Neural Networks

BOSTON UNIVERSITY
MACHINE INTELLIGENCE
COMMUNITY

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MIC Conference

Data: TBA

Project ideas:

Signup:

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Brief Recap:

- Data-driven learning
-

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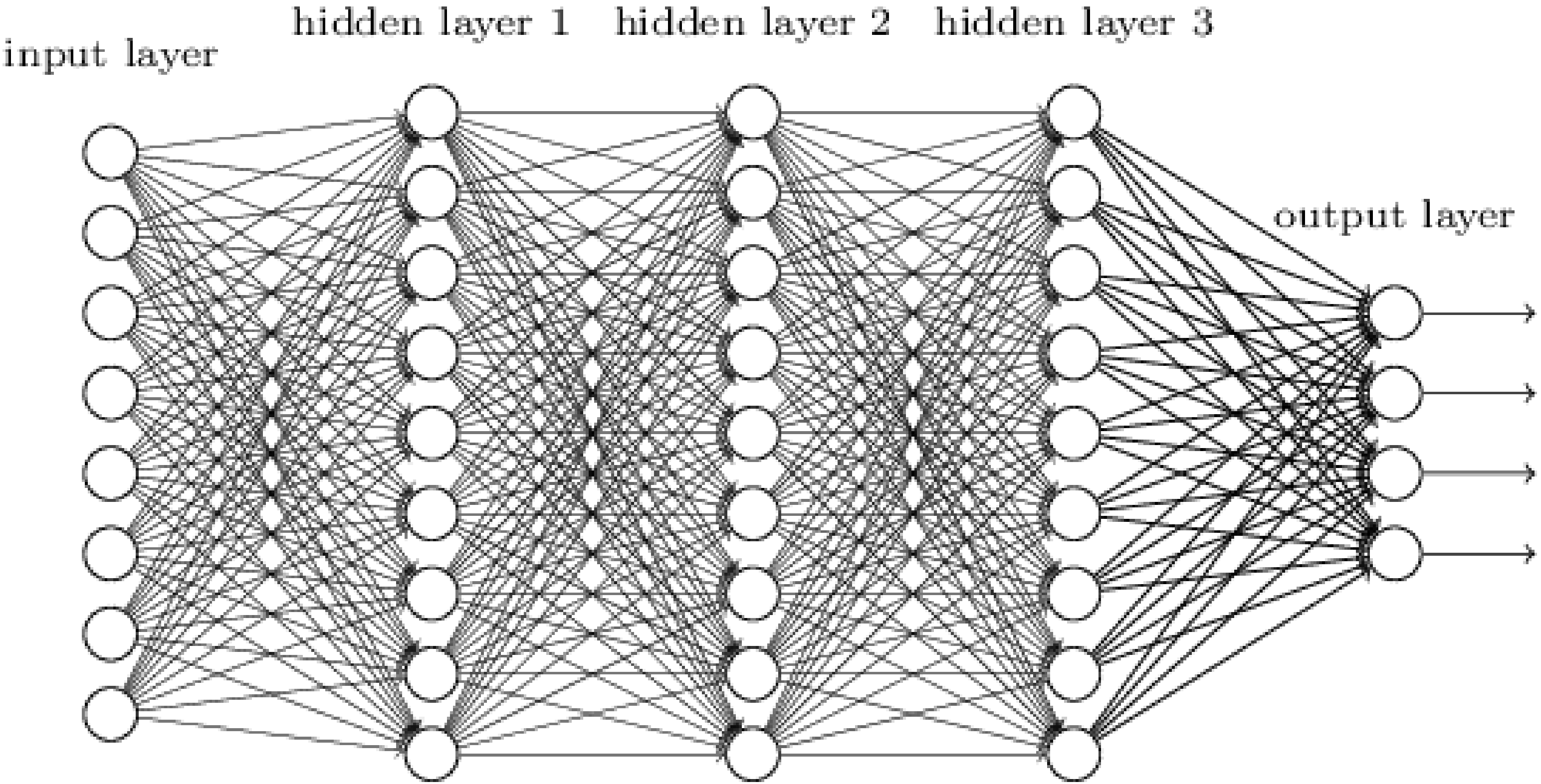
What’s a Neural Network?



