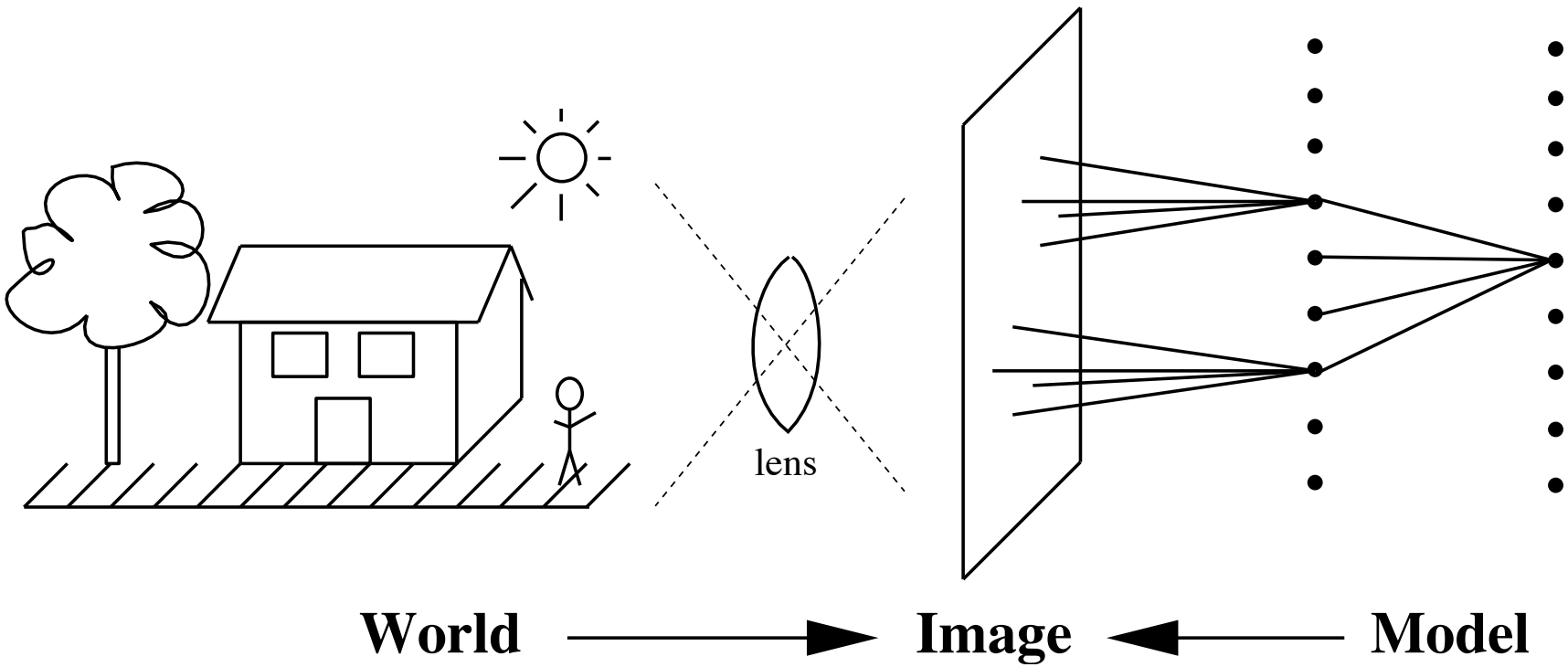
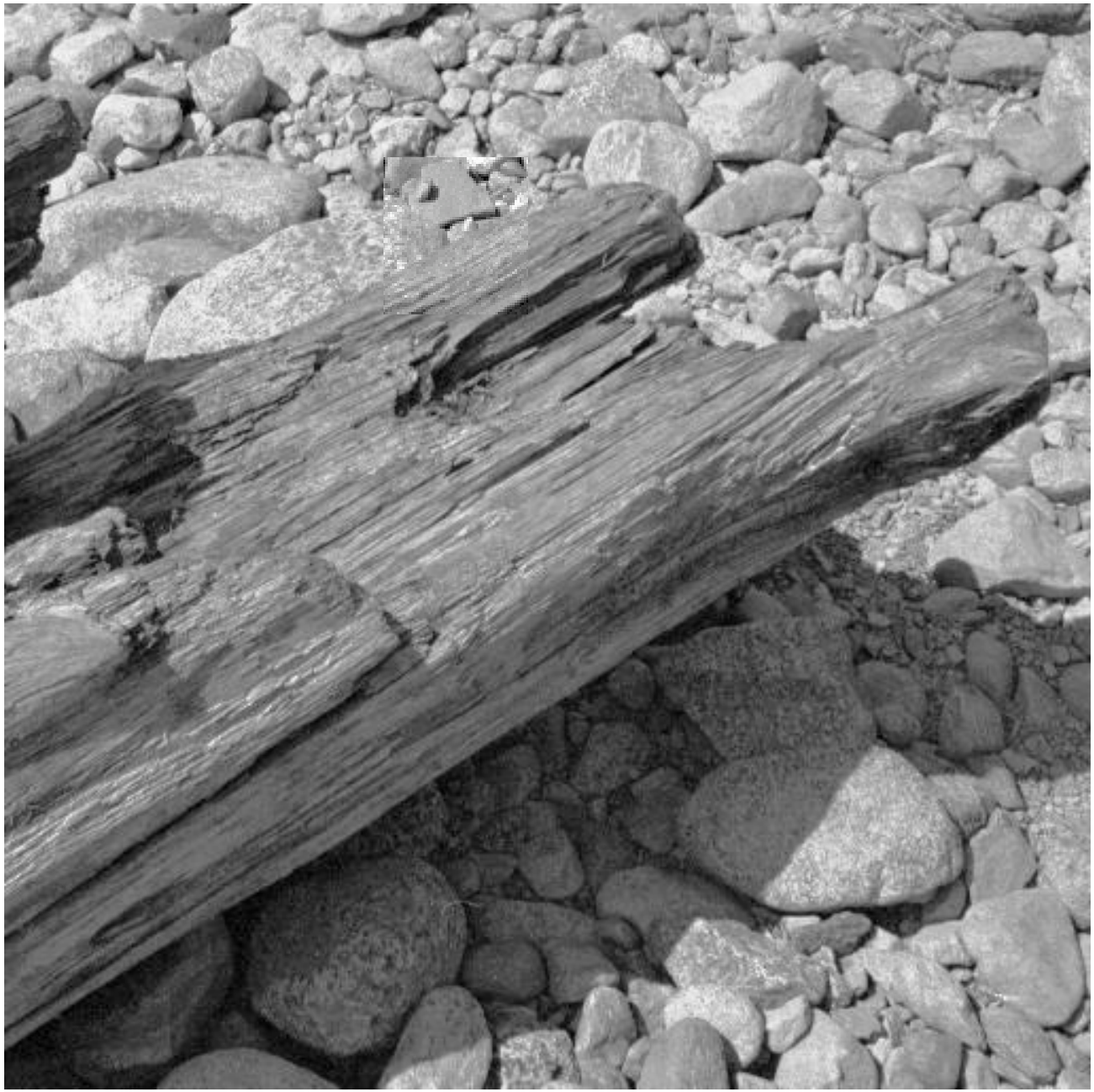
Perception as inference



