by Appending Privacy Information to open Datasets used in Step 0
Step 3A
Set up for demo in case using Homomorphic Encryption (ED: 2 Wks)
Step 3B
Set up for demo in case using Federated Learning (ED:2Wks)
Step 4: Conclusion (ED: 1Wk)

• Check through packet dump on Central Server that Personal Identifiable Information cannot be deciphered
• Make Report for Evaluation

Additional Steps for Advanced users
• Do Step 3C similarly for Differential Privacy
• Do Step 3D similarly for Multi-Party Computing
• Compare 3A, 3B, 3C, 3D
• Combine two or more of 3A, 3B, 3C, 3D to combine their advantages
Questions from participants ?
e.g. take example of available sensors
- scenario-0: What are the sensor inputs that I can assume?
- scenario-1: pick 1 problem in scenario understanding. E.g. pothole handling
- scenario-2: what are the inference outputs possible for this problem?
- how to verify my output?

• Scenario 0: Smartphone’s IMU data: accelerometer, gyroscope, magnetometer readings, camera data: monocular, stereo: RGBD data, LiDAR (point clouds), GPS

Available datasets:

http://www.cvlibs.net/datasets/kitti/

https://idd.insaan.iiit.ac.in/evaluation/an19-leader-board/
ITU-ML5G-PS-019

• Scenario-1: pick 1 problem in scenario understanding. E.g. pothole handling
• scenario-2: what are the inference outputs possible for this problem?

Datasets:
- IDD dataset: 237 pothole annotations

Problem Statement: E.g. Pothole localization and alerting the driver for lane change
Inputs: RGB or RGBD data, Method: Use vision and depth to get the drivable path and detect pothole, depth would further assist, Output: Recommendation to driver to do lane shift as pothole ahead.
• How to verify my output?  
  https://sites.google.com/view/iitd5g/challenge-problems/5g-ai-smart-transportation/evaluation-criteria

Depending upon the problem chosen, metrics would differ:

-Semantic segmentation: mIoU
Mean IoU is defined as the average IoU or Jaccard Index over all classes.
It is defined as the area of intersection between the predicted segmentation regions and the ground-truth, divided by the area of union between the predicted and the ground truth:

\[
mIoU = \text{mean}\left(\frac{A \cap B}{A \cup B}\right)
\]

-Object localization: Precision / Recall / F1 score are popular metrics for reporting the accuracy of Object detection/localization models. Recall and Precision can be defined for each class, as follows:

\[
\text{Precision} = \frac{TP}{TP + FP} \quad \text{Recall} = \frac{TP}{TP + FN}
\]

F1-score indicates the harmonic mean of precision and recall:

\[
F1\text{score} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}
\]
MLFO Functionalities

Functionalities of the MLFO:

- MLFO can monitor & manage ML pipeline
- Policy-based ML pipeline deployment
- Optimal placement of ML pipeline nodes in the network
- Intent-based specification
- Standard representation
- Interoperable integration of data handling [ITU-T Y.3174], [ITU-T Y.3173], and ML marketplaces [ITU-T Y. 3176]
- Chaining/split of ML pipeline nodes, selection of ML models, monitoring model performance, reselection and update
MLFO Reference Implementation Challenge

Implementation of specific concepts including:

• Handling ML Intent from operator: a mechanism for operator specify ML use cases via the ML Intent as specified in [ITU-T Y.3172]

• Control of model management, e.g., selection, training and deployment using MLFO
  • NOTE- No dataset is required for the model management implementation, only meta-data should suffice

• Interaction with ML Marketplace, i.e., ITU-T Y.3176

• Handling of asynchronous operations

• Any other concepts relevant to MLFO functionality or integration
Example-1: ITU-ML5G-PS-024

e.g. Reference point 15 [MLFO <-> ML marketplace]
  - Model_Query API
  - Model_Selection API
  - Model_Discovery_Poll API
  - Model_Discovery_Asynchronous_Update API
  - Model_Deployment API

e.g. Reference point 6 [MLFO <-> Sandbox]
  - Model training trigger
  - model training notification
  - model update trigger request
  - model update trigger response

Participant can pick any API and implement it in a Restful manner.
• Participant should align with attached sequence diagram
• Use a setup with Acumos and ORAN
• Provide adapters for integration with Acumos/ORAN
**Direction:** MLFO → ML marketplace (Model Query)

<table>
<thead>
<tr>
<th>Information element</th>
<th>Type</th>
<th>Mandatory/Optional /Conditional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Optional</td>
<td>Allows query based on model identifier if MLFO has the identifier.</td>
</tr>
<tr>
<td>Model metadata</td>
<td>&lt;Attribute, value&gt; array</td>
<td>Mandatory</td>
<td>Allows query based on metadata.</td>
</tr>
</tbody>
</table>