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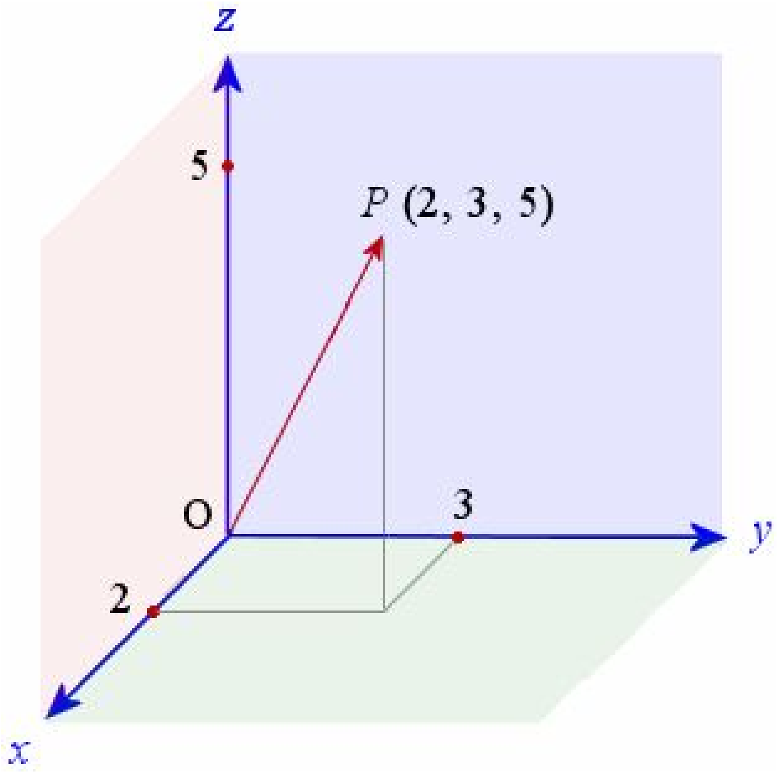
Vectors and Vectorization

- Data is represented in arrays, with each term representing one dimension
- Vectorization is essentially using built-in functions to take advantage of parallel computing capabilities (reduces training time)



