Term Projects: Applying EC techniques to find optimized DL models for suggested projects or your own project

Fall 2025

V4, *Updated on Oct 27*

Suggested Project 1: Find Defective Pallets

- Jayshop: Empowering disenfranchised and disabled workers through gainful employment
- Video: https://photos.app.goo.gl/7MLvciFa5YoqARHXA
- **Non Disclosure Agreement (NDA) is needed**
- Need GPU

Student Non-Disclosure Agreement (NDA) for Class Dataset

Parties:

- **Disclosing Party:** Professor Dr. Chan-Jin "CJ" Chung, on behalf of LTU ("University").
- **Receiving Party:** _____, Student ID: _____ ("Student").

Date: October __, 2025

1. Purpose

For the sole purpose of completing coursework and assignments ("Permitted Purpose") for the class MCS5993 EC and DL ("Class") during the Fall 2025 semester, the University will provide the Student with access to certain Confidential Information.

2. Definition of Confidential Information

"Confidential Information" refers to the proprietary image dataset known as jayshop's automotive pallet image datasets (the "Dataset"), including but not limited to:

- All images, video files, and visual data.
- All associated annotations, labels, and metadata.
- Any subsets, derivatives, or analysis results created by the Student that include or display the Dataset.

3. Student's Obligations

The Student hereby agrees:

- **Use Limitation:** To use the Confidential Information **solely** for the Permitted Purpose and for no other personal or commercial reason.
- **Non-Disclosure:** To hold the Confidential Information in strict confidence. The Student **will not** disclose, publish, distribute, post online (e.g., GitHub, social media, personal websites), or otherwise share the Confidential Information with any other person or entity.
- **Security:** To use all reasonable measures to protect the Dataset from unauthorized access, copying, or disclosure.
- **No Copying:** Not to transfer or copy the Confidential Information to any person or device not directly involved in completing the Permitted Purpose (e.g., no sharing with other students unless part of a group assignment where all members have signed this NDA).

4. Term and Data Destruction

The Student's access to the Confidential Information shall terminate upon the submission of final grades for the Class. Upon termination, the Student **must** promptly and permanently delete and destroy all copies of the Confidential Information (digital or otherwise) from all personal devices, cloud storage, and storage media.

5. Breach of Agreement

The Student's obligation of non-disclosure shall survive the conclusion of the Class. The Student acknowledges that any breach of this Agreement constitutes a violation of academic integrity and may subject the Student to disciplinary action under the University's Code of Student Conduct, up to and including a failing grade for the Class. The University also reserves the right to seek any available legal remedies for damages caused by the breach.

6. Acknowledgment

I, the Student, have read this entire Agreement, understand its terms, and agree to be bound by them as a condition of receiving access to the Confidential Information.

STUDENT (Receiving Party):