Natural scenes are full of ambiguity



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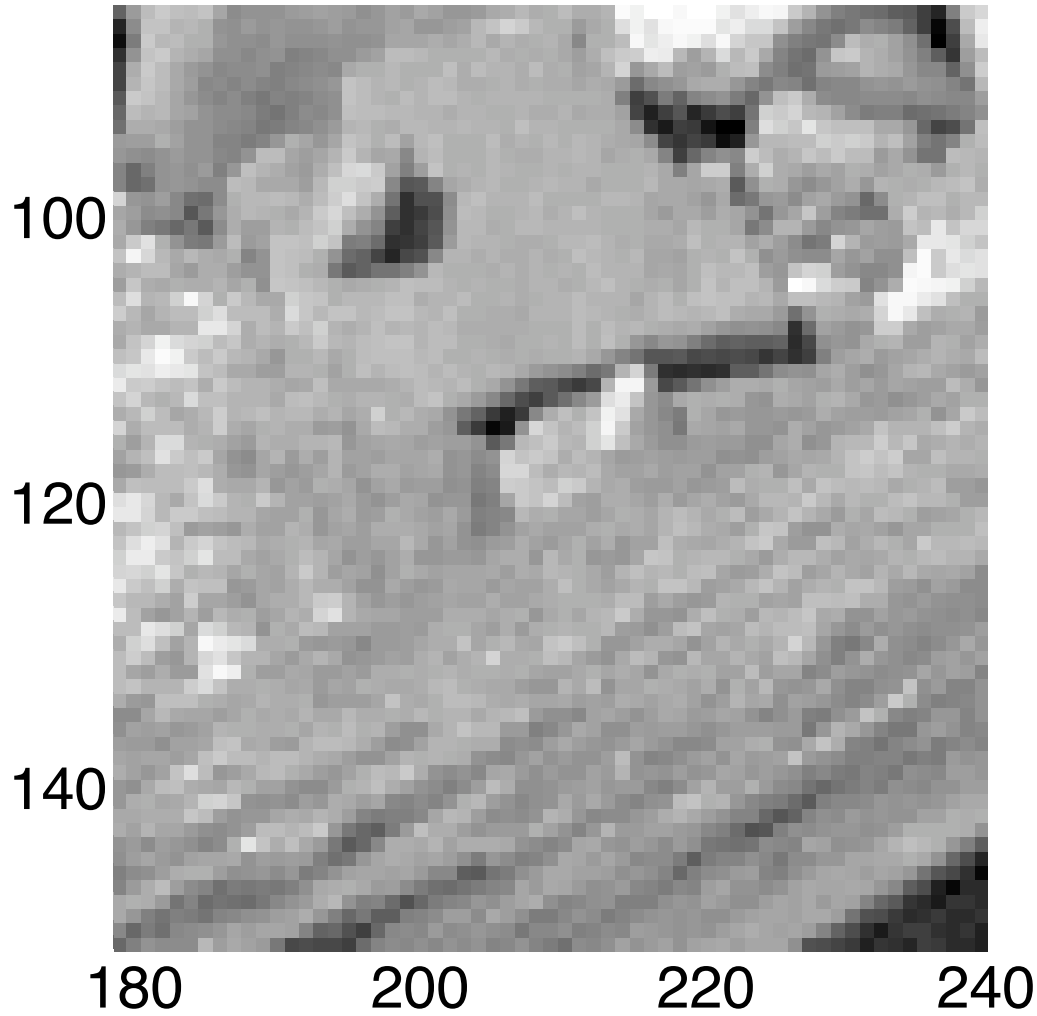
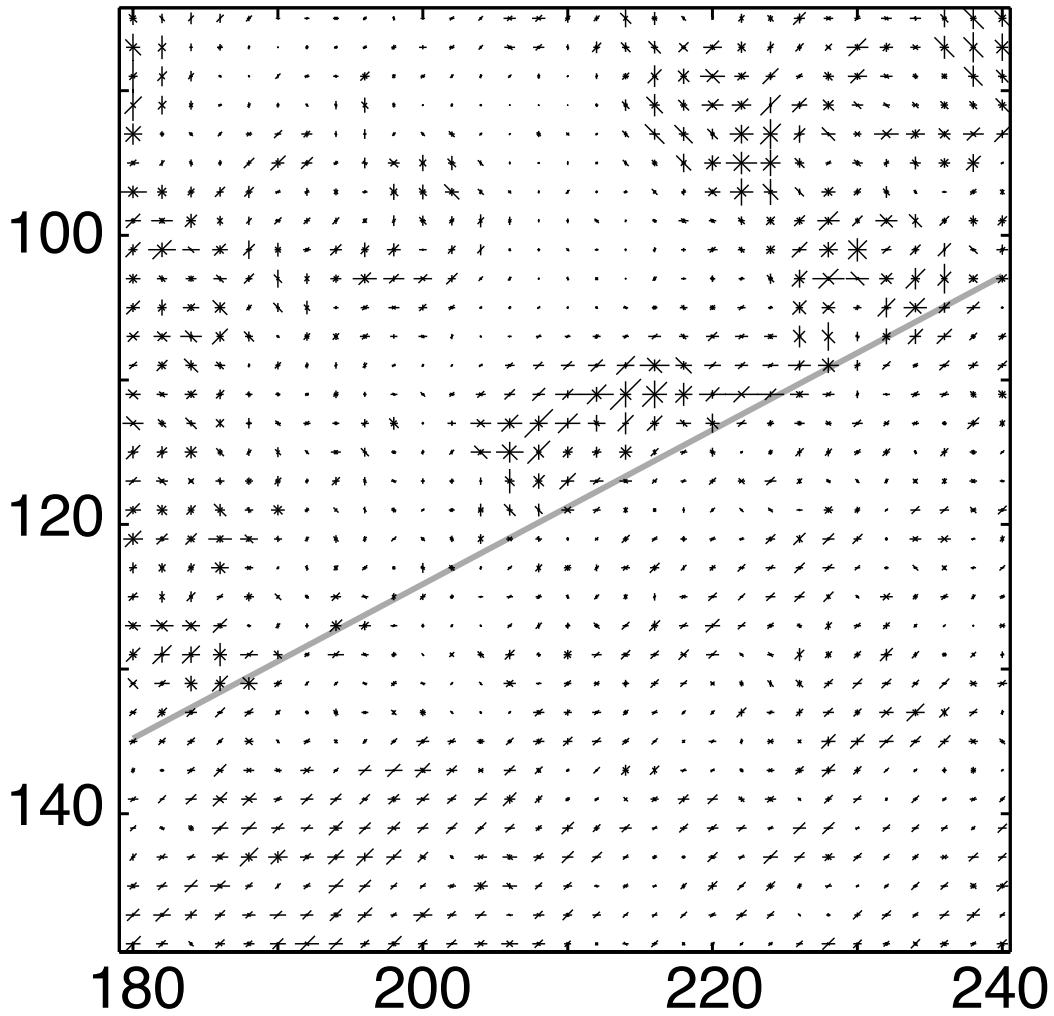




