For given loss function, get (eta_m,G_m) and $f_m(x)$

$$L(y, f(x)) = \exp(-y f(x)).$$

$$(\beta_m, G_m) = \arg\min_{\beta, G} \sum_{i=1}^N \exp[-y_i (f_{m-1}(x_i) + \beta G(x_i))]$$

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1. Let
$$W_i^{(m)} = e^{-\gamma_i \int_{W_i}(x_i)}$$
. We know that $W_i^{(m)}$ does not depend on β or G_i .

$$(\beta_{m},G_{m}) = \underset{\beta,G}{\operatorname{arg min}} \sum_{i=1}^{N} \omega_{i}^{(m)} e^{-\beta \gamma_{i}G_{i}(x_{i})} \text{ For a given } \beta > 0, G_{m} = \underset{G}{\operatorname{arg min}} \sum_{i=1}^{N} \omega_{i}^{(m)} e^{-\gamma_{i}G_{i}(x_{i})} \text{ Since } \omega_{i}^{(m)} \geq 0 \text{ for } \alpha \in \mathbb{R}$$

p.G = 1 Gm = arg min
$$\sum_{i=1}^{N} \omega_i^{(m)} I(y_i \neq G(x_i))$$

all i, and does not depend on G,
$$G_m = \underset{\leftarrow}{arg min} \sum_{i=1}^{N} w_i^{(m)} I(y_i \neq G(x_i))$$

Then,
$$\beta_m = \arg\min_{i=1}^{N} \sum_{i=1}^{N} \omega_i^{(m)} e^{-\beta y_i G_m(x_i)}$$

$$\sum_{i=1}^{N} \omega_i^{(m)} e^{-\beta y_i G_m(x_i)} = \sum_{y_i = G(x_i)} \omega_i^{(m)} e^{-\beta} + \sum_{y_i = G(x_i)} \omega_i^{(m)} e^{\beta} = \left(\sum_{i=1}^{N} \omega_i^{(m)} e^{-\beta} - \sum_{y_i \neq G(x_i)} \omega_i^{(m)} e^{-\beta} \right) + \sum_{i=1}^{N} \omega_i^{(m)} e^{-\beta y_i + G(x_i)} e^{-\beta y_i + G(x_i)}$$

$$\sum_{j \neq G(x_{i})} \omega_{i}^{(m)} e^{\beta} = (e^{\beta} - e^{-\beta}) \sum_{j \neq G(x_{i})} \omega_{i}^{(m)} + e^{-\beta} \sum_{i=1}^{N} \omega_{i}^{(m)} = \left(\sum_{i=1}^{N} \omega_{i}^{(m)}\right) \left((e^{\beta} - e^{-\beta}) \frac{\sum_{j=1}^{N} \omega_{j}^{(m)}}{\sum_{i=1}^{N} \omega_{i}^{(m)}} + e^{-\beta}\right) := \sum_{j=1}^{N} \omega_{i}^{(m)} \left((e^{\beta} - e^{-\beta}) \operatorname{crr}_{m} + e^{-\beta}\right)$$

$$\begin{array}{ll}
\mathbf{P} &= \left(\mathbf{e}^{\mathbf{r}} - \mathbf{e}^{\mathbf{r}}\right) \sum_{\mathbf{j} \neq \mathbf{G}(\mathbf{x}_i)} \mathbf{\omega}_i^{(m)} + \mathbf{e}^{\mathbf{r}} \sum_{i=1}^{n} \mathbf{\omega}_i^{(m)} = \left(\sum_{i=1}^{n} \mathbf{\omega}_i^{(m)}\right) \left(\left(\mathbf{e}^{\mathbf{r}} - \mathbf{e}^{-\mathbf{r}}\right)\right) \\
\mathbf{E} &= \left(\mathbf{e}^{\mathbf{r}} - \mathbf{e}^{\mathbf{r}}\right) \sum_{\mathbf{j} \in \mathbf{G}(\mathbf{x}_i)} \mathbf{\omega}_i^{(m)} + \mathbf{e}^{\mathbf{r}} \sum_{i=1}^{n} \mathbf{\omega}_i^{(m)} = \left(\sum_{i=1}^{n} \mathbf{\omega}_i^{(m)}\right) \left(\left(\mathbf{e}^{\mathbf{r}} - \mathbf{e}^{-\mathbf{r}}\right)\right) \\
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$$\therefore \arg\min_{\beta} \sum_{i=1}^{N} \omega_{i}^{(m)} e^{-\beta \gamma_{i} Q_{m}(x_{i})} = \arg\min_{\beta} (e^{\beta} - e^{-\beta}) \operatorname{err}_{m} + e^{-\beta} := \arg\min_{\beta} f(\beta; m)$$

$$\frac{3}{3\theta}f(\theta;m) = (e^{\theta} + e^{-\theta})\operatorname{err}_m - e^{-\theta} \qquad (e^{\theta m} + e^{-\theta m})\operatorname{err}_m - e^{-\theta m} = 0 \qquad e^{\theta m} = e^{-\theta m}\frac{(1 - \operatorname{err}_m)}{\operatorname{err}_m} \qquad e^{2\theta m} = \frac{1 - \operatorname{err}_m}{\operatorname{err}_m}$$

$$\therefore \beta_{m} = \frac{1}{\lambda} \log \frac{1}{\lambda}$$

$$\therefore \beta_m = \frac{1}{2} \log \frac{1 - err_m}{err_m}$$

2.
$$f_{m}(x) = f_{m-1}(x) + f_{m}G_{m}(x)$$

 $W_i^{(mti)} = e^{-\gamma_i f_{mi}(x_i)} = e^{-\gamma_i f_{mi}(x_i)} e^{-\beta_m \gamma_i G_{mi}(x_i)}$

basis function: individual classifier (stump) $G_m(x) \in \{-1,1\}$