Introduction to Deep Learning in Practice with pytorch

Alberto TONDA, Ph.D. (Senior permanent researcher, DR)

UMR 518 MIA-PS, INRAE, AgroParisTech, Université Paris-Saclay
UAR 3611, Institut des Systèmes Complexes de Paris Île-de-France

Objective of this class

Overview of deep learning architectures and applications, using **pytorch** as the support library

Objective of this class

- At the end of the class, you should know
  - Deep Learning architectures suited to different problems
  - Problems for which DL is suited, and problems for which it is not
  - Basic usage of pytorch and a few other DL libraries
  - Where to find and how to use large pre-trained models
  - Keywords to perform further research/reading

Outline

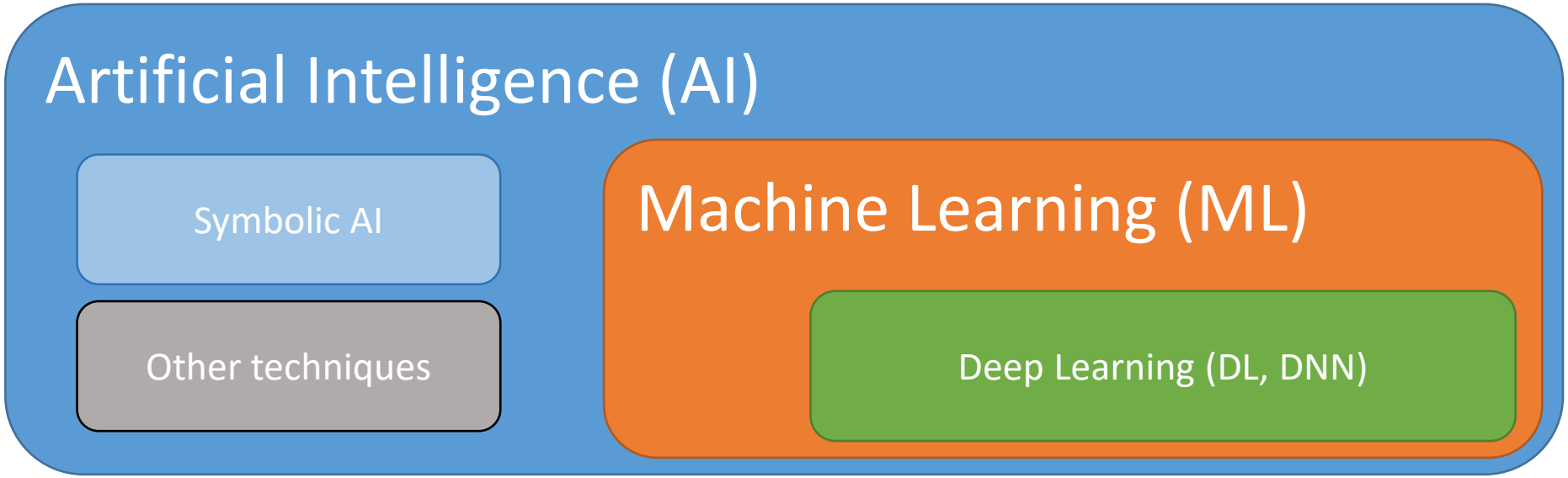
- Existential questions: who am I, why are we here?
- Current state of the field: why deep learning, why pytorch?
- (Tentative) Planning for the class

Who am I?

- Career
  - Bachelor and Master in Computer Science Engineering
  - Ph.D. from Politecnico di Torino, Italy, in 2011
  - Permanent researcher in France since late 2012 (INRAE)
  - Senior researcher (DR) since 2023
- Research interests
  - Stochastic multi-objective optimization
  - Machine learning (explainable AI)
  - Biological/agri-food problems

What is *deep learning*?