**Direction:** ML marketplace → MLFO (Model Query Response)

<table>
<thead>
<tr>
<th>Information element</th>
<th>Type</th>
<th>Mandatory/Optional /Conditional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>Enum</td>
<td>Mandatory</td>
<td>Indicates whether the query was successful and whether the conditional information given below are present (e.g. success/failure).</td>
</tr>
<tr>
<td>Model Identifiers</td>
<td>array of String</td>
<td>Conditional</td>
<td>Contains the ID of the models returned from the ML marketplace (if the result == success). If the result == failure, this field is not present.</td>
</tr>
<tr>
<td>Model metadata</td>
<td>&lt;Attribute, value&gt; array</td>
<td>Conditional</td>
<td>Contains the metadata (if the result == success).</td>
</tr>
</tbody>
</table>

**API description:** enables internal ML marketplace to query from external ML marketplace for models that meet the requirements indicated in ML intent.
**API description:** Model select enables MLFO to select a model from the ML marketplace for the ML pipeline subsystem.

**Direction:** MLFO → ML marketplace

<table>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier</td>
<td>String</td>
<td>Mandatory</td>
<td>MLFO already knows the ID from the search.</td>
</tr>
</tbody>
</table>

**Direction:** ML marketplace → MLFO

<table>
<thead>
<tr>
<th>Information element</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>Enum</td>
<td>Mandatory</td>
<td>Indicates whether the select was successful and whether the conditional information given below are present (e.g. success/failure).</td>
</tr>
<tr>
<td>Identifier</td>
<td>String</td>
<td>Conditional</td>
<td>Present only if result == success. Indicates the ID of the model selected.</td>
</tr>
</tbody>
</table>
**Model_Discovery_Poll API for : ITU-ML5G-PS-024**

**API description:** For models that are already deployed in ML pipeline subsystem, MLFO polls for the updated version from the ML marketplace.

**Direction:** MLFO → ML marketplace

<table>
<thead>
<tr>
<th>Information element</th>
<th>Type</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Mandatory</td>
<td>MLFO already knows the ID from the search.</td>
</tr>
</tbody>
</table>

**Direction:** ML marketplace → MLFO

<table>
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<tr>
<td>Result</td>
<td>Enum</td>
<td>Mandatory</td>
<td>Indicates whether the poll was successful and whether the conditional information given below are present (e.g. success/failure).</td>
</tr>
<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Conditional</td>
<td>Present only if result == success.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indicates the ID of the model polled.</td>
</tr>
<tr>
<td>Model metadata</td>
<td>&lt;Attribute, value&gt; array</td>
<td>Conditional</td>
<td>Contains the metadata (if the result == success).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Indicates the updated metadata if the model was updated in Marketplace.</td>
</tr>
</tbody>
</table>
**Direction:** ML marketplace → MLFO

<table>
<thead>
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<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Conditional</td>
<td>Present only if result == success. Indicates the ID of the model polled.</td>
</tr>
<tr>
<td>Model metadata</td>
<td>&lt;Attribute, value&gt; array</td>
<td>Conditional</td>
<td>Contains the metadata (if the result == success). Indicates the updated metadata if the model was updated in Marketplace.</td>
</tr>
</tbody>
</table>

**API description:** For models that are already deployed in ML pipeline subsystem, if/when the model is updated in the marketplace, marketplace will asynchronously update the MLFO.
## Model deployment API: ITU-ML5G-PS-024

**Direction:** MLFO → ML marketplace

<table>
<thead>
<tr>
<th>Information element</th>
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<th>Mandatory/Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Mandatory</td>
<td>MLFO already knows the ID.</td>
</tr>
<tr>
<td>ML pipeline identifier</td>
<td>String</td>
<td>Mandatory</td>
<td>Indicates the ML pipeline which may be deployed in sandbox or underlay.</td>
</tr>
</tbody>
</table>

**Direction:** ML marketplace → MLFO

<table>
<thead>
<tr>
<th>Information element</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>Enum</td>
<td>Mandatory</td>
<td>Indicates whether the deployment was successful and whether the conditional information given below are present (e.g. success/failure).</td>
</tr>
<tr>
<td>Model Identifier</td>
<td>String</td>
<td>Conditional</td>
<td>Present only if result == success. Indicates the ID of the model deployed.</td>
</tr>
<tr>
<td>ML pipeline identifier</td>
<td>String</td>
<td>Conditional</td>
<td>Present only if result == success. Indicates the ML pipeline to which the model was deployed. This may be deployed in sandbox or underlay. This ID may be in the form of a URI.</td>
</tr>
</tbody>
</table>
# MLFO-triggered operations API: ITU-ML5G-PS-024

