**MFE 230 ZB: Deep Learning and Applications, II**

**Unit value:**1

**Course meeting times and location:**Koret classroom (F320) at Haas

**Instructor:**Laurent El Ghaoui ([elghaoui@berkeley.edu](mailto:elghaoui@berkeley.edu))

**Teaching Assistant:** Vinicio de Sola ([vinicio\_desola@mfe.berkeley.edu](mailto:vinicio_desola@mfe.berkeley.edu))

**Prerequisites**

*MFE 230P:*Data Science in Finance, or equivalent.

*MFE 230ZA:*Deep Learning and Applications I

*Knowledge and skills:* linear algebra, exposure to basics of machine learning and optimization, Python programming; exposure to the main concepts and methods of deep learning, as set forth in MFE 230ZA.

**Methods of instruction**

The course consists in four sessions of four hours each. Teams of students work on a hands-on project and present updates or final results, and instructors provide guidance.

Student teams should go to this [Google sheet (Links to an external site.)](https://docs.google.com/spreadsheets/d/1l3I8tBKCBRZRpBH7rcsU0LsOrld-p2Z-pfss6bYKxfM/edit?usp=sharing) and fill out their project group and title. More details on logistics are [here](https://bcourses.berkeley.edu/courses/1505621/files/80860918?wrap=1)

[Actions](https://bcourses.berkeley.edu/courses/1505621)

**Overview**

The course is on deep learning with applications in finance. It is tailored for students in the MFE program.

Deep learning has been extremely popular recently, which motivates students to learn the material. At the same time, there has been a lot of false or exaggerated claims regarding deep models, for example regarding their robustness and generalization and overfitting properties.

The course aims to provide students with a thorough understanding how deep learning models can or cannot be applied in financial engineering contexts. One of the main goals of this class is to teach students rigorous experimental methods to evaluate published models in a critical way.

The class, therefore, aims to prepare students for a real-life situation faced by many quantitative finance researchers in the industry.

**Schedule**

*Session 1*

* Deep learning for time-series data.
* Reinforcement learning for portfolio optimization.
* Deep learning models for financial texts: FinBERT and equivalents.
* How to critically evaluate claims of a paper and reproducing experiments: computing intervals of confidence for the claimed accuracy of a published model, evaluating robustness to data changes and noise.

Students are expected to form teams for their project by the end of session 4.

*Session 2*

In this session, the teams of students are expected to have delineated a project based on a published deep learning model applied to finance. Each team presents their proposal to the whole class, with the following items:

* Description of the paper, and why it was chosen.
* Description of the project.

As an example:

* *Paper:*“FinBERT: pre-trained model on SEC filings for financial natural language tasks”, chosen due to the interest of the quantitative finance industry towards natural language processing methods.
* *Project:*based on the above paper, evaluate the model on a real data set; using FinBERT for sentiment analysis, maybe on earnings calls data if possible; compare to a baseline such as Naive Bayes; evaluate the robustness of the model.

*Session 3*

In this session, teams present an update on their project and describe challenges encountered, and suggested next steps.

*Session 4*

The last session is devoted to final presentations (to the whole class) of the projects, describing the results of the study, what was learned, and recommendations for further explorations.

**Student learning objectives**

Students will be expected to know how to apply deep learning models in a financial context, using the main deep learning libraries. In addition, they are expected to be able to read and critically evaluate academic or industry papers on deep learning for finance, based on numerical experiments that seek to reproduce the results of the papers.

In terms of competencies/skills/knowledge, at the end of the course students will be expected to demonstrate proficiency in deep learning concepts and related experiments. Special attention will be paid to their coding skills in order to program the experiments in Python. In addition, they are expected to be able to

1. Read technical papers on deep learning in finance.
2. Critically evaluate the results of the papers, using in-depth experiments that seek to reproduce or disprove the claimed
3. Be able to report on the experiments in a clear and concise way, including recommendations on next steps.
4. Materials
   1. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press, 2016. At [http://www.deeplearningbook.org (Links to an external site.)](http://www.deeplearningbook.org/)
   2. Hugo Larochelle (Sherbrooke): http ://www.dmi.usherb.ca/ larocheh/
   3. Christopher Olah’s blog: http://colah.github.io/posts/2015-08- Understanding-LSTMs/
   4. Deep learning course, Charles Ollion et Olivier Grisel : [https://github.com/m2dsupsdlclass/lectures-labs (Links to an external site.)](https://github.com/m2dsupsdlclass/lectures-labs)
   5. Jannes Klaas. Machine Learning for Finance. Packt Publishing, 2019.

**Requirements and Course Evaluation**

The course is evaluated solely based on projects. Students will form teams (of 4 to 5 each) for their project, with the same grade assigned to the whole team.

*Deliverables and grade weighting*

Each team is tasked with

1. Choosing a paper that is relevant to deep learning in finance (10% of the total grade).
2. Critically evaluate the paper, choosing relevant experiments (30%).
3. Presenting the results (20%).
4. Writing a final report (20%)
5. Deliver code in Python (20%).

*Criteria for assessing student work*

1. Relevance: how important is the paper, how relevant is the topic for the financial industry.
2. Critical eye: Ability to be critical towards published results.
3. Presentation skills.
4. Report writing skills.
5. Code writing skills.