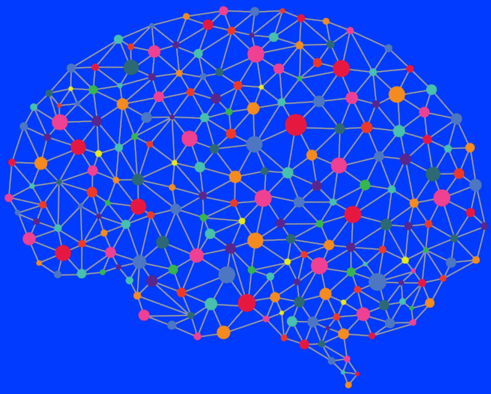
MY_TORCH_

< A CLASH OF KINGS />



MY_TORCH

binary name: my_torch_analyzer
language: everything working on ”the dump”
compilation: when necessary, via Makefile, including re, clean and fclean rules

- ✓ The totality of your source files, except all useless files (binary, temp files, objfiles,...), must be included in your delivery.
- ✓ All the bonus files (including a potential specific Makefile) should be in a directory named bonus.
- ✓ Error messages have to be written on the error output, and the program should then exit with the 84 error code (0 if there is no error).

With your cryptographic innovations, you can now plot against foes and trade with allies—everything's set to claim supremacy over the Iron Throne.

To achieve that goal, you need to send your army to crush your enemies with fire and blood. However, you know -from experience- that even the strongest army can be defeated if they are not properly guided through the use of the deadliest weapon of all: strategy.

Before battling against your foes, you first need to find the optimal strategy to defeat them. You joined the new experimental team of Maesters, that secretly develops a new intelligent weapon that could predict the outcome of any battle, thus giving a huge advantage to the army possessing it. Information is power (or is it power is power?).

To test how efficicent this new weapon is, it will be tested on a smaller scale by simply checking the current state of a chessboard, as we can easily evaluate if it is right or wrong using a regular algorithm.

Project

This project will be split into two parts

- ✓ a **neural network module**,
  a generic module/library that will grant all the tools needed to generate, train, and analyze a neural network.
- ✓ a **chessboard analyzer executable**,
  it can be launched either in training mode, or in evaluation mode.

For this project, it is **MANDATORY** to provide a machine-learning-based solution trained with supervised learning!

In completion, you **SHOULD** provide a professional documentation explaining the results of your benchmarks.

You **MUST** keep every script and training datasets you used to train your network, so that we could *theoretically* generate a new neural network and train it the same way as you did.
You **MUST** push a pre-trained neural network that can be loaded with your analyzer, and its name **MUST** start with "**my_torch_network**". This neural network will be automatically evaluated with your analyzer on the autograder.

You don't have to push your training datasets, as they can get quite heavy. However, you must be able to show them during the Defense.

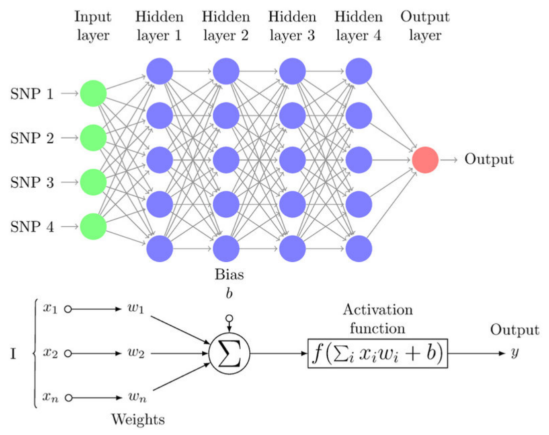
Obviously, libraries handling neural networks (pytorch, tensorflow, ...) are NOT allowed.

The NN module

You need to create a neural network module (or library), that can either be dynamically loaded or directly imported, depending on your programming language. Your module must allow (at least) the following functionalities:

- ✓ Creating a new neural network.
- ✓ Saving/loading a neural network.
- ✓ Training a neural network.

Before training an artificial neural network, you need to think about its hyperparameters.



The more configurable your module is, the better!

Finding a good configuration might be tricky at first, and you might want to try different ones. Therefore, it is advised to find a way to generate blank neural networks. For example, you could:

- ✓ Create a script that would generate new random neural networks from a configuration file. This script could be part of your NN module. For example:

Terminal

```
$>  ./my_torch_generator --help
USAGE
    ./my_torch_generator config_file_1 nb_1 [config_file_2 nb_2...]

DESCRIPTION
    config_file_i   Configuration file containing description of a neural network we want
to generate.
    nb_i         Number of neural networks to generate based on the configuration file.
$> ls
basic_network.conf my_torch_generator
$> ./my_torch_generator basic_network.conf 3 && ls
basic_network_1.nn basic_network_2.nn basic_network_3.nn basic_network.conf
my_torch_generator
```

- ✓ Allow the generation of new neural networks directly in code, using your neural network module.
- ✓ Anything else that comes to your mind (and that would make sense!).

The format used for your possible configuration files and for storing your neural networks is entirely up to you. However, you need to think carefully about what information is really needed!

The analyzer

The analyzer will be used to evaluate your neural network module. Therefore, you need to create an executable that, given a neural network, will either train it (using your NN module), or use it to make a prediction.

