Decision Boundary

In order to get our discrete 0 or 1 classification, we can translate the output of the hypothesis function as follows:

```
\begin{align*}& h_\theta(x) \geq 0.5 \rightarrow y = 1
\newline& h_\theta(x) < 0.5 \rightarrow y = 0
\newline\end{align*}
```

The way our logistic function g behaves is that when its input is greater than or equal to zero, its output is greater than or equal to 0.5:

```
\begin{align*}& g(z) \geq 0.5 \newline& when \; z \geq
0\end{align*}
```

Remember.

```
\begin{align*}z=0, e^{0}=1 \Rightarrow
g(z)=1/2\newline z \to \infty, e^{-\infty} \to 0
\Rightarrow g(z)=1 \newline z \to -\infty, e^{\infty}\to
\infty \Rightarrow g(z)=0 \end{align*}
```

So if our input to g is $\theta^T X$, then that means:

```
\begin{align*}& h_\theta(x) = g(\theta^T x) \geq 0.5
\newline& when \; \theta^T x \geq 0\end{align*}
```

From these statements we can now say:

```
\begin{align*}& \theta^T x \geq 0 \Rightarrow y = 1
\newline& \theta^T x < 0 \Rightarrow y = 0
\newline\end{align*}
```

The **decision boundary** is the line that separates the area where y = 0 and where y = 1. It is created by our hypothesis function.

Example:

```
\begin{align*}& \theta = \begin{bmatrix}5 \newline -1
\newline 0\end{bmatrix} \newline & y = 1 \; if \; 5 +
(-1) x_1 + 0 x_2 \geq 0 \newline & 5 - x_1 \geq 0
\newline & - x_1 \geq -5 \newline& x_1 \leq 5
\newline \end{align*}
```

In this case, our decision boundary is a straight vertical line placed on the graph where $x_1 = 5$, and everything to the left of that denotes y = 1, while everything to the right denotes y = 0.

Again, the input to the sigmoid function g(z) (e.g. $\theta^T X$) doesn't need to be linear, and could be a function that describes a circle (e.g. $z = \theta_0 + \theta_1 x_1^2 + \theta_2 x_2^2$) or any shape to fit our data.