Signature: _____

Printed Name: _____

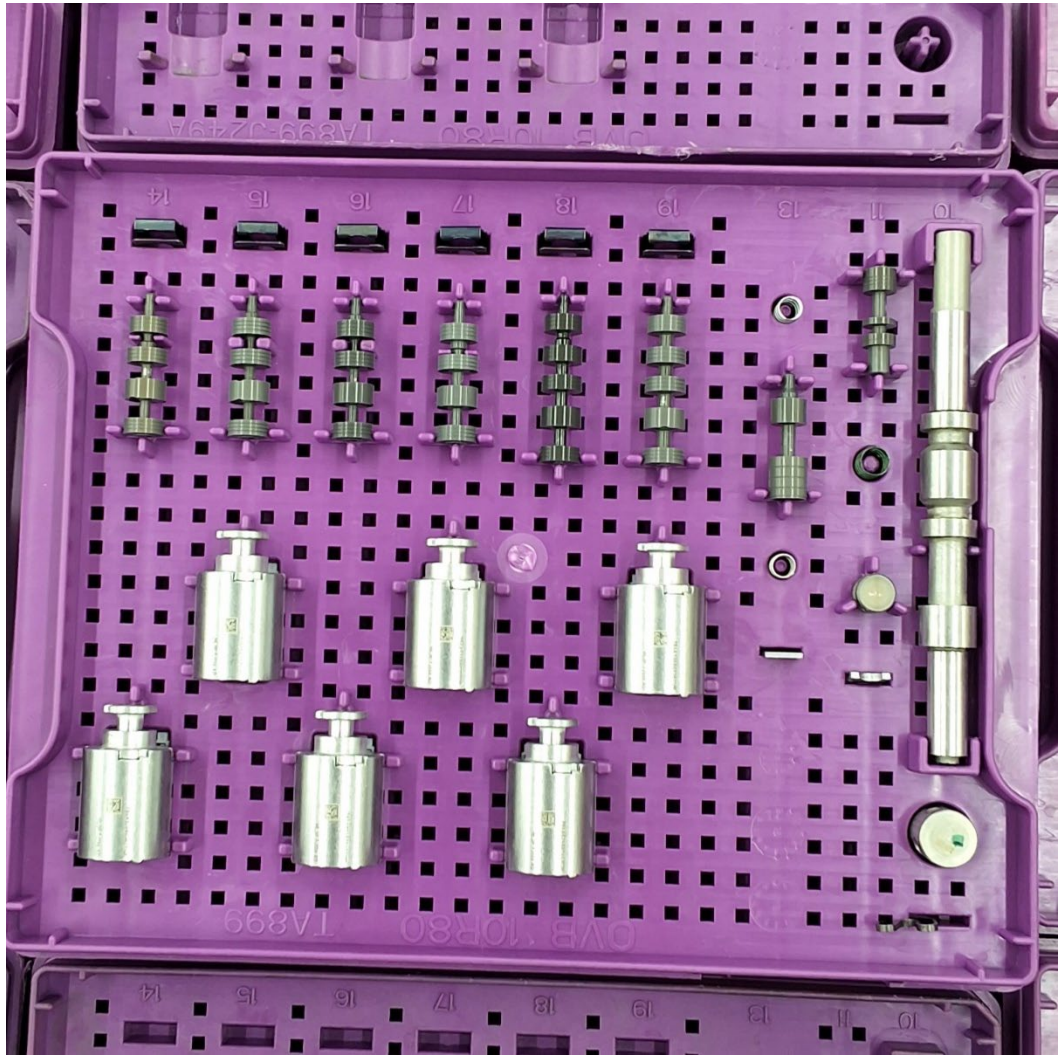
Date: _____

PROFESSOR (Disclosing Party):

