INF721

2024/2

UFV

Deep Learning

A1: Introduction

Lecture Outline

- Instructor and students
- Introduction
- Syllabus
- Machine Learning
  - Brief history
  - Problems and data types

Professor

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PhD in Computer Science, University of California, Santa Cruz

Artificial Intelligence & Criativity

Music Generation, Procedural Content Generation, Game AI

Contact

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Students

My name is ...

I am a *[first, second...]* year *[undergrad, masters, phd]* student in *[computer science, physics, ...]*

I am taking this course because ...

Algorithms are traditionally implemented as concrete **functions**

$y = f(x)$

Problem 1: double a number

$$f(8) = 16$$

$$f(24) = 48$$

Pr ber

Solution

$$f(x) = 2 * x$$

Problem 2: shortest path

f(Viçosa, Belo Horizonte) = Viçosa
Teixeiras
Ponte Nova
Ouro Preto
Belo Horizonte

Problem 2: shortest path

f(Viçosa, Belo Horizonte) = Viçosa

Solution

Dijsktra's Algorithm
Bellman-Ford
Floyd-Warshall

Belo Horizonte

Problem 3: image classification

f() = Cat

f() = Dog

Problem 3: image classification

f(

Solution

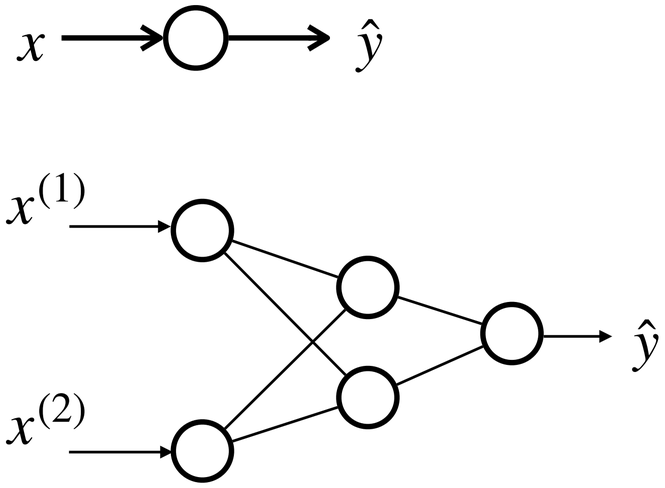
🤔

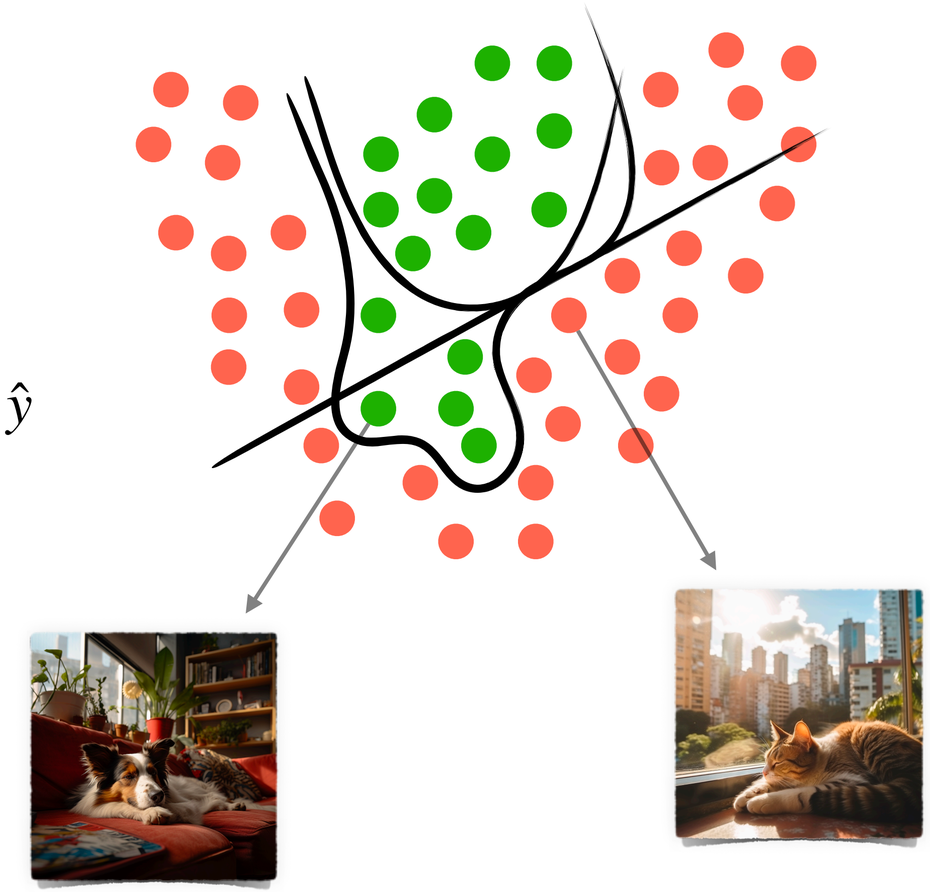
f() = Dog

The goal of **Machine Learning** is to find a function from experience (data) to perform a particular task

