9. binary classifier g: $P(g(\vec{x}) = -1 \mid y = +1) = \varepsilon_+$

$P(g(\vec{x}) = +1 \mid y = -1) = \varepsilon_-$

distribution: $P(y=+1) = P(y=-1) = \frac{1}{2}$

$\rightarrow E_{out}(g) = \frac{1}{2}\varepsilon_+ + \frac{1}{2}\varepsilon_-$

distribution: $P(y=-1) = p$

constant classifier $g_c \rightarrow E_{out}(g_c) = p$

(always predict +1)

$E_{out}(g)$ over distribution $P(y=-1)=p$:

$\rightarrow P(y=+1) = 1-p$

$$E_{out}(g) = P(g(\vec{x}) = -1 \mid y=+1)\, P(y=+1) + P(g(\vec{x}) = +1 \mid y=-1)\, P(y=-1)$$

$$= (1-p)\varepsilon_+ + p\varepsilon_-$$

$E_{out}(g) = E_{out}(g_c)$:

$$(1-p)\varepsilon_+ + p\varepsilon_- = p$$

$\rightarrow \varepsilon_+ - p\varepsilon_+ + p\varepsilon_- = p$

$\rightarrow \varepsilon_+ = p + p\varepsilon_+ - p\varepsilon_-$

$\rightarrow \varepsilon_+ = p(1 + \varepsilon_+ - \varepsilon_-)$

$\rightarrow p = \dfrac{\varepsilon_+}{1 + \varepsilon_+ - \varepsilon_-}$ $\square$