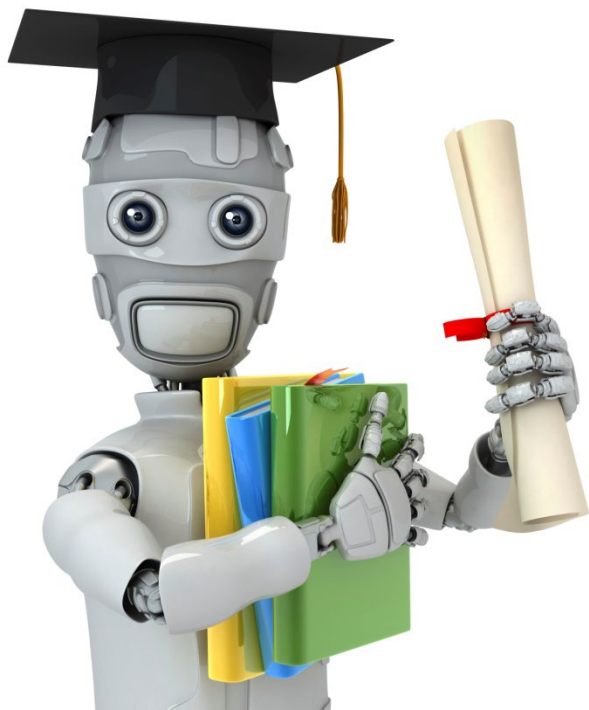


Machine Learning

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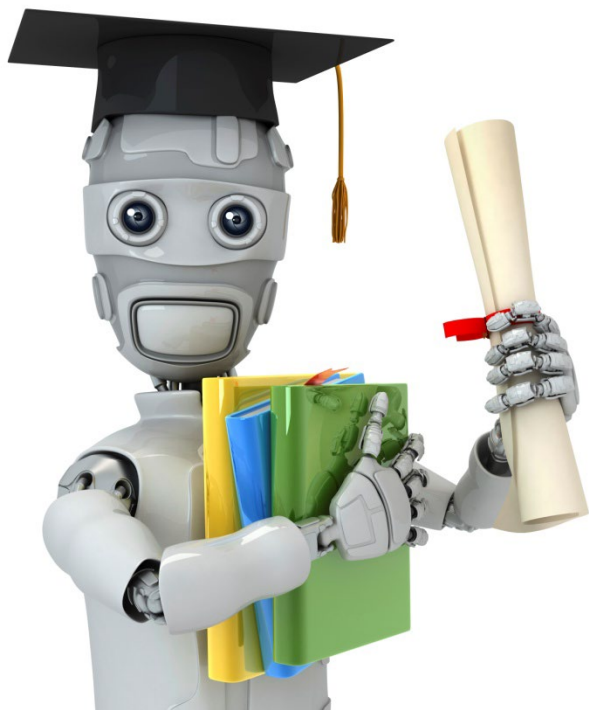
Basic operations



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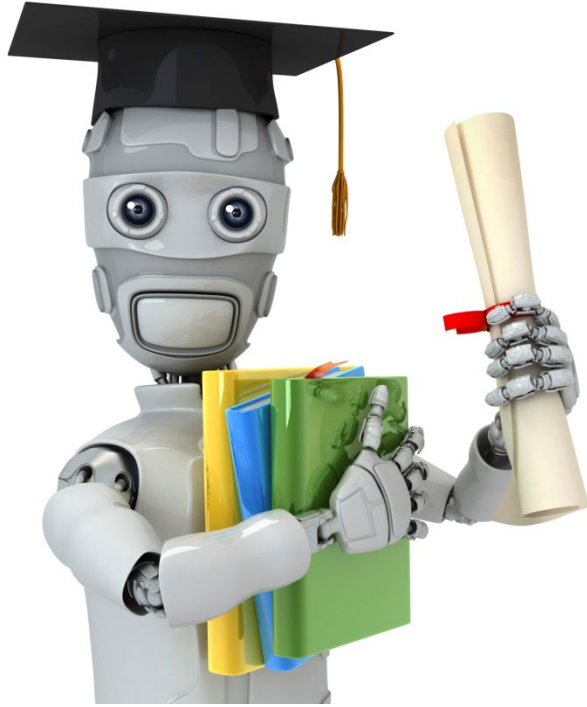
Moving data around