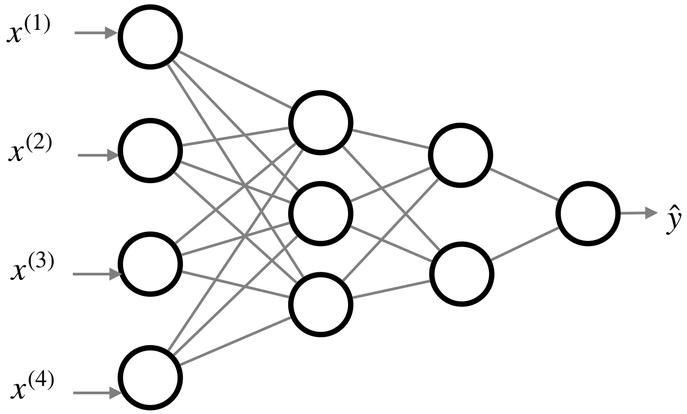
Neural Networks

Shallow Networks





Deep Neural Networks



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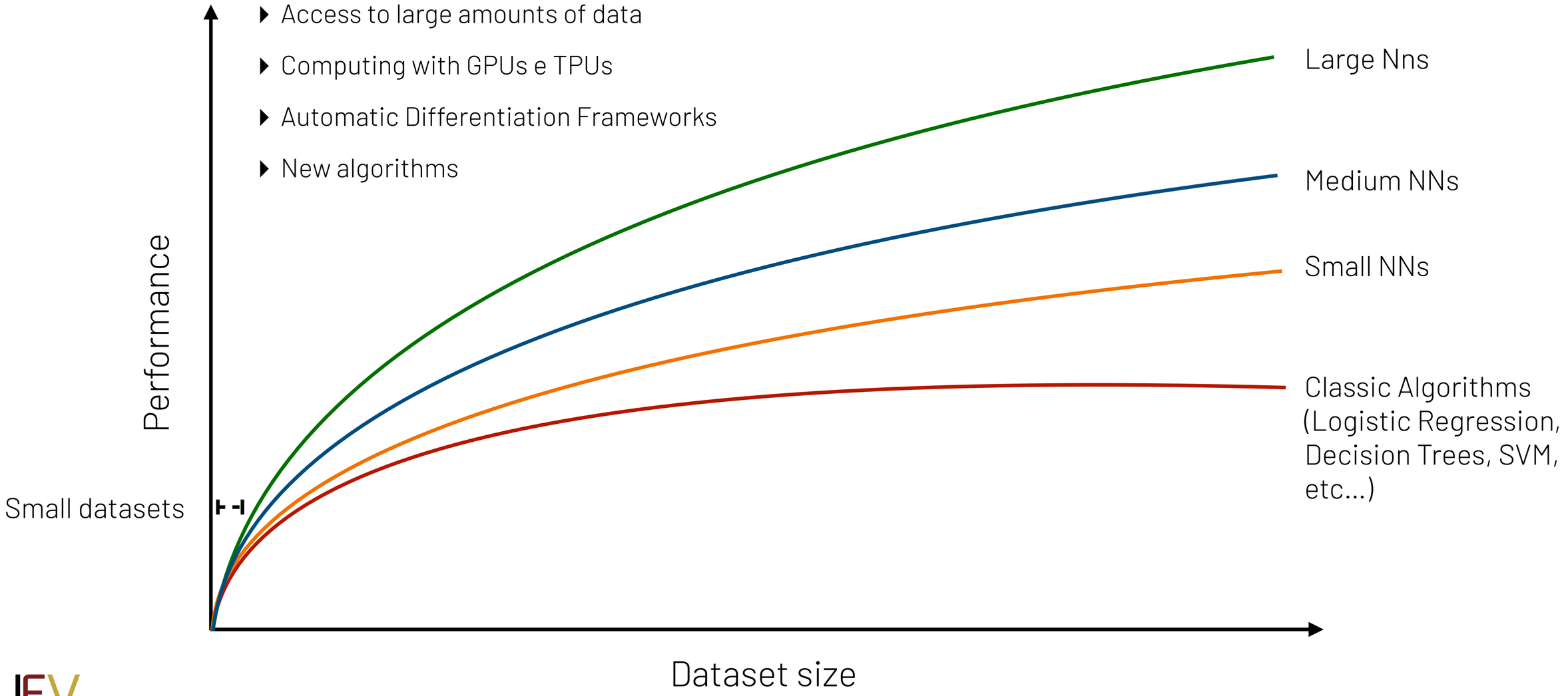
The Neural Networks (NNs) success



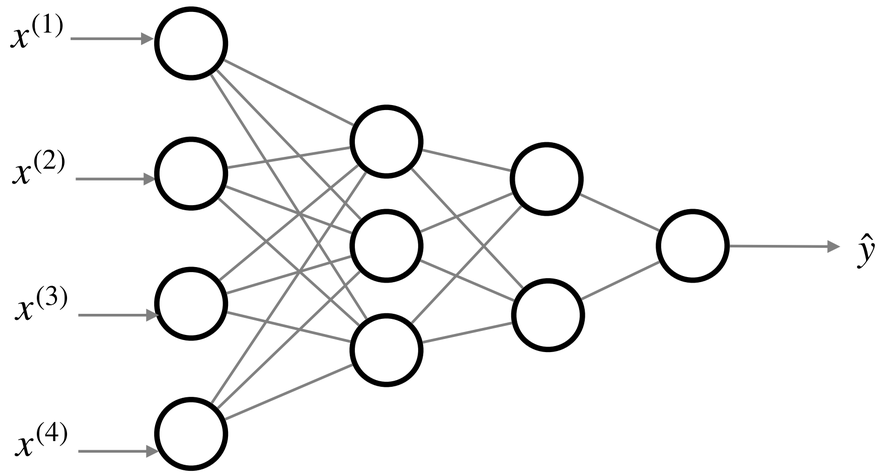
This course

This course introduces students to the fundamentals and modern techniques of Deep Learning, aiming at enabling students to design and implement deep neural networks for classification, regression, and generation of unstructured data.

