Project Name: CP 37 - Self-Organising Map-based Deep Learning Networks
Project Period: Semester 2, 2020
Sponsor(s) or Client: Associate Professor Masahiro Takatsuka
Organisation: The University of Sydney
Project Supervisor: Frank Fu

Background: *The context for this project*	Neural networks have often been difficult to visualize and their behavior hard to explain. Self-Organising Maps (SOMs) present themselves as a possible option to create a novel deep learning network that can be visualized and explained. It may also be a solution to the current curse of dimensionality by summarising the feature space.
Aim *Purpose of the project.*	This project aims to carry out the feasibility research study on building a new type of deep learning networks using Self-Organising Maps (SOMs)
Objectives (SMART): *Goals of the project.*	Implement a web interface allowing an end user to classify and visualise data using a SOM whose parameters and structure can be controlled.
Success Criteria: *What does success look like for the sponsor and how can it be measured.*	Completion of all objectives and implementation of the scope. The sponsor will consider the user experience and functionality of the SOM code and interface. The number of scope items implemented will indicate success.
Deliverables *List the outputs that will be produced as part of the project including the final product or service.*	A minimum feasible product that can create and visualise basic SOMs A web app that can easily be used to create and visualise SOMs based neural networks
Scope *The work that needs to be accomplished in order to deliver/complete the project.*	1) An implementation of SOMs for use as an autoencoder in a deep-learning framework. Should be able to create basic SOM neuron grids, with each neuron having an associated weight vector. The SOM should be able to accept inputted data vectors and compute the dot product between its weight and the input data. The framework should also support multiple layers of SOMs, with further SOM layers taking combinations of the previous SOM layer as its input to capture more complicated features. The weights of the neurons within the SOMs should be updated during training in a way that allows it to best capture clusters in the inputted data. 2) A user interface to use the SOM. A simple web app that allows users to easily input data, train a SOM and produce output from the trained SOM. The user should also be able to specify hyperparameters and the

	structure of the SOMs, which includes features such as the number of SOMs, combinations of SOMs in further layers and other connection parameters. 3) Support classification using the SOMs encoding to create a Learning Vector Quantization (LVQ) neural network. Users should be able to classify their input vectors based on a SOM+LVQ model. This model will use the final layer's SOM as input to the LVQ algorithm. Users should be able to provide input data and receive a classification output for the data after training the SOM. 4) Testing suite for the SOM. Unit tests will be written for all minor functions within the SOM. Examples of this will include distance computation, neighbour selection, BMU (best matching unit) selection, weight adjustment, input vector computation from multiple SOMs, SOM weighting and the LVQ classifier. Overall black-box testing is challenging due to randomisation and a large number of computations. One approach is to test a small (9 node) SOM on a few input vectors with a fixed random seed. 5) Model evaluation metrics and visualisation The product will display accuracy and other evaluation metrics (Precision, Recall, F1 Score, etc). It will also include visualisations such as SOM node activation heatmaps across the neural network layers. This will enable a domain expert to identify primitive and compound feature patterns in 2D and potentially reveal hidden structure within the dataset.
Extension Scope *Optional work that is not required but can be done for extension*	- The ability to automatically determine the optimal SOM structure from inputted data. - Additional metrics for performance to be supported. - Additional visualisations of SOM layers. - The ability to predict values from inputted data
Out Scope *Work you are not required to deliver as part of your project*	- Creating a cross platform app - Implementing complicated SOMs that address the boundary problems that ordinary SOMs face
Milestones *Key checkpoints with the client e.g. client deployment, approval deadlines*	1) A simple frontend supporting the implementation and visualisation of a single SOM will be created first. This will be delivered as a minimum feasible product on 4th October. 2) The LVQ will be implemented to allow classification output to be produced

	3) The creation of multiple SOMs and multiple layers will then be supported and the frontend will be updated to allow users to specify the structure of the SOMs. 4) Model evaluation suite will be produced for the front end 5) If time permits, the optional features will be developed and final product will be delivered 22 November
Human Resources: *Are there other specialist staff or subject matter experts that will participate?*	No
Other Resources: *Are there other resources to be utilized in the project? Data? Equipment?*	Sample data to test and implement the SOMs provided by the client.
Reporting/ Meeting Frequency: *With what regularity will the team meet with the client and report to the client.*	Meeting times are flexible, the client can be contacted on Discord at any time. Ideally, meetings will be held once a fortnight or more frequently if required.

Client signature: 

Date: 23/Sep/2020