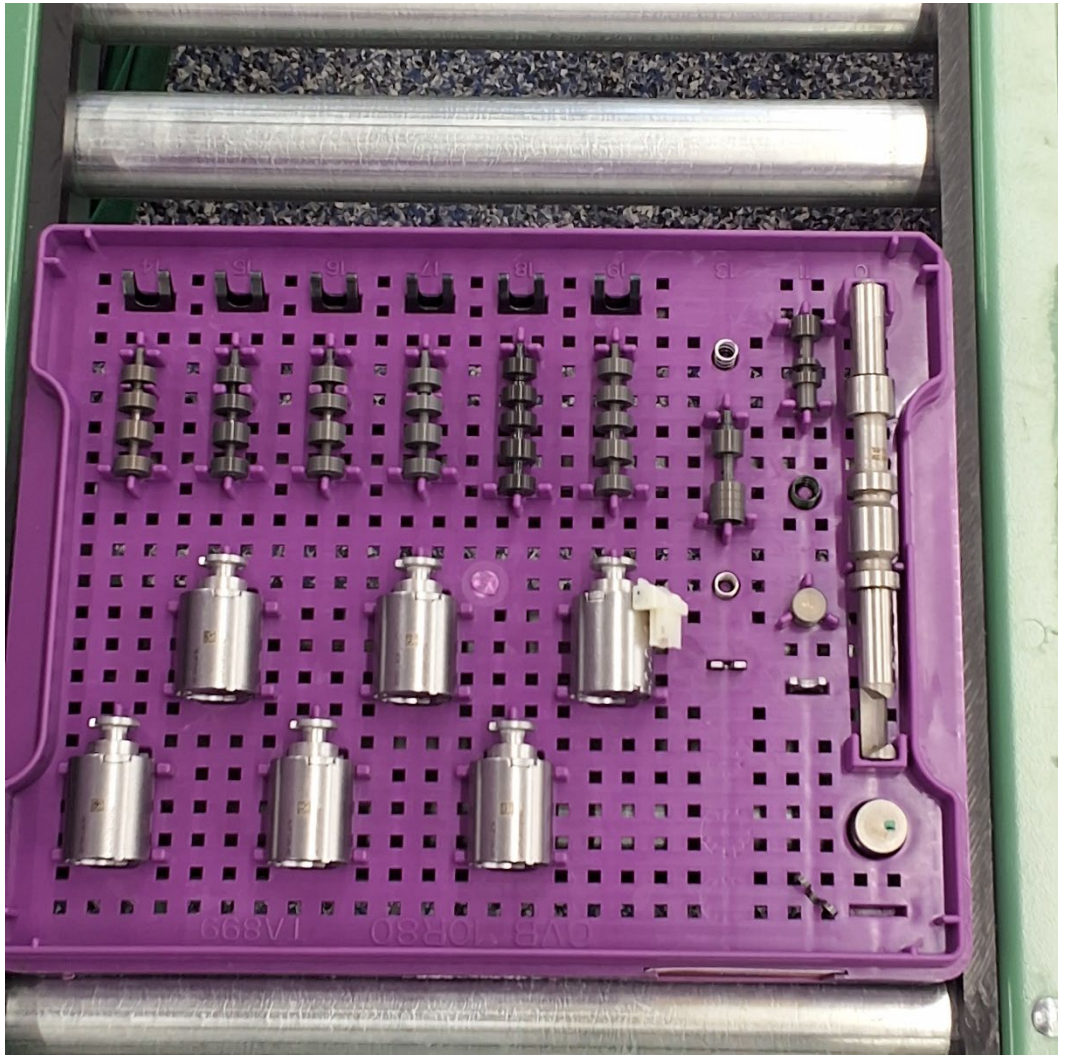
Signature: _____

Printed Name: Chan-Jin "CJ" Chung

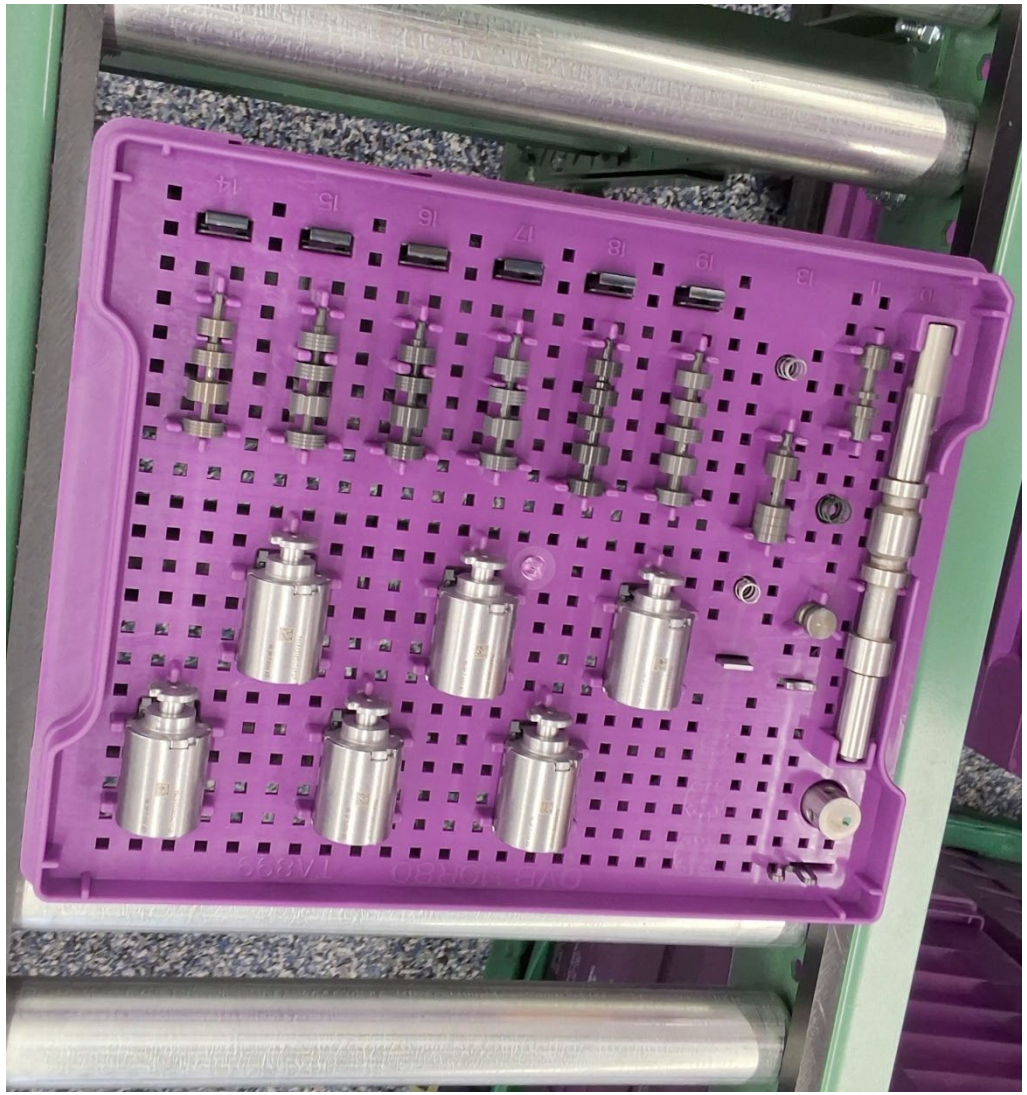
Date: _____



Good



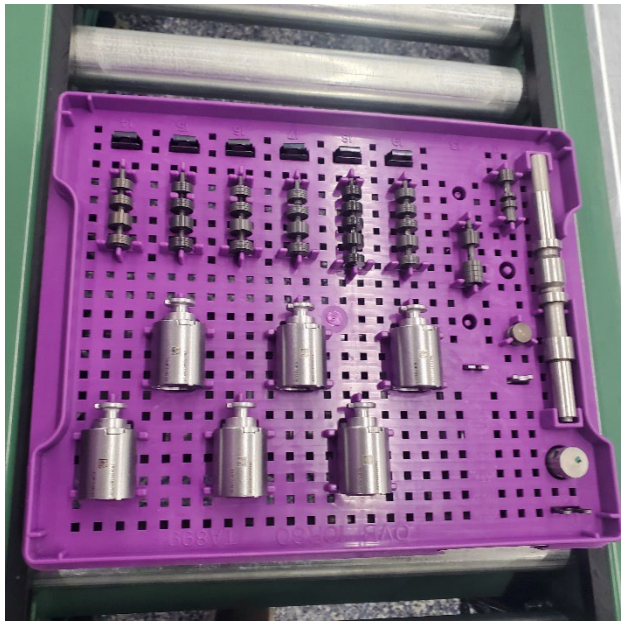
Bad

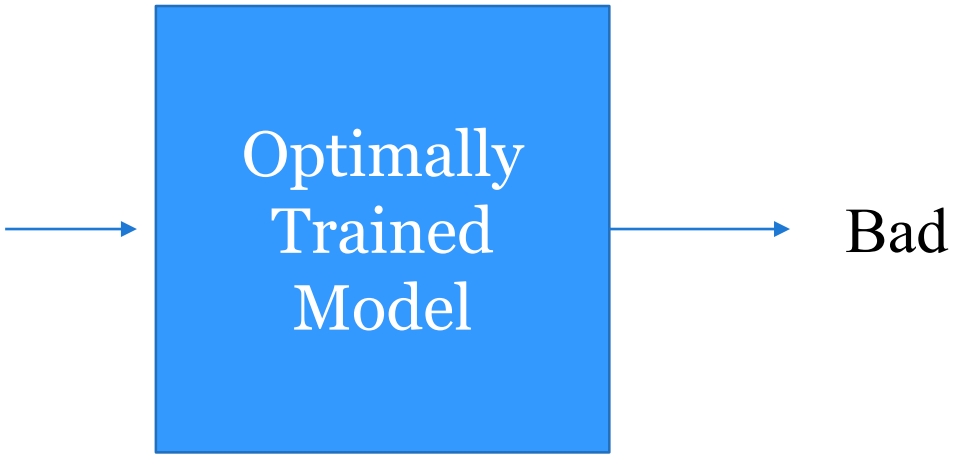


Good

Bad

Test





- ES(1+1) with 1/5 rule
- Another Evolutionary Algorithm
- Random Search

Accessible only for Abdul

```
============================================================
Dataset root: /content/drive/MyDrive/DL_data/jayshop/pallets
============================================================

[test]
  class: bad                  31 images
  class: good                 20 images
  -------------------------
  Total images in test      : 51

[train]
  class: bad                  95 images
  class: good                 67 images
  -------------------------
  Total images in train     : 162

[validation]
  class: bad                  31 images
  class: good                 20 images
  -------------------------
  Total images in validation: 51
============================================================
```

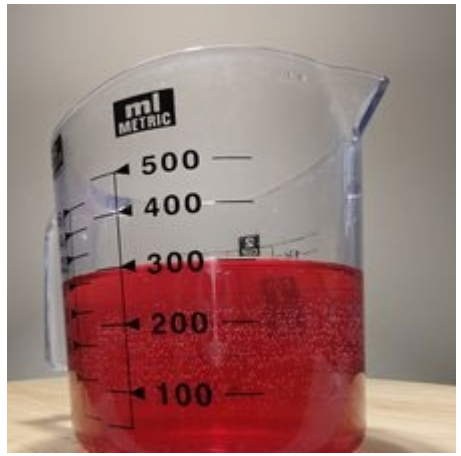
Suggested Project 2: Regression Problem - Estimate the volume of a measuring cup in ML