Content

1. Neural Network Fundamentals

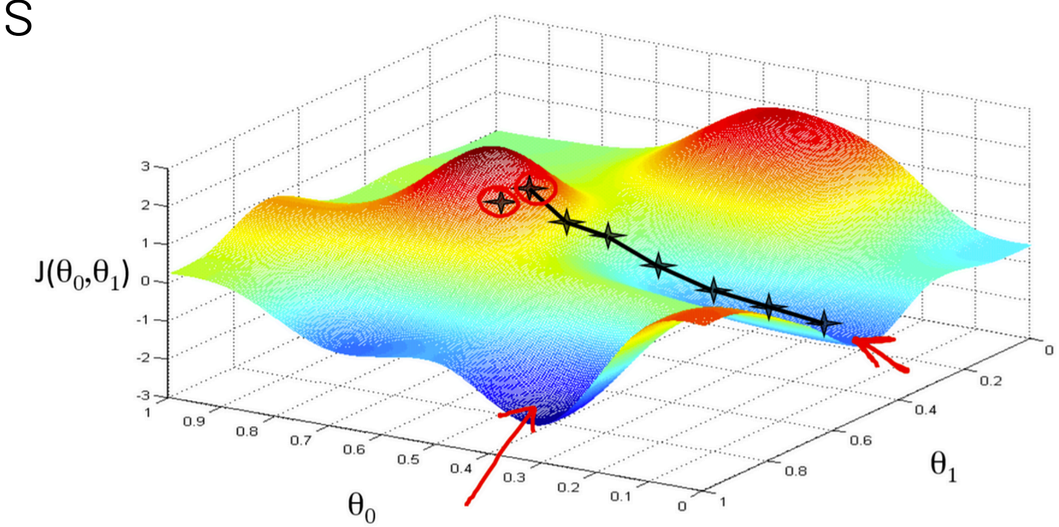
- Machine Learning
- Linear Models
- Gradient Descent
- Multilayer Perceptron (MLP)
- Backpropagation
- Numpy implementations



Content

2. Improving Neural Networks Performance

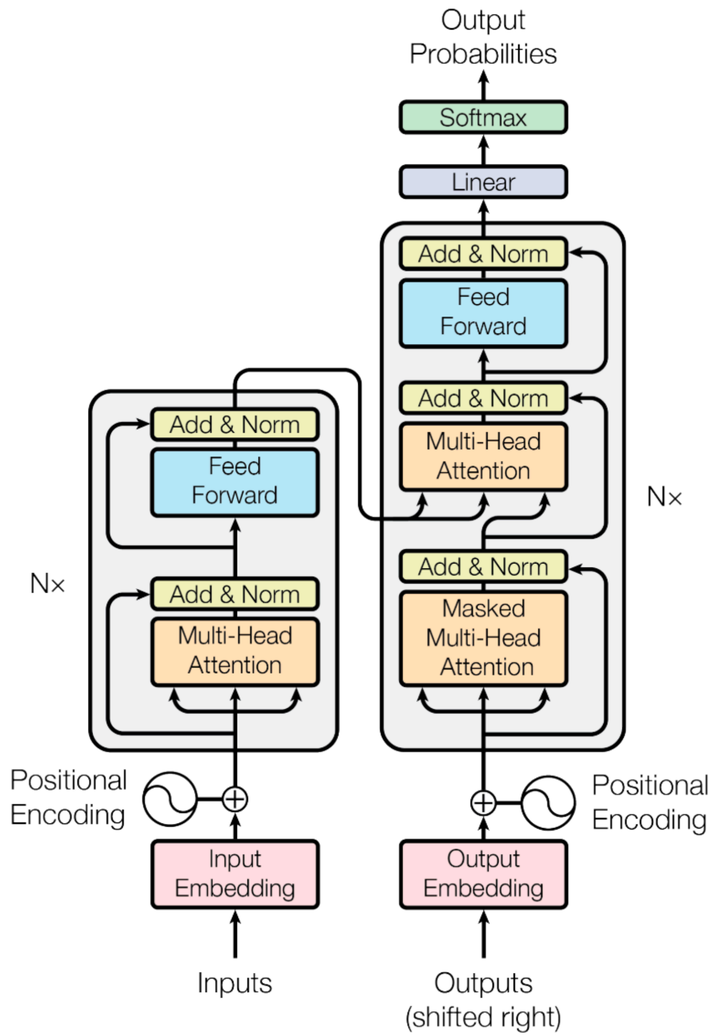
- Regularization
- Normalization
- Advanced Optimization Algorithms
- Hyperparamenters Tunning
- Autograd



