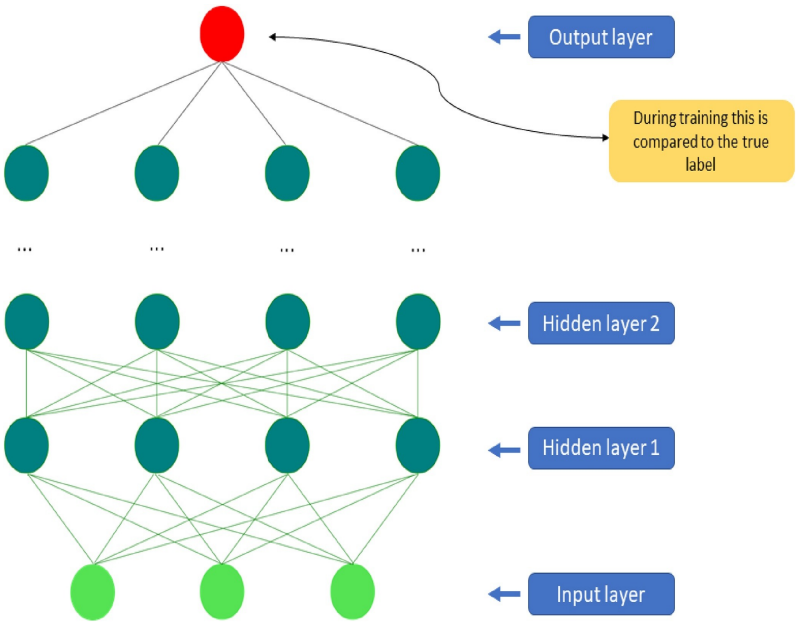
Deep Learning for Medical Image Classification

Dr Luisa Cutillo (l.cutillo@leeds.ac.uk)

What is deep learning? Artificial neural networks (ANN) are often termed *deep learning* (DL). DL is a set of machine learning algorithms used to discover complicated patterns in large data sets. The increased access to *big* data, the availability of user-friendly software frameworks, and the always-increasing compute power, in particular GPUs, is nowadays enabling the use of ANN to address a wide variety of problems in computer vision, language modeling and robotics. Medical images capture enormous amounts of data, at a pace far surpassing what "traditional" methods of analysis can process. Application of DL to medical imaging is therefore highly desirable.

Roughly speaking, a neural network consists of a number of connected computational units, called *neurons*, arranged in layers. There's an input layer where data enters the network, followed by one or more *hidden layers* transforming the data as it flows through, before ending at an output layer that produces the neural network's predictions. Indeed, the word "deep" in "deep learning" refers to the number of layers through which the data is transformed.



The basic form of artificial neural networks are parametrized mathematical functions $y = f(\mathbf{x}; \theta)$ that maps an input $\mathbf{x}$ to an output $\mathbf{y}$ by feeding it through a number of nonlinear transformations:
$f(\mathbf{x}) = (f_n \circ \cdots \circ f_1)(\mathbf{x})$.
Here each component f_k, called a network *layer*, consists of a simple linear transformation of the previous component's output, followed by a nonlinear function Today's deep learning methods are mostly implemented in open-source libraries such as TensorFlow, a framework originating from Google Research or CNTK from Microsoft. Rather than use these libraries directly, it is becoming popular to call them from higher level frameworks such as Keras. In this project we will use the Tensorflow library via the Keras framework.

Some (or all) of the following **objectives** will be addressed:
(i) Become familiar with deep learning frameworks and related literature;
(ii) Understand how deep learning can be applied to medical images processing;
(iii) Develop a jupyter notebook using state-of-the-art open-source code, sources of data and problems related to medical imaging.

There are no **prerequisite** modules for this project, but knowledge of one or more of Computational Mathematics (MATH 1920) or Numerical Analysis (MATH 2600) is desirable. However, it is essential that you either have some programming experience in python (e.g. MATH 1920) or the willingness to learn.

Useful references: [1]A.S. Lundervold, A. Lundervold / Z Med Phys 29 (2019) 102–127; [2] A. Maier et al. / Z Med Phys 29 (2019) 86–101; [3] J Digit Imaging (2018) 31:283–289 285
[4] https://github.com/paras42/Hello_World_Deep_Learning