Goal: Overview of definition of learning from Machine Learning.

MLPs: perceptron, weights, non-linear activation function, feed-forward topology.

Let X be the stimuli space and Y be the (discrete) set of class labels.

Supervised Learning Problem: To classify[1] stimuli based on example stimulus-class pairs.

- **Input:** *labeled training examples* $\{(x_1, y_1), ..., (x_n, y_n)\}$ drawn from $P(x, y)$, and unlabeled stimuli $\{x_{n+1}, ...\}$ to be classified one at a time.
- **Output:** Best-guesses for class labels $\{y_{n+1}, ...\}$, or more generally estimates of the class probabilities $P(y|x_{n+1})$, etc.
- **Evaluation:** Mean-square error of predicted to actual class labels, or expected perplexity.
- **Example:** A child sees images x_i and is told by their parent the name y_i of that type of object. He is later able to identify the same classes of objects in new images.
- **Implementation:** An MLP with any number of layers, x presented to first layer, weights trained via back-propagation of error between output layer and y.

Unsupervised Learning Problem: To learn class structure from stimuli.

- **Input:** *unlabeled examples* $\{x_1, ..., x_n\}$ drawn from marginal $P(x)$.
- **Output:** Inferred class structure Y and estimates of the probabilities $P(y|x_i)$.
- **Evaluation:** Similarity (e.g. mutual information) between learned class structure and actual structure.
- **Example:** A feral child sees images x_i but has no parent to tell them the names of things.
- **Implementation:** An MLP with each layer trained to satisfy suitable intrinsic statistical criteria (such as fidelity and sparsity). Methods include sparse autoencoders, restricted Boltzmann machines, and perhaps a multi-neuron version of Chklovskii's rule.

Semisupervised Learning Problem: To classify stimuli given many unlabeled examples and a limited number of labeled examples.

- **Input:** That of both supervised and unsupervised cases.
- **Output:** Same as supervised case.
- **Evaluation:** Same as supervised case.
- **Example:** A child who sees many images only some of which are named for them. (The most realistic case.)
- **Implementation:** The MLP of unsupervised case plus a final supervised stage.

[1] This discussion is in terms of classification, but the concepts can be easily extended to regression, reenforcement learning, and other frameworks.