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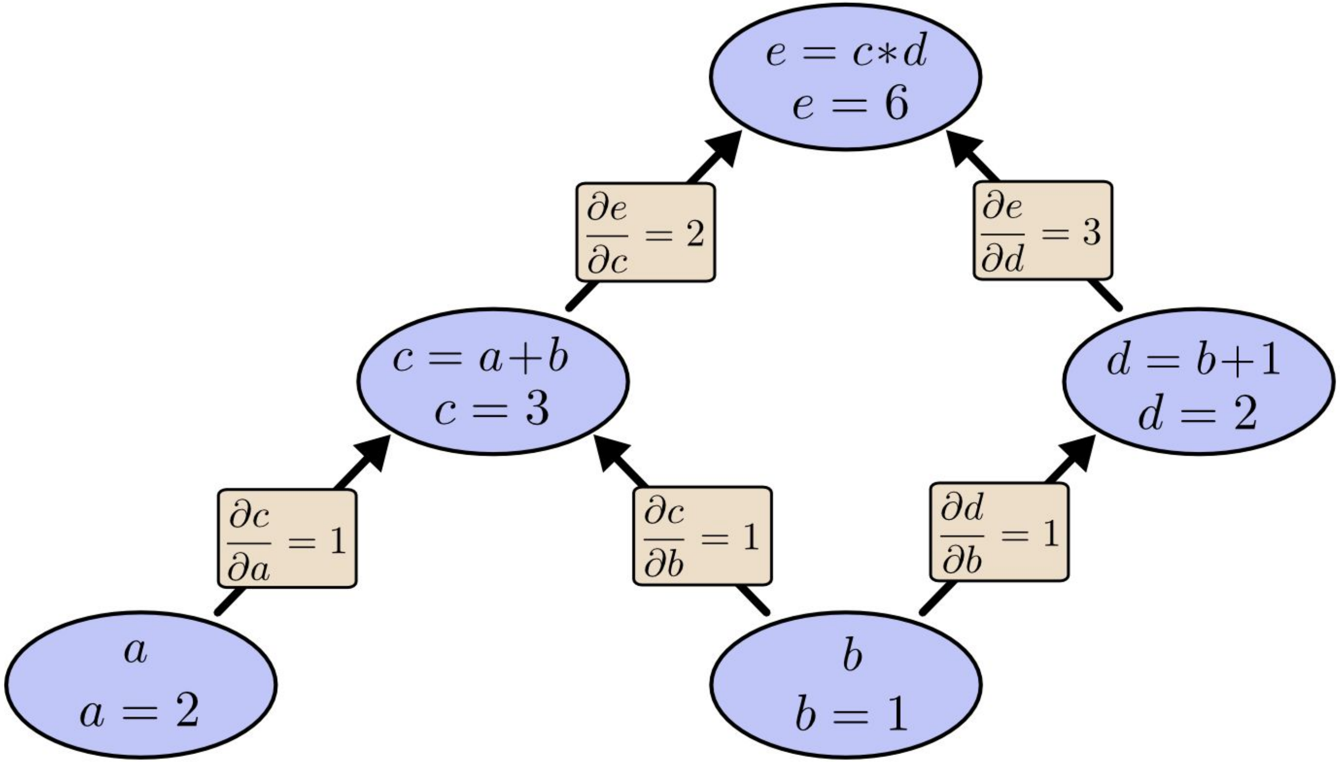
Computation Graph



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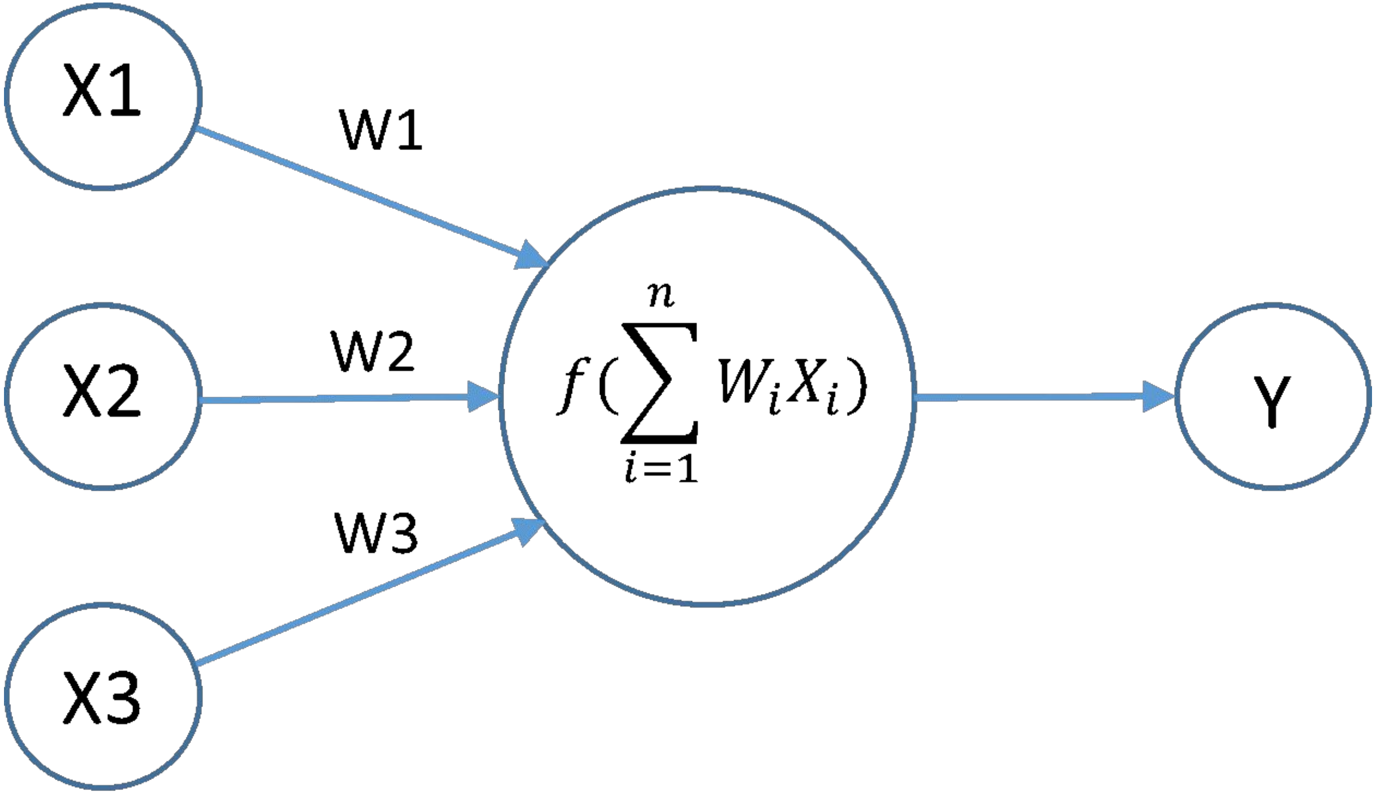
Neural Network (who decides function f)