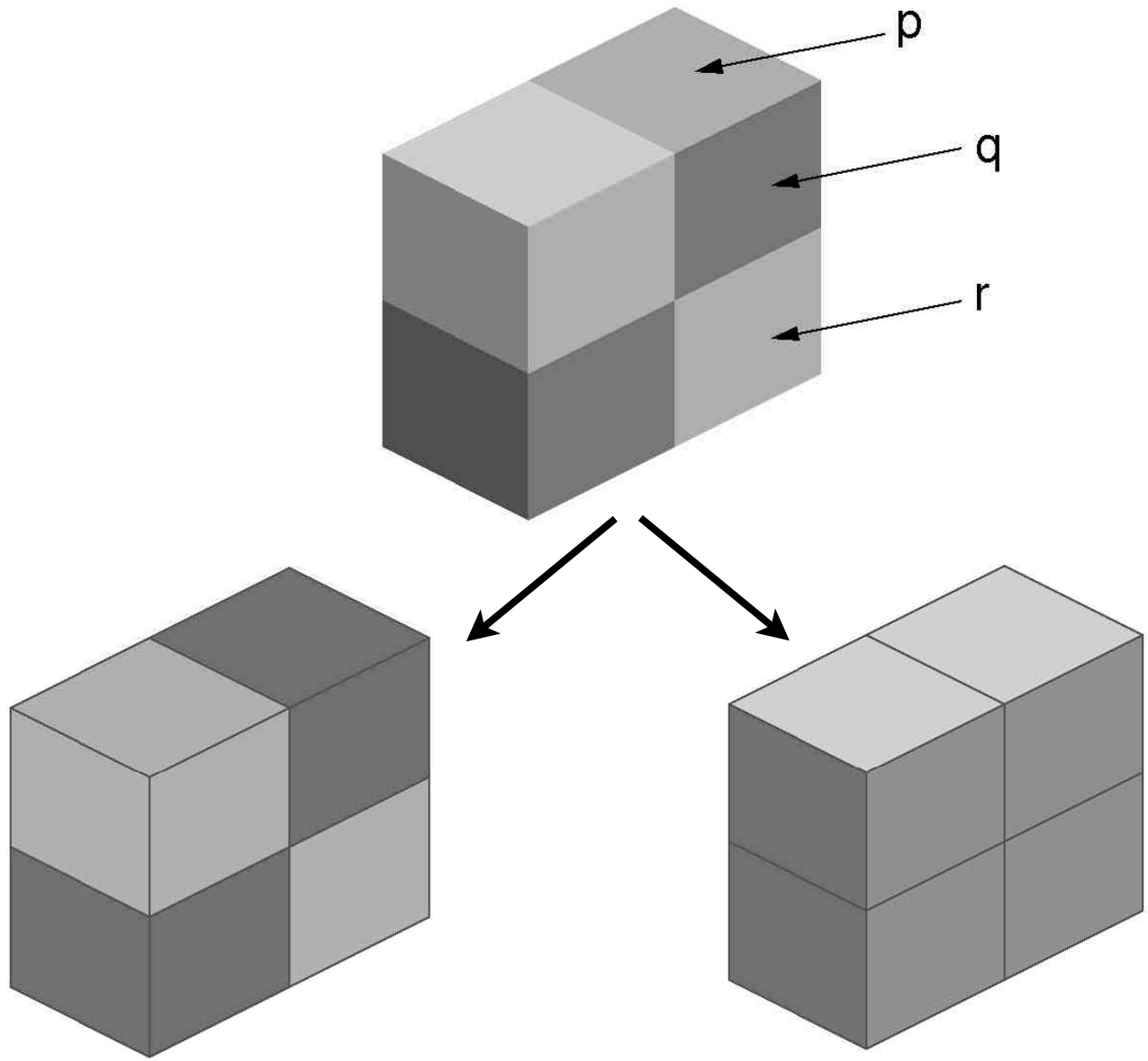
What do these edges mean?

What do these edges mean?