- One technique among many in Machine Learning
- Rebranding of Artificial Neural Networks
- Currently extremely successful

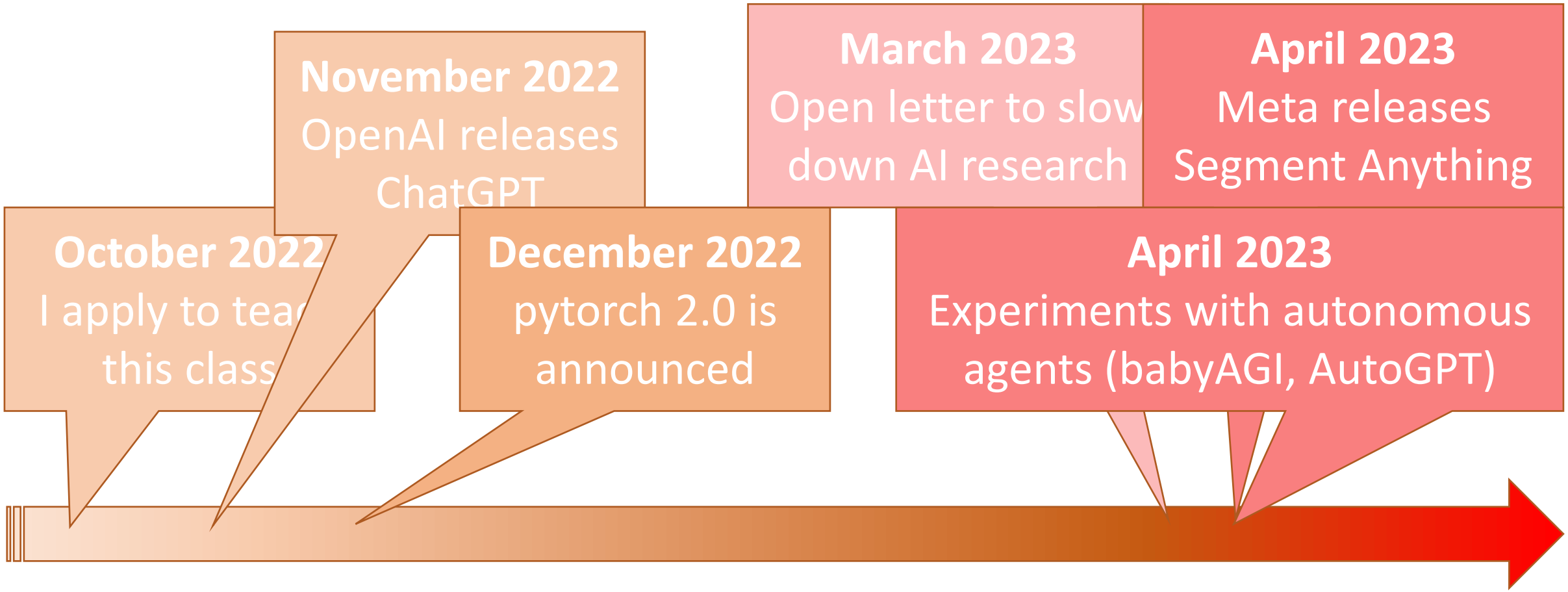


Why is this subject relevant now?

