Astola H., Kangas A., Minunno F., Mõttus M. (2026). Emulating a forest growth and productivity model with deep learning. Silva Fennica vol. 60 no. 1 article id 25012. https://doi.org/10.14214/sf.25012

Metadata form of Silva Fennica / CODE

This form is designed for writing the elements of metadata, which are used in the description of research materials such as data and codes. The form is based on the work done in the Work Group "Description of research materials" under the Finnish Open Science Coordination.

Item	Description	Responsible
Name of the code	**artisTrain.py**: A stand-alone Python code to train and evaluate a PyTorch model from command line interface in cloud computing facilities. **artisTrainWrapper.py**: A stand-alone Python code for searching the (semi)optimal hyper-parameter values and network structure parameters for the deep neural networks.	Author
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Owner of the material	VTT technical research Centre of Finland, ROR: **https://ror.org/04b181w54**	Author
Publisher	VTT technical research Centre of Finland, ROR: **https://ror.org/04b181w54**	Author
Funder	Research Council of Finland, ROR: **https://ror.org/05k73zm37** European Union (EU), ROR: **https://ror.org/019w4f821**	Author
Description	**artisTrain.py:** A stand-alone Python code to train and evaluate a PyTorch model from command line interface in cloud computing facilities. The program ingests a parameter file (text file) that defines the data sets used, the used model type and architecture parameters, and the parameters for model training. The input data is be provided in two separate text (CSV) files, one including the 25-year growth predictions (named prebasdata_*.csv), and the other the climate data named (WEATHER_*.csv). The climate data may be selected from two options: 1) with yearly averages (*_Y_norm.csv), or 2) with monthly averages (*_M_norm.csv). When run, the program trains the specified model with using the forest field plot data (initial state) and the pre-computed forest variable and	Author

	carbon balance predictions for 25 years in the future as training targets. The process includes also the evaluation of the model using test set data that is independent from training and validation data sets (all included in prebasdata_*.csv) **artisTrainWrapper.py** A stand-alone Python code for searching the (semi)optimal hyper-parameter values and network structure parameters for the deep neural networks. The wrapper contains three separate functions, each dedicated to the different model types (RNN encoder model, sequence-to-sequnce/encoder-decoder model, and transformer model). The wrapper performs a systematic search with the defined input parameter values given in input parameter file. The wrapper results are written in *.csv file. The programs artisTrain.py and artisTrainWrapper.py take the parameter text file as command line input. All the definitions and data set definitions are included in this file (see item: 'Variables' below).	
Methods	The model software tools were written in Python using the PyTorch library with support for GPU computation. A tool (artisTrain.py) was implemented for training the prediction models for the defined variables and for recording the test set performance. Another tool for optimizing the model structure and hyperparameters was implemented as a separate tool (artisTrainWrapper.py). The optimisation of the hyper-parameters and the model training for the performance evaluation was done in a cloud computing cluster provided for the project by the CSC – IT Center for Science Ltd. (Finland). The model training software was run on a computing node of CSC's Puhti supercomputer containing a GPU and four CPUs.	Author
Variables	The description of the variables that control the model generation and evaluation process (artisTrain.py), as well as controlling the model hyper-parameter optimization program (artisTrainWrapper.py), are included in a single parameter file (text file) that is provided as the only command line parameter to the programs. The definitions of the parameters are given in an example parameter file in the code repository (**FC_RNN_GRU_GPU_0_HDBA_yyyymmdd_example.txt**).	Author
Author keywords	Forest growth modelling; Deep neural networks; Recurrent neural networks; Encoder-decoder model; Sequence-to-sequence model; Transformer	Author
Vocabulary keywords (community standard)	NA	Author
Discipline	.	Archive/Repository/Publisher
Type of material		Author

	Model code.	
Language	GBR	Author
Time range covered	NA	Author
Geographic region	NA	Author
Version	NA	Author
File format(s)	Data: text formats (*.csv, *.txt) Code; Python (*.py)	Author
Availability of the materials (open, embargo, registration, limited, registration required)	Open	Author
Justification for access restrictions	NA	Author
Licence	**CC BY 4.0**	Author
Connections with other research materials	1) The material is derived from another material e.g., research data is derived from raw data (IsBasedOn)	Author
Access to the connected research materials	The Sequence-to-sequence model has been developed starting from the code available at: https://github.com/bentrevett/pytorch-seq2seq/blob/master/1%20-%20Sequence%20to%20Sequence%20Learning%20with%20Neural%20Networks.ipynb The RNN encoder model has been developed starting from the code available at: https://github.com/SheezaShabbir/Time-series-Analysis-using-LSTM-RNN-and-GRU/blob/main/Pytorch_LSTMs%2CRNN%2CGRU_for_time_series_data.ipynb The Transformer model has been developed starting from the code available at: https://pytorch.org/tutorials/beginner/transformer_tutorial.html	Author
Codes only: hardware/software		Author

requirements for running the code	A PC or Laptop computer equipped with 13th Gen Intel® Core™ i7-1365U, 1.80 GHz (or similar); 32.0 GB RAM; Windows 10; Python v. 3.9; Pytorch https://www.python.org/ https://pytorch.org/	
Connections to other products of research	NA	Author
Personal data	NA	Author
Confidential or secret data	NA	Author
Publication date	08.01.2026	Archive/Repository/Publisher
Preservation policy	Decision and plan for preserving the material permanently or for a specific time. Justify why this decision was made. Please note that the author is responsible on removing the material after the predefined preservation time.	Author
Permanent identifier (PID)	https://github.com/vttresearch/forest_growth_model_emulator.git	Archive/Repository/Publisher