What do these edges mean?

What is this?

What do these edges mean?

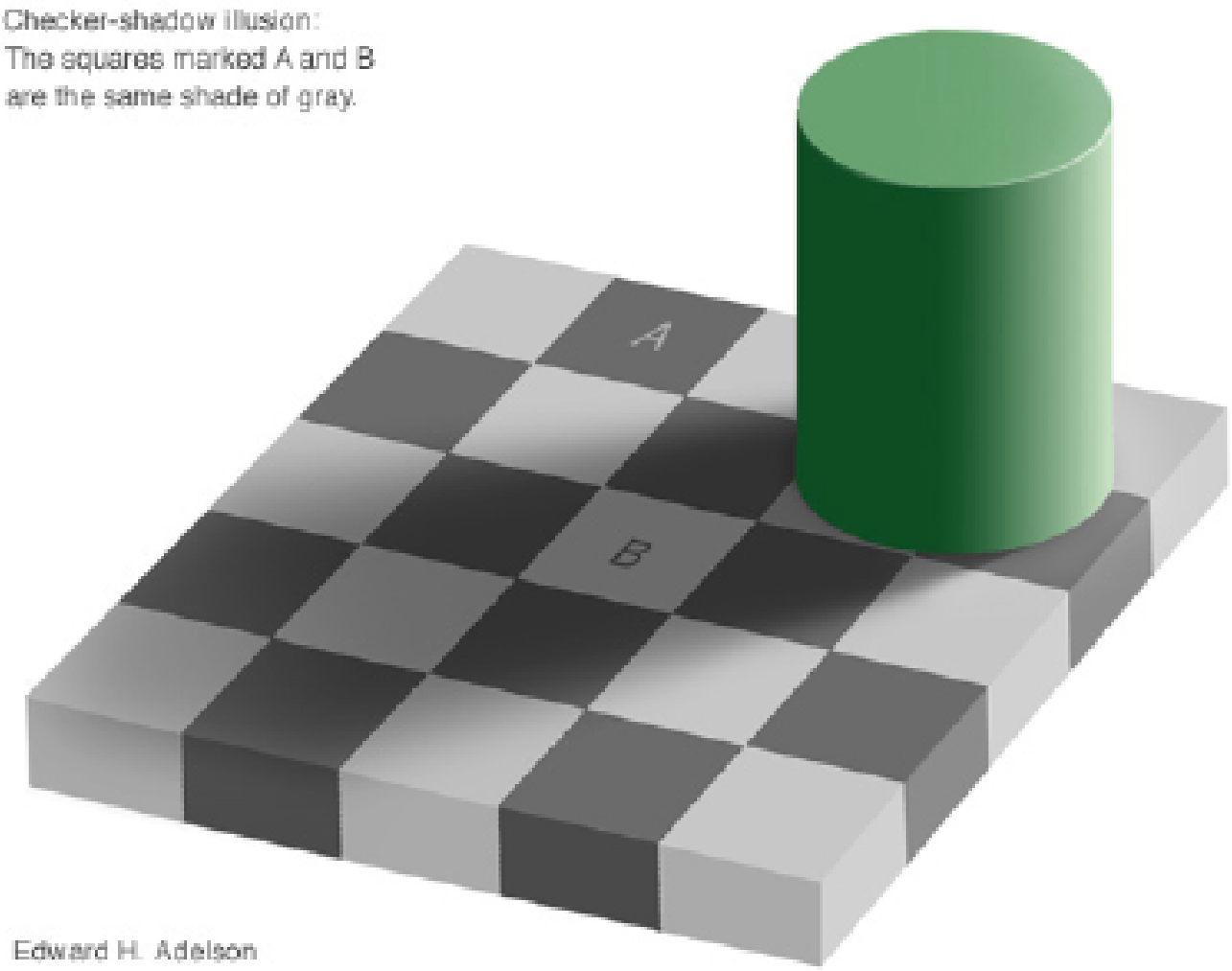


