

An introduction to conditional density estimation using the R interface to Keras

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Outline

- 1 Background
- 2 Installing the R interface to Keras
- 3 Deep learning
 - Basics of neural networks
 - Architecture/types
 - Training via backpropagation
 - Avoiding overfitting
- 4 Building a Keras model
- 5 Practicals
 - Least-squared regression
 - Logistic regression
 - Single quantile regression
 - GPD regression

What is Keras?

- Keras is a high-level API for fast deep learning developed by Google and written in Python, released in 2015
- Whilst it used to support a number of different back-ends (Theano, MILA; CNTK, Microsoft) it now solely runs on top of Tensorflow
- Tensorflow is a free open-source machine learning (not just DL) library written in Python, C++ and CUDA that does all of the lower-level computations for Keras
- Keras is the most popularly applied deep learning software due to its simple yet powerful framework, followed closely by Facebook's PyTorch. This can also be used in R (see <https://www.rstudio.com/blog/torch/>)

Objectives

The objectives of this short-course are:

- Understand the basics of deep learning and neural networks
- Build and train simple feed-forward prediction and regression models using the R interface to Keras
- Perform conditional density estimation using neural networks

Some suggested reading

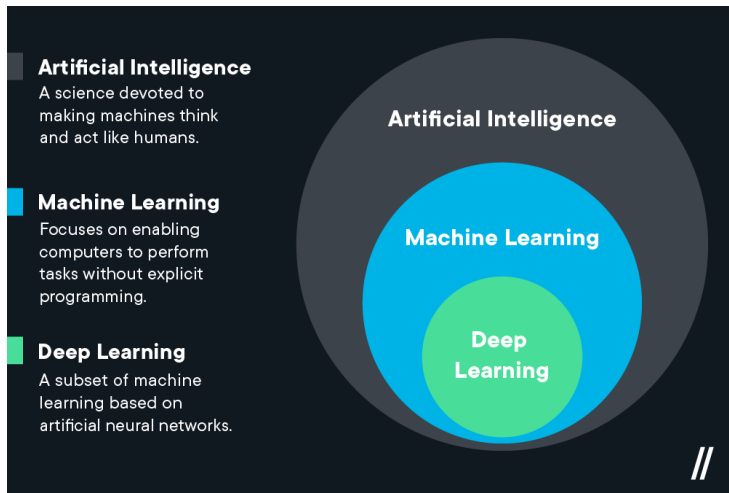
- Chollet, F. with Allaire, J. J. (2018). Deep learning with R
- Any of the multitude of Keras for R blogs, see e.g., blogs.rstudio.com, r-bloggers.com, towardsdatascience.com, analaticsvidyha.com. Even those that give code written in Python as it's very easy to translate!
- Rodrigeus, F., Pereira, F. C., (2022). Beyond expectation: Deep joint mean and quantile regression for spatiotemporal problems
- For conditional density estimation using deep learning (tailored towards extremes):
 - Cannon, A. J. (2010). A flexible nonlinear modelling framework for nonstationary generalized extreme value analysis in hydroclimatology + Cannon, A. J. (2011). GEVcdn R package
 - Carreau, J., Bengio, Y. (2007). A hybrid Pareto model for asymmetric fat-tailed data: the univariate case
 - Richards, J., Huser, R., (2022). High-dimensional extreme quantile regression using partially-interpretable neural networks: With application to U.S. wildfires

Installation

First thing's first, let's get Keras installed

- Open *installation.R*
- Download and install Python 3.8.4 from <https://www.python.org/downloads/macos/> (unless you already have a working version of Python ≥ 3.5)
- Install the `keras` and `tensorflow` R packages
- Create a virtual Python environment
- Configure the Rstudio Python interpreter
- Install the latest versions of the Python libraries *tensorflow* and *keras*

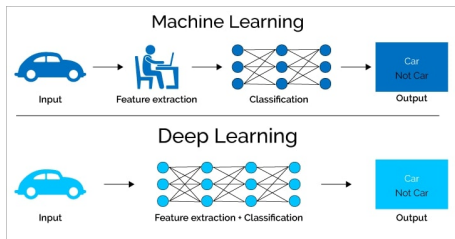
What is deep learning?



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Deep learning vs. machine learning

- Uses ANNs to replicate human brain
- Algorithms are much more complex and require less human intervention \Rightarrow no manual feature extraction required
- Typically requires substantially more data. Gives rise to the concept of transfer learning, i.e., using pre-trained models



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Thanks for your attention!