## Request (pull mechanism): MLFO → ML sandbox subsystem

<table>
<thead>
<tr>
<th>Information element</th>
<th>Type</th>
<th>Mandatory/Optional /Conditional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message ID</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Identifier of the message, indicating “ML-triggered operation”</td>
</tr>
<tr>
<td>Operation code</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Code of the operation to be performed</td>
</tr>
<tr>
<td>Policies &amp; Requirements</td>
<td>Json</td>
<td>Conditional</td>
<td>Metadata including policies, requirements.</td>
</tr>
<tr>
<td>Simulation environment metadata</td>
<td>Json</td>
<td>Conditional</td>
<td>Includes simulation configuration, available resources, time constraints, etc.</td>
</tr>
</tbody>
</table>

## Response (or push method): ML sandbox subsystem → MLFO

<table>
<thead>
<tr>
<th>Information element</th>
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<th>Mandatory/Optional /Conditional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message ID</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Identifier of the message, indicating “ML-triggered operation”</td>
</tr>
<tr>
<td>Response code</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Code of the operation response (OK, Bad request, Error, etc.)</td>
</tr>
<tr>
<td>Response data</td>
<td>(variable)</td>
<td>Conditional</td>
<td>Depending on the request type, different response data types can be provided (e.g., training data set, trained ML model, validated ML model).</td>
</tr>
</tbody>
</table>
**Request:** ML sandbox subsystem → MLFO

<table>
<thead>
<tr>
<th>Information element</th>
<th>Type</th>
<th>Mandatory/Optional /Conditional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message ID</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Identifier of the message, indicating “Sandbox asynchronous message”</td>
</tr>
<tr>
<td>Message code</td>
<td>Integer</td>
<td>Mandatory</td>
<td>Code of the asynchronous message type</td>
</tr>
<tr>
<td>Additional information</td>
<td>String list</td>
<td>Conditional</td>
<td>Additional information related to the message type</td>
</tr>
</tbody>
</table>
References

- ITU-T Y.3176
- ML5G-I-238
Thank You

Q&A
ITU AI/ML in 5G Challenge Open House and Roundtable No. 2
19 August 2020

Neeraj Kumar (neeraku@hike.in)
Senior ML Scientist, Hike Private Limited

Ankur Narang, PHD
VP - AI and Data Technologies, Hike Private Limited
Senior Member IEEE, ACM (India, ESP)

Sponsors: Cisco, ZTE
Organizer: ITU
e.g. take example of Unity
   - scenario-0: how to setup? What are the steps from content -> VR?
   - scenario-1: are there examples of “shared” baselines content?
   - scenario-2: are there development setups? (so that I can reduce hardware dependency)
   - scenario-n: what are the steps to the final demo? Just as an example.

https://github.com/tensorflow/tfjs-models
Scenario 0 : Unity Setup Steps:

1. Link to download unity: [https://unity3d.com/get-unity/download](https://unity3d.com/get-unity/download)
2. Choose "Download Unity Hub"
3. Start Unity Hub Installation.
4. Click on "Skip the wizard" on the bottom left corner.
5. Go to Installs.
6. Install the latest beta version (2020.x.x) and all dependencies (check mark the boxes) by going on "Install" on the left panel and then clicking on "Add".
7. Log/Sign up to Unity by clicking on the icon on the top right corner.
8. Go to settings by clicking the "settings"/"gear" icon on the top right. Go to licence management and choose 'activate new license'. Choose the type and activate.
9. Clone any sample git repository(e.g.: [https://github.com/hsunami10/Unity-Projects](https://github.com/hsunami10/Unity-Projects))
10. Go to the "Projects" in the left pane in unity hub, click on "Add" and fill the path to the cloned repository, then, choose the unity version you just installed and click on the name of the project.


In order to export characters from some external library, we simply need to install the SDK for unity.

Live2d Setup:

2. To generate a 2d character with Live2D and import it to the Unity project.

Follow the given link for tutorials on the same: [https://docs.live2d.com/cubism-sdk-tutorials/getting-started/](https://docs.live2d.com/cubism-sdk-tutorials/getting-started/)
Scenario 1: ARCore as Augmented Reality tool and integration with Unity

- You can place an animal like tiger in the garden using ARCore and it is open source.
- Other use case - using the hand gesture, model can predict the certain do certain activities in live cricket matches like victory sign can be used for showing 6 on paper using ARCore.
- Rendering can be done on Unity, UnReal Engine, etc,
- [https://developers.google.com/ar](https://developers.google.com/ar) - ARCore Developers Guide

Scenario 2: Development Set up - We can use Unity developers guide and programming is done in C# to reduce the hardware dependency. ARCore objects can be rendered using Unity.

Scenario n: Steps for Final demo:

- Step 1: Pick a use case
- Do a 2D or 3D model and incorporate it in ARCore.
- Render it in Unity or Unreal Engine