Content

3. Advanced Arquitectures

- Convolutional Neural Networks
- Recurrent Neural Networks
- Transformers
- Case Studies
- Transfer Learning
- Implementação em Pytorch



Content

4. Generative AI

- Generative Adversarial Networks
- Autoregressive Models
- Variational Autoencoders
- Difusion Models

“Foto realista de um cachorro dormindo no sofá de um apartamento; livros e plantas ao fundo.”, **Midjourney**

Prerequisites

INF213: Data Structures

- Python programming
- Basic data structures and their associated algorithms

MAT135: Analytic Geometry and Linear Algebra

- Basic operations with vectors and matrices

MAT140: Calculus I

- Derivatives of composite and multivariate functions

Grading

- Exams (40%)
- Programming Assignments (40%)
- Final Project (20%)

Exams

A list of (mostly multiple choice) questions taken **individually** in the classroom with a duration of 1:40h

- Midterm Exam 1
- Midterm Exam 2

Make up exams

- If you can’t take an exam for any personal reason, let the instructor know in advance so we can schedule a make up exam

Programming Assignments

Implementing neural networks in Python and Jupyter Notebook using pre-defined classic datasets, with a duration of 1.5 weeks.

- P1: Logistic Regression
- P2: Multilayer Perceptron
- P3: Convolutional Neural Networks
- P4: Recurrent Neural Networks

Late Policy

- 15% penalization for each day late
- Max of 2 days late per assing

Final Project

Proposal, implementation, and evaluation of a transformer model for a learning problem of interest to the students, conducted individually or in pairs, with an approximate duration of 4 weeks.

- FP1: Project Proposal
- FP2: Project Implementation
- FP3: Project Presentation

Schedule

Week	Date	Lecture	Programming Assignment
1	09/09	1. Introdution	
	11/09	2. Linear Models	
2	16/09	3. Gradient Descent	**PA1: Logistic Regression**
	18/09	4. Evaluting Neural Networks	
3	23/09	5. MLP I	
	25/09	6. MLP II	**PA2: Multilayer Perceptron**
4	30/09	7. Advanced Optimization Algorithms	
	02/10	8. Regularization and Normalization	
5	07/10	9: Hyperparameter Tunning	
	09/10	**Midterm Exam I**	
6	14/10	10. CNNs I	**PA3: Convolutional Neural Networks**
	16/10	11. CNNs II	
7	21/10	12. RNNs I	
	23/10	13. RNNs II	

Schedule

Week	Date	Lecture	Programming Assignment
8	28/10	14. Word Embeddings	**PA4: Recurrent Neural Networks**
	30/10	**Holyday (Dia da Cidade)**	
9	04/11	15. Attention	**FP2: Project Implementation**
	06/11	16. Transformer I	
10	11/11	17. Transformers II	
	13/11	18. Transfer Learning	
11	18/11	**Midterm Exam II**	
	20/11	19. GANs	
12	25/11	20. Variational Autoencoders	
	27/11	21. Diffusion Models	
13	02/12	22. Multimodal Learning	
	04/12	23. Conclusion	
14	09/12	**Final Project Presentation I**	
	11/12	**Final Project Presentation II**	

Communication

Google Spaces — Prefered!