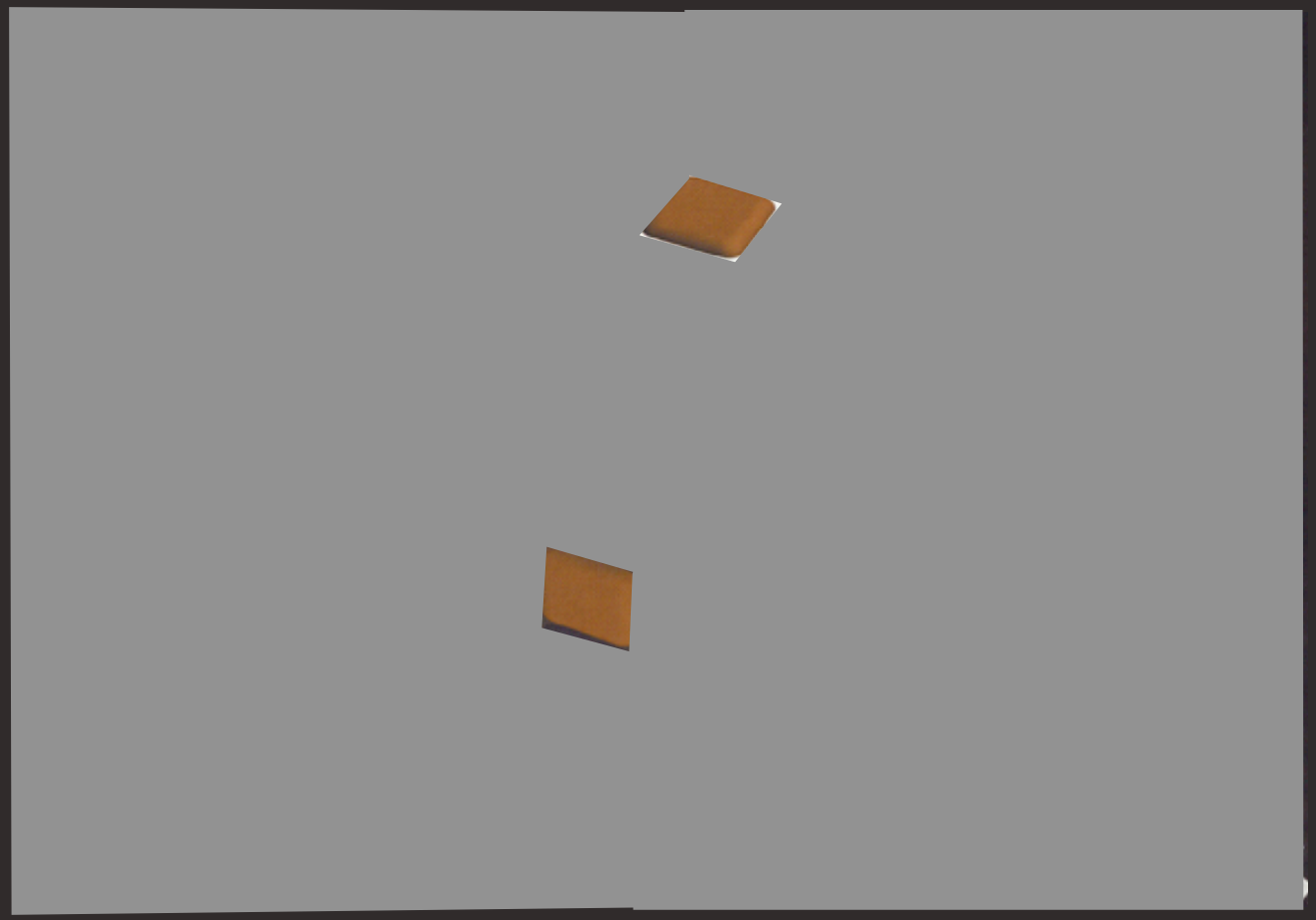
reflectance

shading

