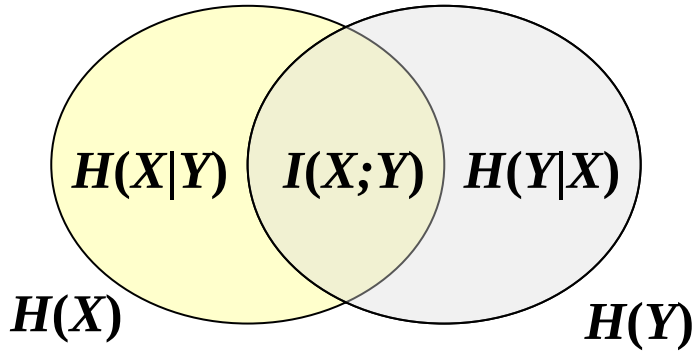
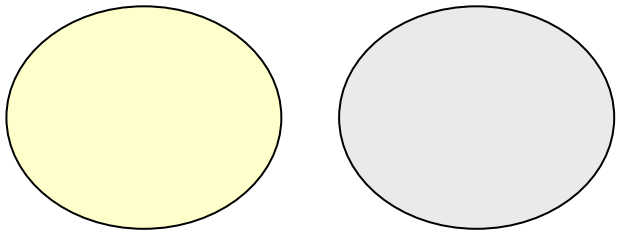
conditional entropy, mutual information

$$H(X \mid Y) = H(X,Y) - H(Y)$$

$$I(X;Y) = H(X) + H(Y) - H(X,Y)$$

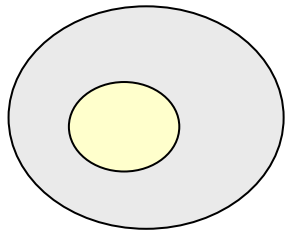


X and Y are independent



$$H(X|Y) = H(X)$$
$$I(X;Y) = 0$$

X is determined by Y

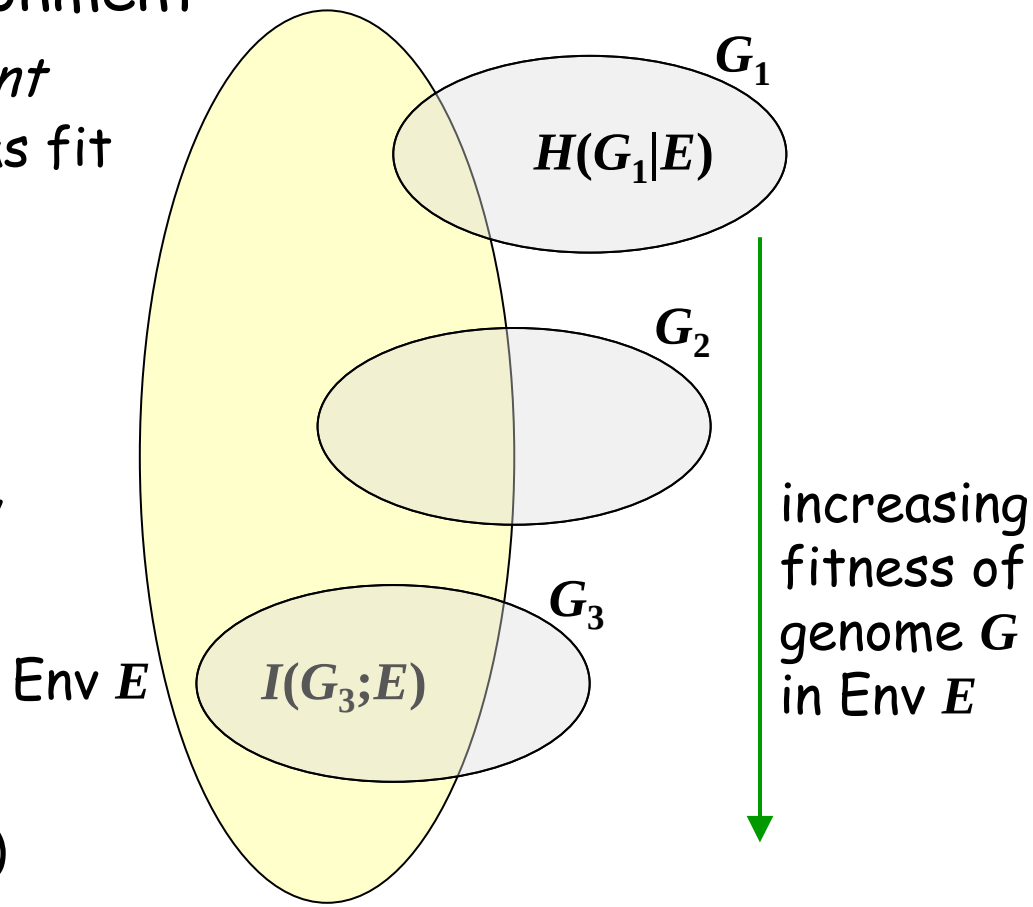


$$H(X|Y) = 0$$
$$I(X;Y) = H(X)$$

example: evolution

[Adami 2002]

- consider information in the genome *in the context of* information in the environment
  - *same* genome in a *different* environment wouldn't be as fit
- evolution is ***increasing mutual information***
  - fitter organisms exploit their environment better, so must contain more info about their env
  - (total information in a genome can change, as genome changes size, etc)



example: emergence

[Weeks et al 2007]

- consider information in the high level description S *in the context of* information in the low level description E
  - *same* high level model in a *different* low level environment wouldn't be as good
- modelling /engineering as ***increasing mutual information***
  - small H(S|E) ⇒ good model / impl
  - large H(E|S) ⇒ redundancy
  - use I as a fitness function to search for better models / impls ?