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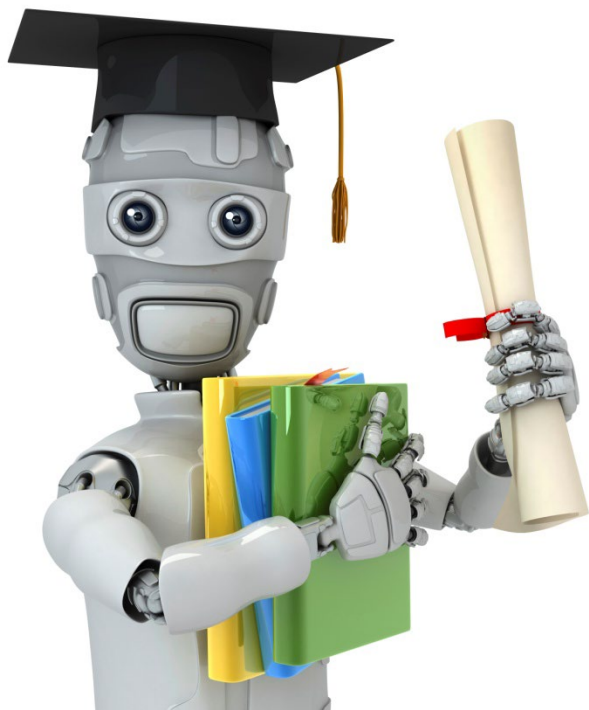
Computing on data



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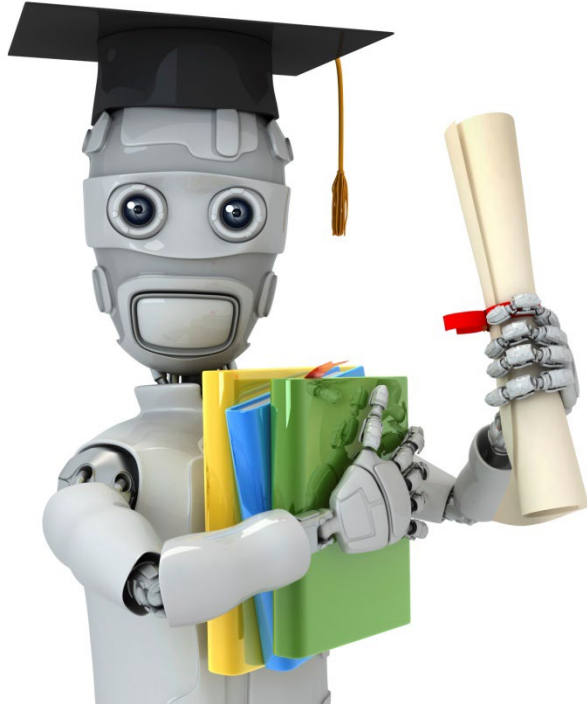
Plotting data



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Control statements: for,
while, if statements



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Vectorial implementation

Vectorization example.

$$\begin{aligned} h_{\theta}(x) &= \sum_{j=0}^n \theta_j x_j \\ &= \theta^T x \end{aligned}$$

Unvectorized implementation

```
prediction = 0.0;
for j = 1:n+1,
    prediction = prediction +
                  theta(j) * x(j)
end;
```

Vectorized implementation

```
prediction = theta' * x;
```

Vectorization example.

$$\begin{aligned}h_{\theta}(x) &= \sum_{j=0}^n \theta_j x_j \\ &= \theta^T x\end{aligned}$$

Unvectorized implementation

```
double prediction = 0.0;
for (int j = 0; j < n; j++)
    prediction += theta[j] * x[j];
```

Vectorized implementation

```
double prediction
    = theta.transpose() * x;
```


Gradient descent

$$\theta_j := \theta_j - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_j^{(i)} \quad (\text{for all } j)$$

$$\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_0^{(i)}$$

$$\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_1^{(i)}$$

$$\theta_2 := \theta_2 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_2^{(i)}$$

$$\begin{aligned}\theta_0 &:= \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_0^{(i)} \\ \theta_1 &:= \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_1^{(i)} \\ \theta_2 &:= \theta_2 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_2^{(i)} \\ (n &= 2)\end{aligned}$$

$$u(j) = 2v(j) + 5w(j) \quad (\text{for all } j)$$

$$u = 2v + 5w$$