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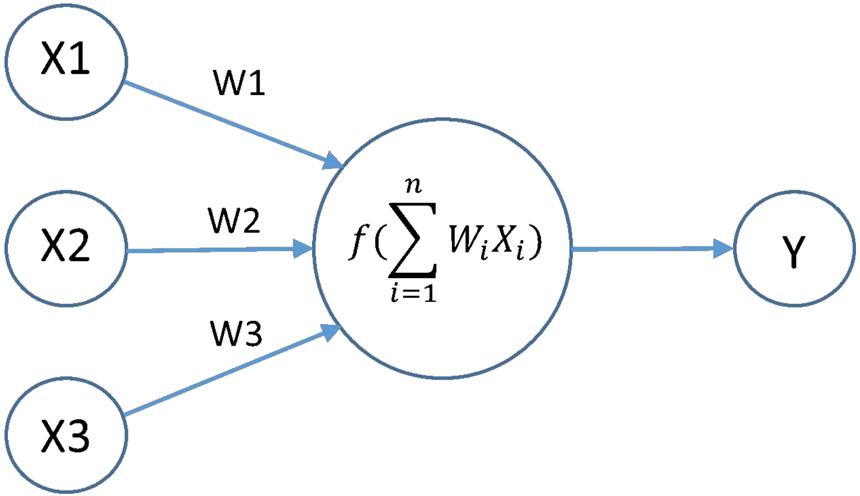
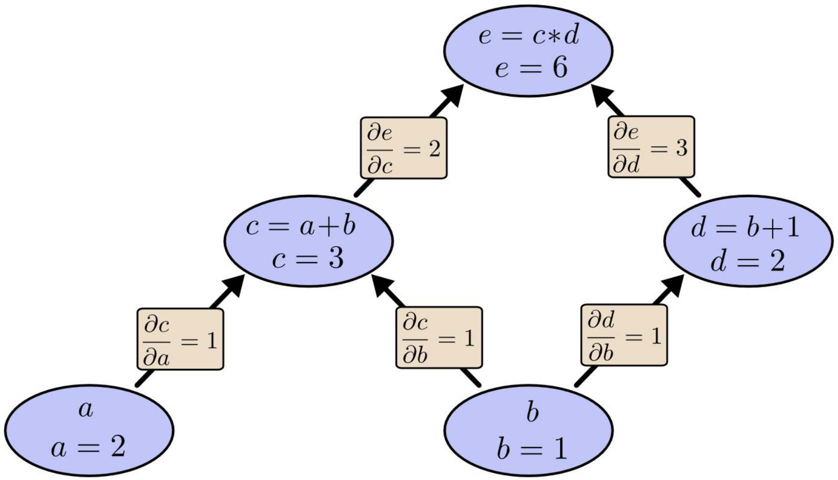
Neural Networks as Computational Graphs