- Questions about course content and logistics (~30 minutes latency)

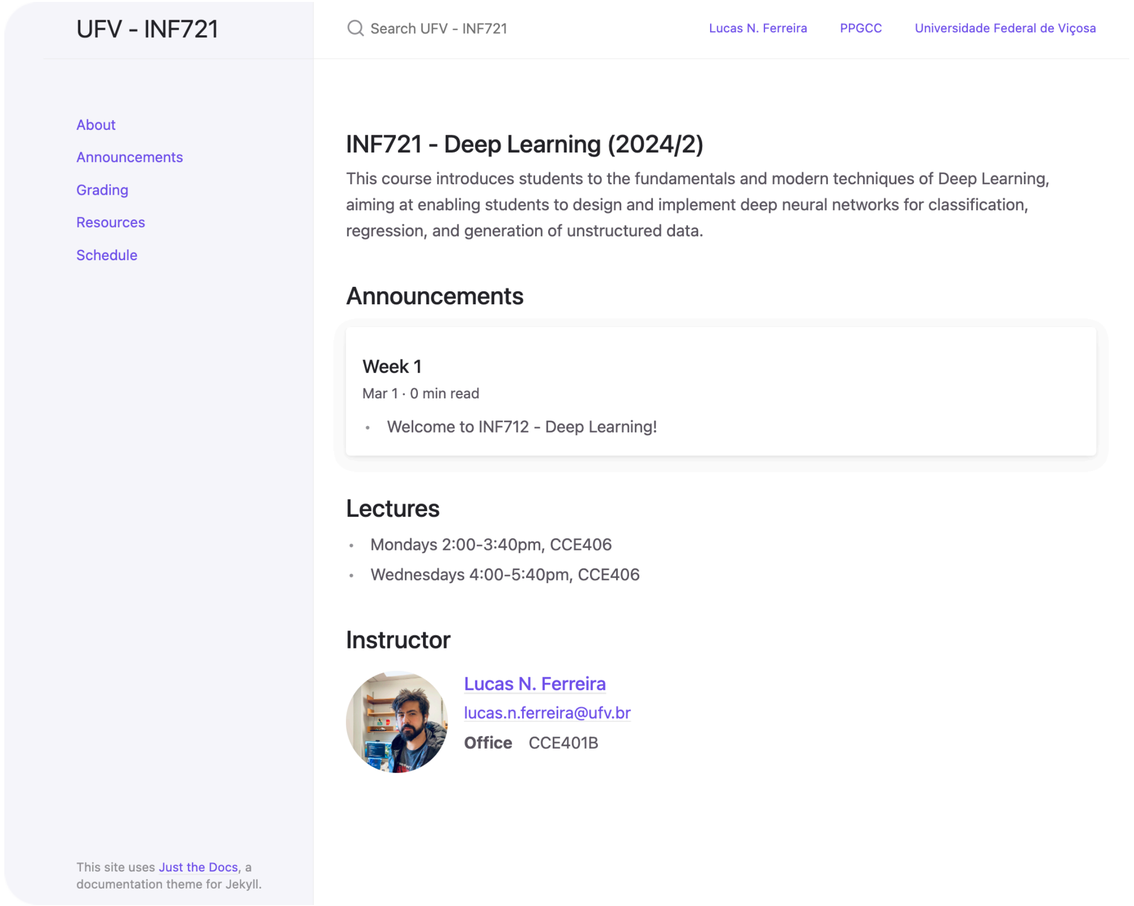
Email

- Personal matters, such as grading and attendance (~2 days latency)

Appointments

- Email, direct message, or talk to me after class to schedule an appointment

Course Website



Moodle will be used only for posting grades and managing submissions.

All relevant information can be found on the course webpage:

https://ufv-inf721-2024-2.lucasnferreira.com

Next lecture

2. Linear models

Discuss simple models that are the basis to how neural networks solve supervised learning problems:

- Linear Regression
- Perceptron
- Logistic Regression

During this discussion we will asee examples of:

- Hypothesis Spaces
- Loss Functions
- Optimization Algorithms
- Perfoemance Metrics