100 ml

150 ml

200 ml

250 ml



300 ml

350 ml

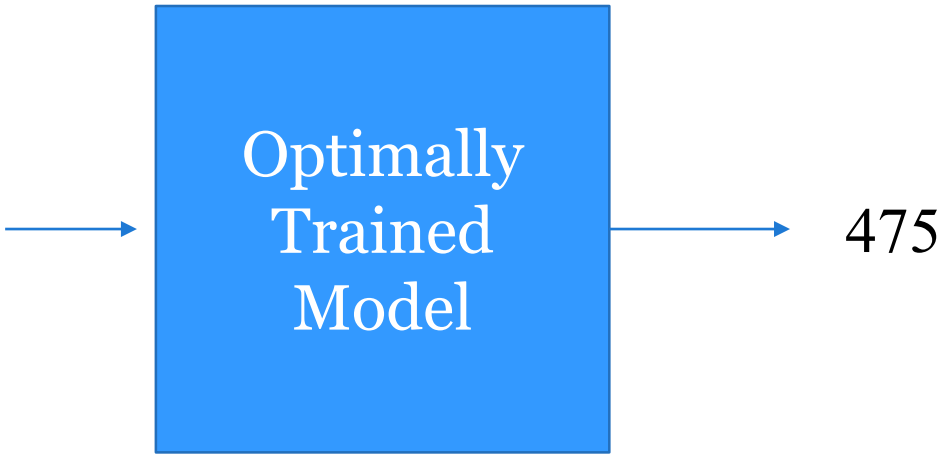
400 ml

450 ml

500 ml

Need GPU

Test



- ES(1+1) with 1/5 rule
- Another Evolutionary Algorithm
- Random Search

Datasets

- No separate validation folder
- Split your training dataset into training and validation sets without creating a separate directory using the **validation_split** and subset arguments in **tf.keras.utils.image_dataset_from_directory**.

```
============================================================
Dataset root: /content/drive/MyDrive/DL_data/mcup
============================================================

[test]
  class: 105                  21 images
  class: 155                  22 images
  class: 205                  44 images
  class: 260                  50 images
  class: 310                  35 images
  class: 355                  44 images
  class: 410                   9 images
  class: 470                  43 images
  class: 505                  43 images
  ------------------------
  Total images in test      : 311

[train]
  class: 100                  43 images
  class: 150                  44 images
  class: 200                  44 images
  class: 250                  44 images
  class: 300                  44 images
  class: 350                  40 images
  class: 400                   4 images
  class: 450                  44 images
  class: 500                  44 images
  ------------------------
  Total images in train     : 351
============================================================
```

Will provide more data later. Please start to test as is.

Dataset Link:
https://drive.google.com/drive/folders/1xSxWOkBX2ZanNMQN2neNeW_0f4PoWzkL?usp=drive_link

Suggested Project 3: Leveraging EC for Your Own Image Classification or regression Problem

- Application must be unique. (Real-world project preferred)
- Required Model Optimization Algorithms
  - ES(1+1) with 1/5 rule
  - Another Evolutionary Algorithm such as using Cov. Matrix or Genetic Algorithms
  - Random Search

Suggested Project 4: Time series forecasting with Multivariate Time Series Datasets – *Extension of HW5*

- ES(1+1) with 1/5 rule
- Another Evolutionary Algorithm such as GA **and** Cov. Mat.
- Random Search
- You may not need GPU

Suggested Project 5: sequence-to-sequence (seq2seq) time series prediction using "Jena Weather Dataset"

- Seq2Seq time series prediction means using past time-series data (a sequence) to predict future time-series data (another sequence) — not just one next point, but several future steps.
- Multi-step horizons (Not just one step ahead, "seq2one")
- Optimize the model using 2 EAs
- https://www.kaggle.com/datasets/harishedison/jena-weather-dataset/data

Suggested Project 6 – Any research oriented project using EC and DL

- Must prepare a draft poster or paper at the end the semester

Use Discussions to express your initial interest

- Choose one out of 6 suggested projects.
- Group project possible up to 2 members
- **Due by Sat. Oct 18**
- Final decision/approval must be done by **Wed. Oct 22**

Project Evaluation

- Completed as planned?
- Functionality: Work as intended?
- User Interface (if applicable): Is the project user-friendly and accessible?
- Complexity: Is the project appropriately challenging for a senior-level?
- Code quality: Is the code clean, maintainable, and well-documented? Are best practices, standards followed?
- Size: not too small for a semester project?
- Others
  - Innovation? Does the project demonstrate creativity or a novel approach?
  - Scalability: Could the project handle growth in users or data volume?
  - Documentation (Poster, Papers)
  - Peer evaluation
  - …

Project Evaluation, Continued

- Expected final product: A poster for “LTU Research Day”, Friday, April 24, 2026
- Clearly specify the author of each result
- Clearly specify the author of each poster section/subsection
- Peer evaluation

Current 10 Project Proposals (as of Oct 27)

Any Changes?