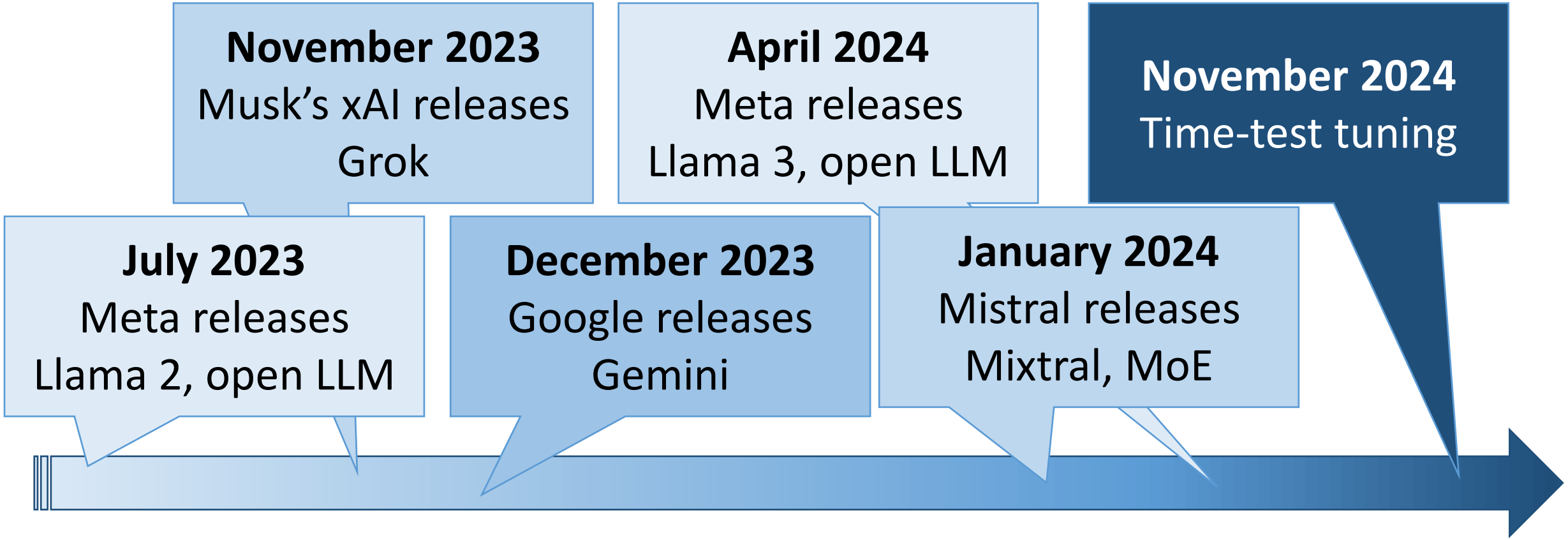
- Artificial Intelligence achieved important goals in last decade
  - Human-competitive* play in difficult games
  - Improvement in state of the art for image/video classification
  - Generation of images, text, and sound
- Availability of data and computing (phones)
- Attempts at commercial use of AI
  - Self-driving vehicles
  - Assistants for text and code generation
  - Prediction of protein structures
  - …

Why is this subject relevant now?

Current state of the field



Current state of the field



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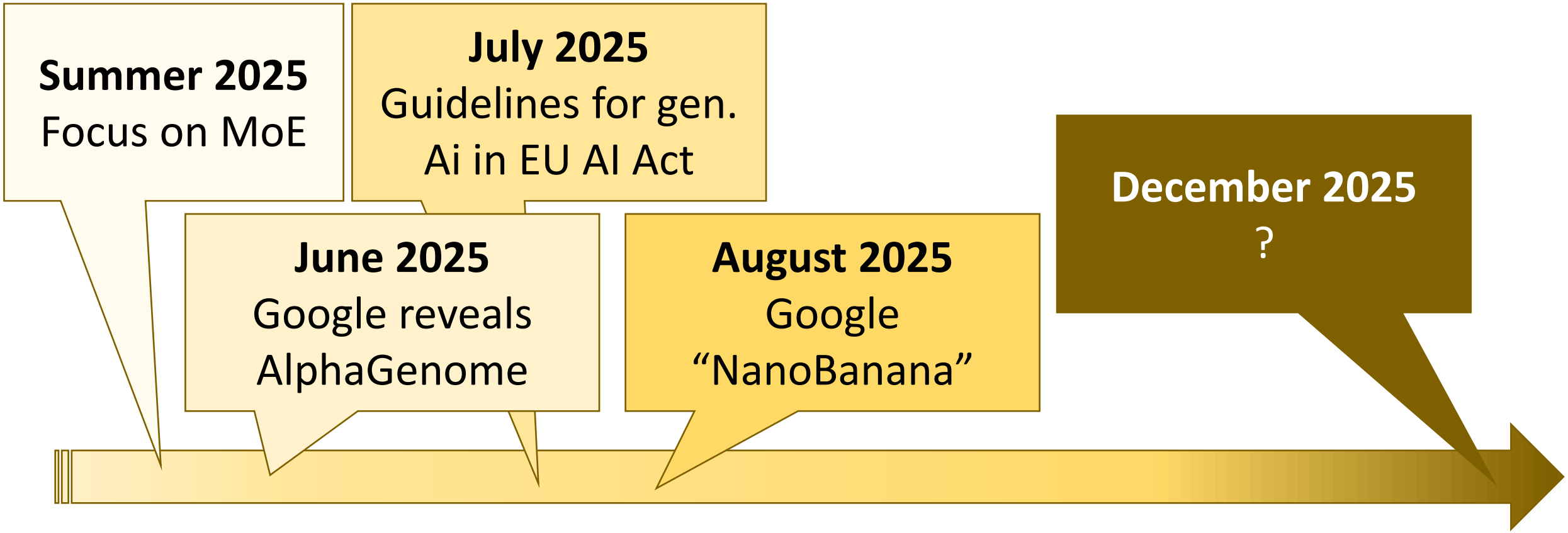


