bayes' rule & diagnostic testing

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early HIV testing in the military

- first screen with ELISA
- if positive, two more rounds of ELISA
- if either positive, two Western blot assays
- only if both positive, determine HIV infection

data

ELISA

- sensitivity (true positive): 93%
- specificity (true negative): 99%

$P(+ \mid HIV) = 0.93$

$P(- \mid no\ HIV) = 0.99$

Western blot

- sensitivity: 99.9%
- specificity: 99.1%

prevalence: 1.48 / 1000

$P(HIV) = 0.00148$

$$P(has\ HIV \mid ELISA +) = ?$$

Sources:

- Petricciani (1985). Licensed tests for antibody to human T-lymphotropic virus type III: sensitivity and specificity. Annals of internal medicine, 103(5), 726-729.
- Burke et. al. (1987). Diagnosis of human immunodeficiency virus infection by immunoassay using a molecularly cloned and expressed virus envelope polypeptide: comparison to Western blot on 2707 consecutive serum samples. Annals of internal medicine, 106(5), 671-676.
- Burke et. al. (1987). Human immunodeficiency virus infections among civilian applicants for United States military service, October 1985 to March 1986. New England Journal of Medicine, 317(3), 131-136.

prior probability

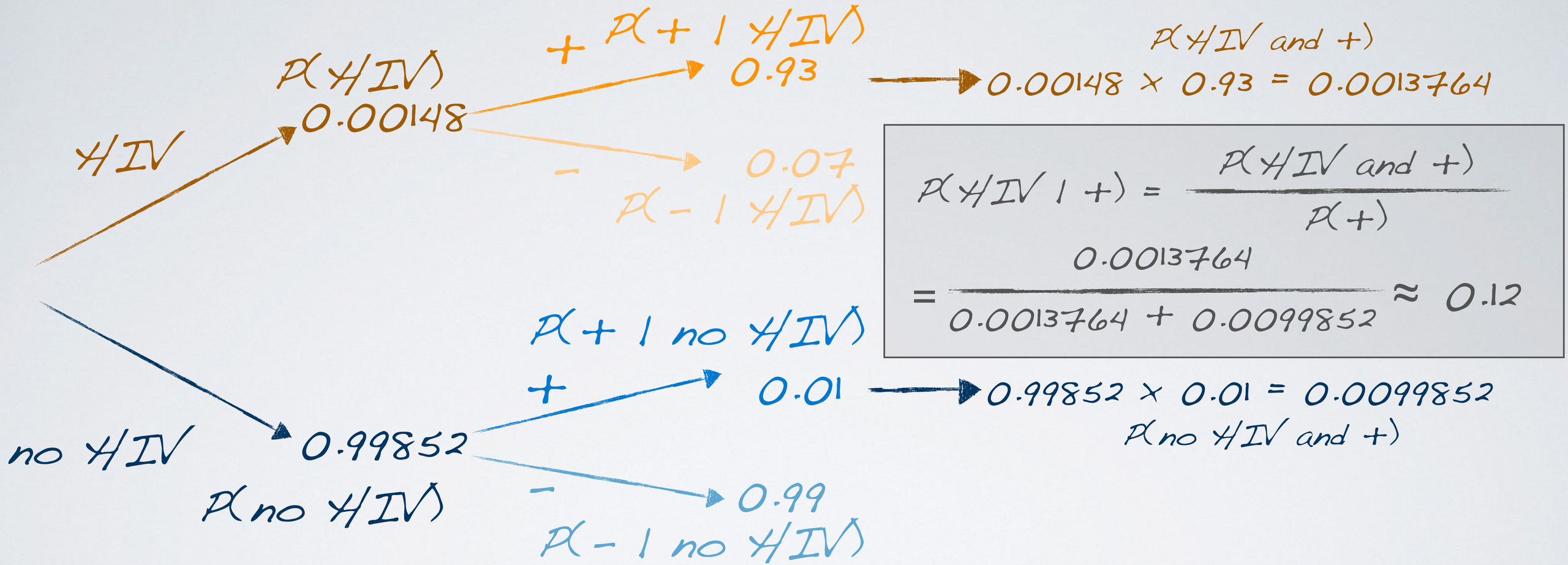
Prior to any testing, what probability should be assigned to a recruit having HIV?

$P(HIV) = 0.00148$

posterior probability

When a recruit goes through HIV screening there are two competing claims: recruit has HIV and recruit doesn't have HIV. If the ELISA yields a positive result, what is the probability this recruit has HIV?

posterior probability



$$P(\text{HIV} \mid +) = \frac{P(\text{HIV and } +)}{P(+)}$$

$$= \frac{0.0013764}{0.0013764 + 0.0099852} \approx 0.12$$