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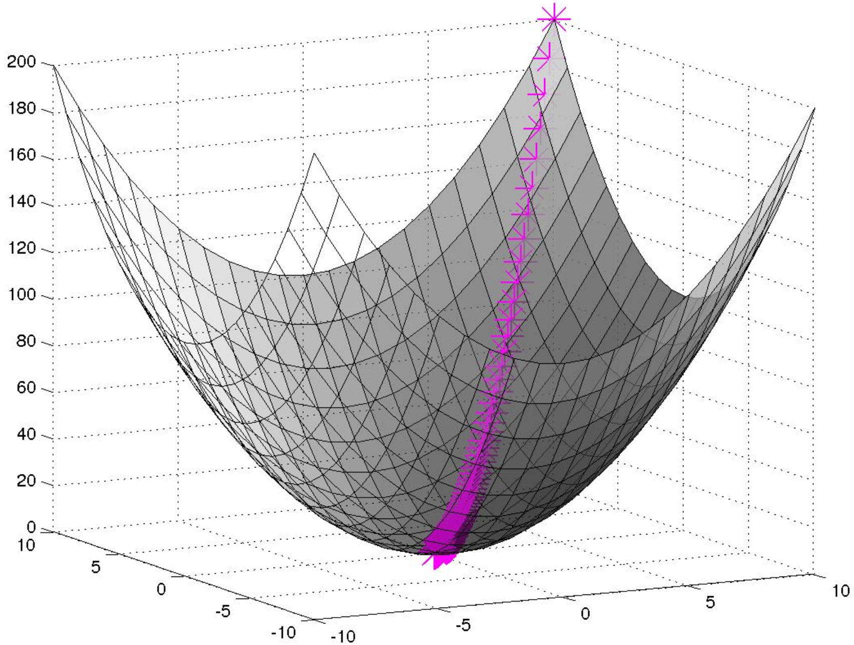
Gradient Descent

- The process by which your neural net is trained to be accurate
- Through numerous

  Iterations of logistic

  regression
- Reach the global minima!
-



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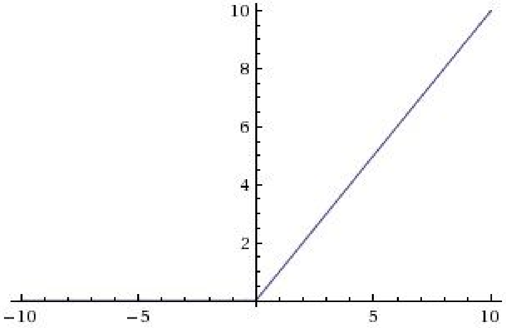
Logistic Regression Cost Function

- Used when output of neural network is 0 (false) or 1 (true)

Activation Functions

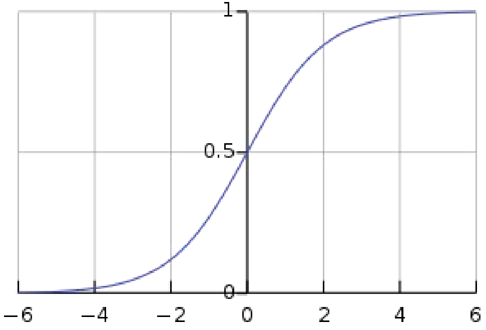
ReLU

(Rectified Linear Unit):