Are you concerned about the increase in artificial intelligence?
No, but I'm concerned about the decrease in real intelligence.

Your neural network takes a chessboard as input, and outputs the state of the game:

- ✓ "Checkmate": A player has won ;

✓ ”Check”: A player has the other player's king checked ;

✓ ”Nothing”: Nothing in particular.

Handling stalemates is considered a bonus

Try to go step by step! First, your AI could only differenciate two states: ”Check” (checks and checkmates) and ”Nothing”. Then, as your training algorithm gets more and more sophisticated, try to make your AI differenciate a ”Check” from a ”Checkmate”. And finally, in case of a check or checkmate, try to see if your AI could tell if it's the whites or the blacks that have the advantage!

The chessboards will be represented using the Forsyth–Edwards Notation.

Feel free to design you neural network as you like. However, you'll be asked to justify your **hyperparameters**.

Your design choices matter! Don't forget to benchmark

In prediction mode, your program **MUST** analyze every chessboard in the given file, and give its prediction in the same order as they are listed. In train mode, there are no limitations.

```
Terminal
$> ./my_torch_analyzer --help
USAGE
    ./my_torch_analyzer [--predict | --train [--save SAVEFILE]] LOADFILE CHESSFILE

DESCRIPTION
    --train     Launch the neural network in training mode. Each chessboard in FILE must
contain inputs to send to the neural network in FEN notation and the expected output
separated by space. If specified, the newly trained neural network will be saved in
SAVEFILE. Otherwise, it will be saved in the original LOADFILE.
    --predict   Launch the neural network in prediction mode. Each chessboard in FILE must
contain inputs to send to the neural network in FEN notation, and optionally an expected
output.
    --save      Save neural network into SAVEFILE. Only works in train mode.

    LOADFILE    File containing an artificial neural network
    CHESSFILE    File containing chessboards
```

Terminal

```
$>  cat chessboards.txt | head -n 5
rnb1kbnr/pppp1ppp/8/4p3/6Pq/5P2/PPPPP2P/RNBQKBNR w KQkq - 1 3
rnbqkbnr/pppppppp/8/8/8/8/PPPPPPPP/RNBQKBNR w KQkq - 0 1
rnbqkbnr/pppppppp/8/8/3P4/8/PPP1PPPP/RNBQKBNR b KQkq d3 0 1
rnbqkbnr/pppp2pp/8/4pp1Q/3P4/4P3/PPP2PPP/RNB1KBNR b KQkq - 1 3
8/8/8/8/8/8/8/k1K5 w - - 0 1
$> ./my_torch_analyzer --predict my_torch_network_basic.nn chessboards.txt | head -n 5
Check
Nothing
Nothing
Check
Nothing
$> ./my_torch_analyzer --predict my_torch_network_medium.nn chessboards.txt | head -n 5
Checkmate
Nothing
Nothing
Check
Nothing
$> ./my_torch_analyzer --predict my_torch_network_full.nn chessboards.txt | head -n 5
Checkmate Black
Nothing
Nothing
Check White
Nothing
```

Analysis and Optimization

You will be asked to demonstrate multiple numerical analysis and optimization methods.

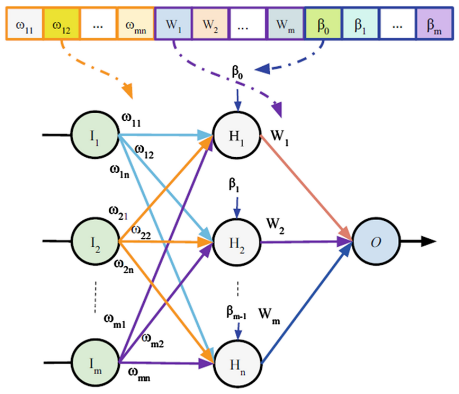
Overfitting

One major issue with machine learning is overfitting. Your program **MUST** try to avoid that during the training process.

Hyperparameter optimizations

During the training phase, your cost function may converge toward a *local minimum*, and get stuck. Playing with the learning rate and randomness could help unstuck it, but you could use a better approach in order to optimize the learning method.

Instead of trying to find yourself how to fine-tune the hyperparameters, you may want to take a look on Hyperparameter Optimization and Metaheuristics



Optimization

Optimizing learning speed and efficiency is crucial. Multiple methods exist and could be implemented, here is an example list:

- ✓ MC dropout
- ✓ (Mini-)Batch/Stochastic gradient descent
- ✓ Weight initialization strategies (LeCun, Xavier, ...)
- ✓ Etc.

Documentation

You should be aware by now that writing and maintaining professional documentation is extremely important. You could provide a README, some benchmarks, as well as any document that can help you justify in the Defense your design choices.
The more *useful* and *relevant* documentation you provide, the better!

A ”benchmark” without any visual proof is not worth anything!

Bonus

- ✓ Optimize the speed learning using parallel computing (multithreading, multicore programming, GPGPU, ...)
- ✓ A display of multiple learning curves on the same graph (useful to compare models)
- ✓ Evaluate the learning phase with multiple metrics.
- ✓ A full chess-playing AI

v 2.5.0