IMPORTANT CONTACT NUMBERS

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$$P(y=1 \mid x;\theta) = \frac{1}{1+e^{-\theta^T x}} = \frac{e^{\theta^T x}}{1+e^{\theta^T x}}$$

$$\theta^T x = \theta_0 + \sum_{i=1}^{n} \theta_i x_i$$

$$P(y=0 \mid x;\theta) = \frac{1}{1+e^{\theta^T x}}$$

$$P(y=1 \mid x) > P(y=0 \mid x)$$

$$\Rightarrow \frac{e^{\theta^T x}}{1+e^{\theta^T x}} > \frac{1}{1+e^{\theta^T x}}$$

$$\Rightarrow e^{\theta^T x} > 1 \Rightarrow \theta^T x > 0 \Rightarrow \theta_0 + \sum \theta_i x_i > 0$$

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$$h_\theta(x^i) = \frac{e^{\theta^T x^i}}{1+e^{\theta^T x^i}} = \frac{e^A}{1+e^A} \qquad A = \theta^T X$$

$$1 - h_\theta(x^i) = \frac{1}{1+e^A}$$

$$l(\theta) = \sum y^i \log h_\theta(x^i) + (1-y^i)\log\left(\underline{1 - h_\theta(x^i)}\right)$$

$$= \sum \left(y^i \log \frac{e^A}{1+e^A} + (1-y^i) \log \frac{1}{1+e^A} \right)$$

$$= \sum \left(y^i \log e^A - y^i \underline{\log(1+e^A)} - (1-y^i)\underline{\log(1+e^A)} \right)$$

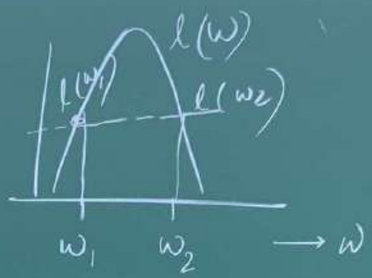
$$= \sum y^i \log e^A - \log(1+e^A)$$

$$= \sum \left(y^i A - \log(1+e^A) \right) = \sum_{i=1}^{m} \left(\underline{y^i \left(\sum_{j=0}^{n} \theta_j x_j^i \right) - \log\left(1 + e^{\sum_{j=1}^{n} \theta_j x_j^i} \right)} \right)$$

$$= \sum_{i=1}^{m} y^i \underbrace{\theta^T x^i}_{f_i(\theta)} - \underbrace{\sum_{i=1}^{m} \log\left(1 + \exp(\theta^T x^i)\right)}_{g(x_i,\theta)} \quad g(x_i,\theta)$$

Concave f^n

$l(w)$ is concave. if the line joining two points, $l(w_1)$ and $l(w_2)$ does not lie above the fnction on the interval $[w_1, w_2]$



$$l\left(t x_1 + (1-t) x_2\right) \geq t\, l(x_1) + (1-t)\, l(x_2) \text{ "}$$

$$t \in [0, 1] \qquad x_1, x_2 \in [w_1, w_2]$$

1. if f is convex, $-f$ is concave and vice versa ✓

2. A linear combination of n convex functions is also a convex (same for concave)
coeff should be non-negative.

3. The second derivative of a convex function (should be twice differentiable) is non-negative $\rightarrow f(x) = \log(1 + \exp(x))$
$\rightarrow$ convex

4. if f and g are convex, $g \circ f = g(f(\cdot))$ is convex

$$\rightarrow \ell(w) = \underbrace{\sum_{i=1}^{m} y^i f_i(\theta)}_{\text{convex/concave}} - \sum_{i=1}^{m} g(f_i(\theta))$$