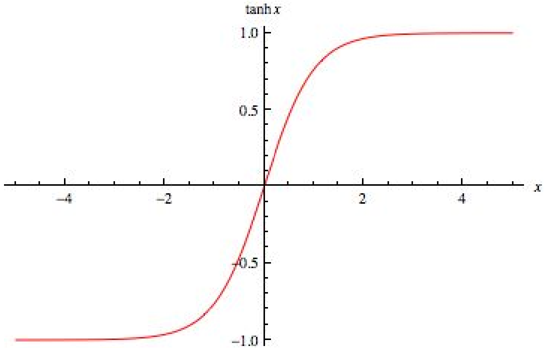
max(0,x)

Sigmoid ($\boldsymbol{\sigma}$):



1/(1+e^-x)

Tanh:



2*$\boldsymbol{\sigma}$(2x)-1

Levels of Supervision During Learning

Supervised Learning - you *have* labeled data; your data comes in pairs of input and desired output.

Unsupervised Learning - you *do not have* labeled data; your neural net looks to group different inputs based on similarities i.e. *clustering.*

Semi-supervised Learning - you have *some* labeled data; labeled data is expensive to generate, so you use a mix of labeled and unlabelled.

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A Tidbit on the Universal Approximation Theorem

A multilayer perceptron can approximate *continuous functions* on a compact subset of real numbers with mild assumptions on the activation function. (Thanks Wikipedia)

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A Basic Multilayer Perceptron with PyTorch

```python
import torch
import torch.nn as nn

class MLP(nn.Module):

    # one hidden layer
    def __init__(self, num_inputs, num_hiddens):
        super(MLP, self).__init__()
        self.fc1 = nn.Linear(num_inputs, num_hiddens)
        self.relu = nn.ReLU()
        self.fc2 = nn.Linear(num_hiddens, 1)

    def forward(self, x):
        output = self.fc1(x)
        output = self.relu(output)
        output = self.fc2(output)
        return output

net = MLP(5, 3)
print(net)

parameters = list(net.parameters())
print(parameters)
print(len(parameters))
print(parameters[0].size())
```

Output:

```
MLP (
  (fc1): Linear (5 -> 3)
  (relu): ReLU ()
  (fc2): Linear (3 -> 1)
)
[Parameter containing:
-0.1721  0.0375 -0.4098  0.0769 -0.4214
 0.0392 -0.1720  0.3798  0.1420 -0.4239
 0.3698  0.3336 -0.4313  0.3198  0.2039
[torch.FloatTensor of size 3x5]
, Parameter containing:
-0.2104
 0.0990
 0.1316
[torch.FloatTensor of size 3]
, Parameter containing:
-0.2340 -0.2816  0.4150
[torch.FloatTensor of size 1x3]
, Parameter containing:
 0.1908
[torch.FloatTensor of size 1]
]
4
torch.Size([3, 5])
```

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Paper Discussion Time!

http://cs.stanford.edu/~quocle/tutorial1.pdf

Read through, and we will reconvene in ~5minutes

**Feel free to start discussing with your peers if you finish beforehand!

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Real World Applications

Image Identification (CNNs)

Natural Language Processing (RNNs)

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Additional Resources

Andrew Ng's deeplearning.ai course (highly recommend!):

https://www.coursera.org/learn/neural-networks-deep-learning/lecture/Cuf2f/welcome

Segway for Next Workshop: PyTorch 60minute Blitz (with CNNs!):

http://pytorch.org/tutorials/beginner/deep_learning_60min_blitz.html

Challenge Yourself: Efficient Backprop by Yann LeCun

http://yann.lecun.com/exdb/publis/pdf/lecun-98b.pdf

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