Current state of the field

- Large availability of open-*ish* source tools
  - The open source movement in computer science is strong
  - It's useful for companies to have other people use their code
  - For deep learning, it started with Tensorflow, 2017 (Google)

- General Purpose Graphic Processing Units (GPGPUs)
  - GPUs originally created for gaming, lots of processors (low-spec)
  - Great for *massive parallelization* of simple computations

Current state of the field

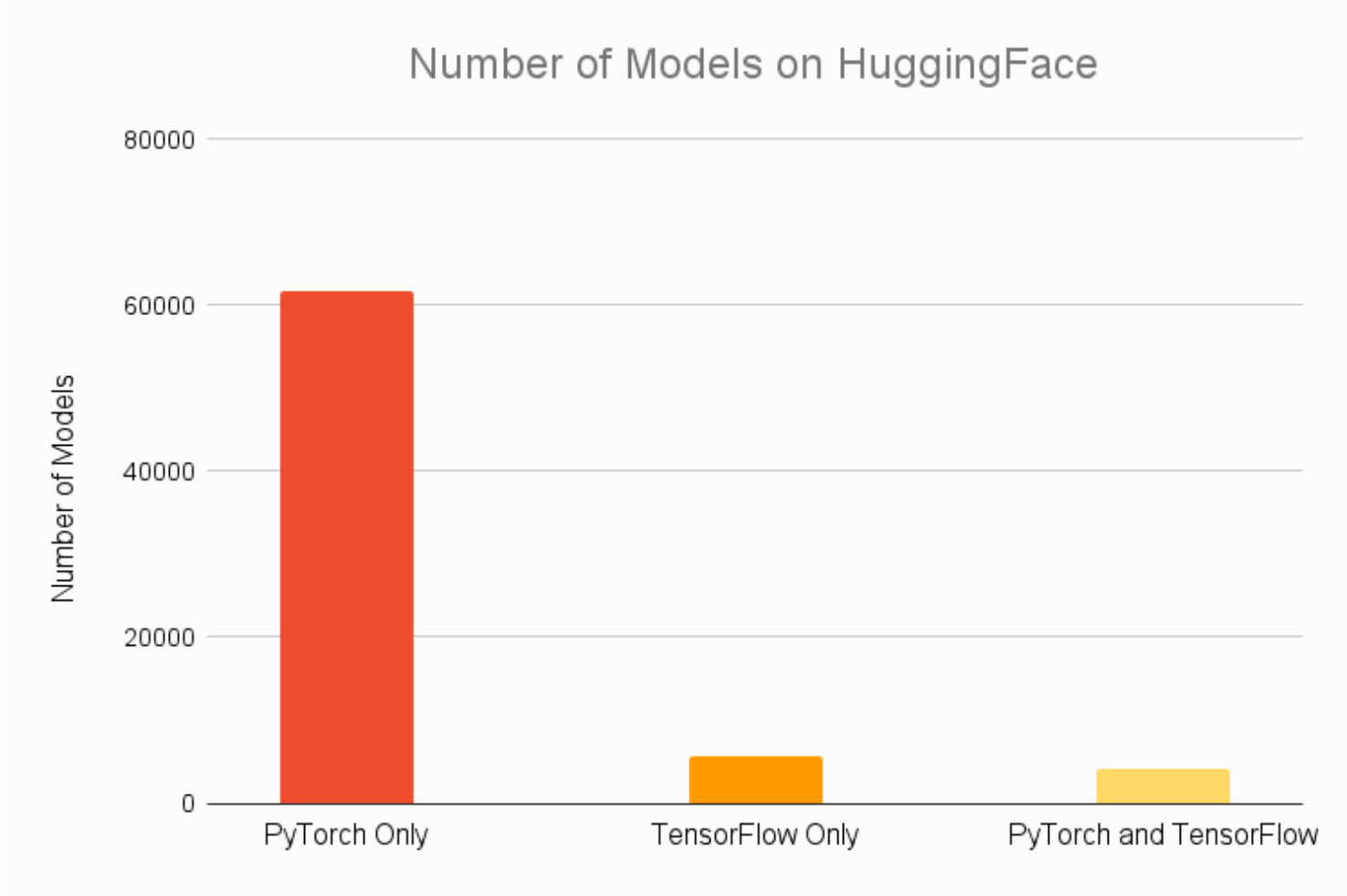
- A vast (unreasonable?) amount of *enthusiasm*!
- Why is that?
  - **Competition** between large companies (Microsoft, Meta, Google)
  - **Tools** that are relatively accessible to non-experts
  - Considerable amount of **passionate practitioners**
  - Communities *obsessed* with AI (existential risk, accelerationists, …)
  - Charismatic influencers (Sam Altman, Eliezer Yudkowsky, Yann Le Cunn, Gary Marcus, …)