Name	Project Title	Notes	
Jacob Moore	Genetic Algorithms for Partial Quantization of Resnet-18	CIFAR-10	
Abdul Kareem Ansari	Automated Detection of Defective Pallets Using Evolutionary Computation Optimized Deep Learning	CNN+DNN HPO	
V Harsha Vardhan Yellela	Deep Food Image Classifier with Binary Expert Layer: A CNN-HPO Approach with ES(1+1)	Need datasource	OK, but too many classes
Venkata Sayee Joginipally, Anirudh Komaragiri	Regression Problem - Estimate the volume of a measuring cup in ML	CNN+DNN HPO	
Ravali Kamindla, Gouthami Vasam	Time series forecasting with Multivariate Time Series Datasets. (Extension of HW5 from Suggested Project 4)		
Renuka Jayvant Jagadale	Time series forecasting with Multivariate Time Series Datasets (Extension of HW5)		
Fnu Mohammed Abdul Nafeh	Car Damage Cost Predictor Using Deep Learning Optimized with Evolutionary Algorithms	No dataset	OK, but too big dataset
Travis Bowman, Anthony Gabrail	Battery classification and segmentation	No mention about EC	OK, U-Net HPO
Deepak Goud Nalla	Hand Gesture Recognition using Deep Learning	No mention about EC	
Sathwika Kuppirala & Manikanta Jakkidi	Regression Problem: Estimate the volume of a measuring cup in ML(Suggested Project 2)	CNN+DNN HPO	

Quiz #3 on Wed Oct 29 at 7:10pm

- ***Please read the class announcement sent on Oct 27.***

- Questions are from HW4 and HW5. Main goals of them are for HPO (HyperParameter Optimization)
- Some of your solutions are quite different from my sample programs and other classmates' solutions. However, please understand that you must understand my sample code files provided to do well for Qz#3.
- Since this course is mainly for "Evolutionary Computation/Algorithms", there will be **NO** detailed questions about the AirQuailty Time Series model.
- Questions will focus on
  - How to define Hyperparameter vectors (1D array),
  - How to define objective (evaluation) functions, AND
  - How to use ES(1+1) with 1/5 success rule algorithm to find an optimized 1D array.
- Read HW3 and HW4 requirements, too. Some questions will be related to the specific requirements.
- For simplicity for HW5 questions, AirQuality time series prediction problem will not be used. Instead, Much simpler univariate Time Series prediction problem may be used. Therefore, it is recommended to study this program too: TimeSeries_Simple.ipynb
- Quiz style:
  - Fill in the blank fields
  - Fill in the space (structure English or pseudo code is fine)
  - Some True/False or Multiple Questions

Please email me at cchunf@ltu.edu, if you have any questions.

Course Plan, Continued

- HW6 – ES(M+L) and Covariance Matrix Adaptation + 1/5th ?
- 1st Project Presentation on **Mon. Nov 10**
  - Project goals and description
  - Dataset description
  - Any Test Results

} => Poster Abstract

Extra Credit Opportunity 1

- Do the project 5 - sequence-to-sequence (seq2seq) time series prediction using “Jena Weather Dataset”

Extra Credit Opportunity 2

- Do some extra work for your chosen project
  - 4th HPO algorithm
  - Using "Keras Tuner" for HPO.

    https://www.geeksforgeeks.org/deep-learning/keras-tuner-for-hyperparameter-optimization/
    - **Random Search**: Samples hyperparameters randomly from the space; simple but potentially inefficient.
    - **Bayesian Optimization**: Uses past evaluation results to guide the search toward promising regions. It uses probabilistic models (like Gaussian processes) to choose next parameters, aiming for efficiency.
    - **Hyperband**: Uses early stopping and adaptive resource allocation to speed up the search by pruning bad trials early, effectively balancing exploration and exploitation.
- The extra work must be approved by the instructor