Why pytorch?

- Several competing libraries
  - keras, pytorch, theano, …

- pytorch (currently) most popular
  - Eager execution, for rapid prototyping
  - Analysis step by step
  - Availability of models

Why pytorch?


Number of Models on HuggingFace
Number of Models
80000
60000
40000
20000
0
PyTorch Only
TensorFlow Only
PyTorch and TensorFlow

HuggingFace?

- French-American company
- Weird name (IMHO), but $4.5 \cdot 10^9$\$ evaluation
- Library for deep neural networks (*transformers* and others)
- Hub, to share and discuss trained models
  - Extremely successful, several useful models
  - Users can download, fine-tune, change and share
  - Relatively easy to use, loved by practitioners

Competition

Keras 3:
Keras for JAX, TensorFlow,
and PyTorch

FLAX
neural network library in JAX

(Tentative) Planning

December 01
Introduction, ML summary, Basics of deep neural networks

09h45,
Amphi II

December 03
Convolutional Neural Networks

09h30,
Amphi IV

December 04
Recurrent Neural Networks, Embeddings, Autoencoders

09h30,
Amphi VI

December 08
Generative models, Deep reinforcement learning, Concept bottlenecks

09h45,
Amphi III

December 10
Project and/or advanced topics (Physics-informed Neural Networks, Hybrid models, Neural-symbolic AI, Causality)

09h30,
Amphi III

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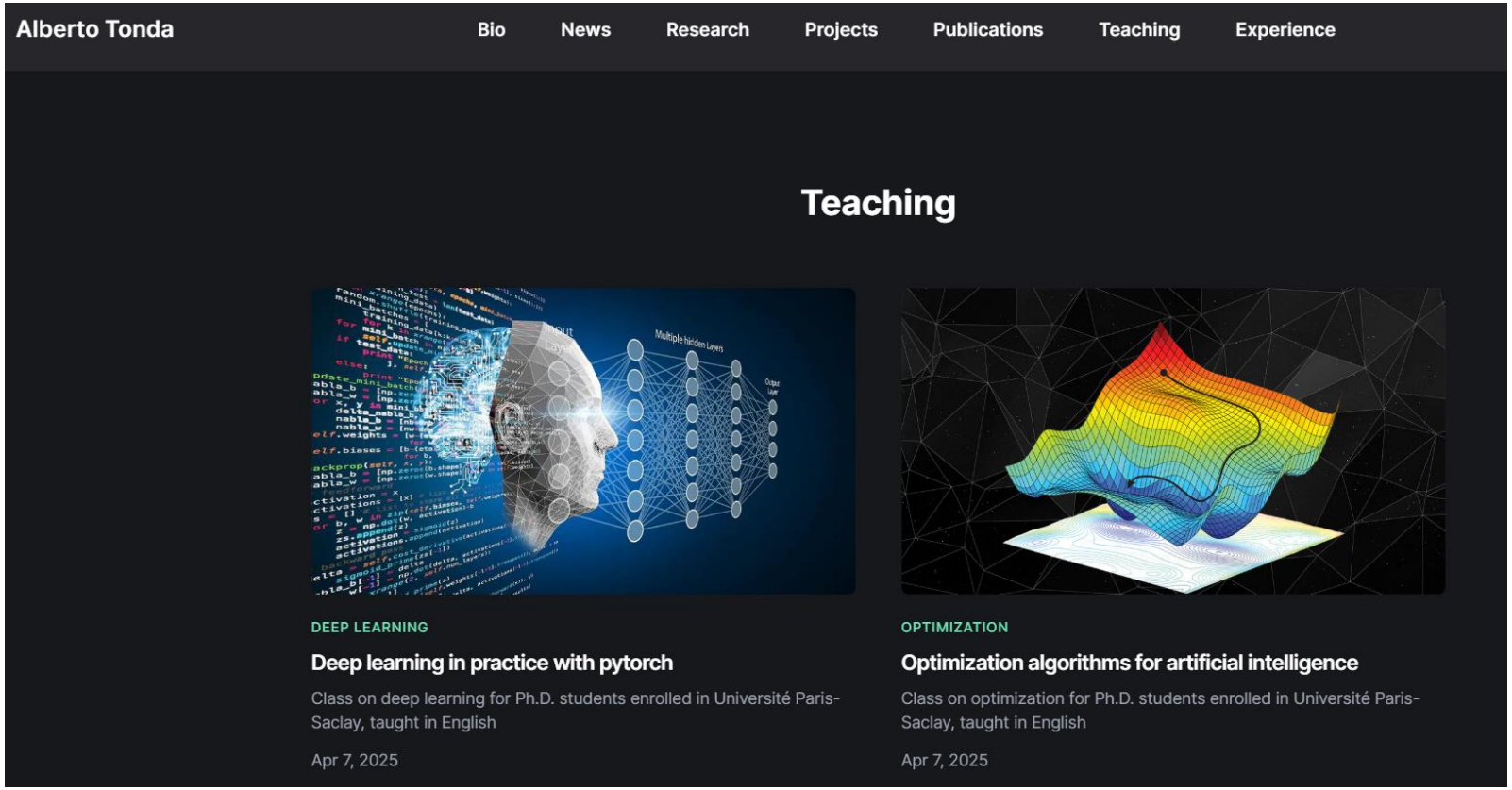
Pacing likely all over the place

Learning from last year's class

Class material

https://albertotonda.github.io



References

"When you are copying from one source, it's *plagiarism*; when you are copying from multiple sources, it's **research**."

-- Prof. Notestein, Yale, 1929

Prof. **Vincent Guigue**, AgroParisTech & Sorbonne University,
here depicted with cool sunglasses, https://vguigue.github.io/

"Practical deep learning", https://jxmo.io/deep-learning-workshop/
"Understanding deep learning", https://udlbook.github.io/udlbook/
"Deep learning with pytorch", https://github.com/deep-learning-with-pytorch/