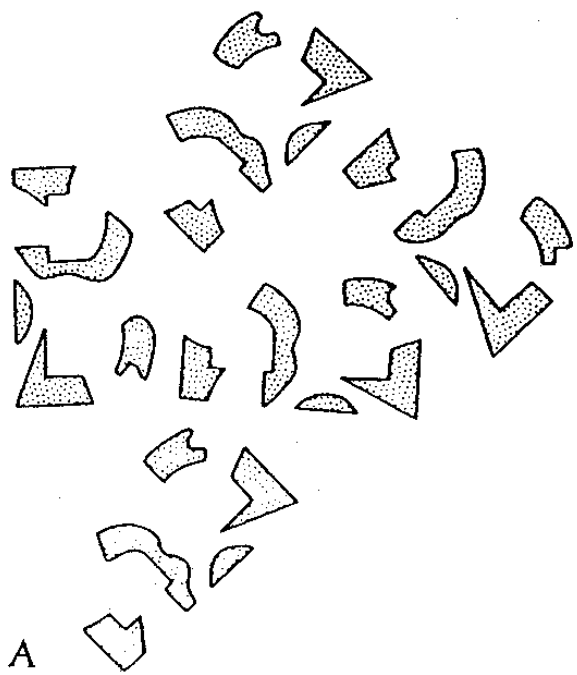
(Adelson, 2000)

Lightness perception depends on 3D scene layout





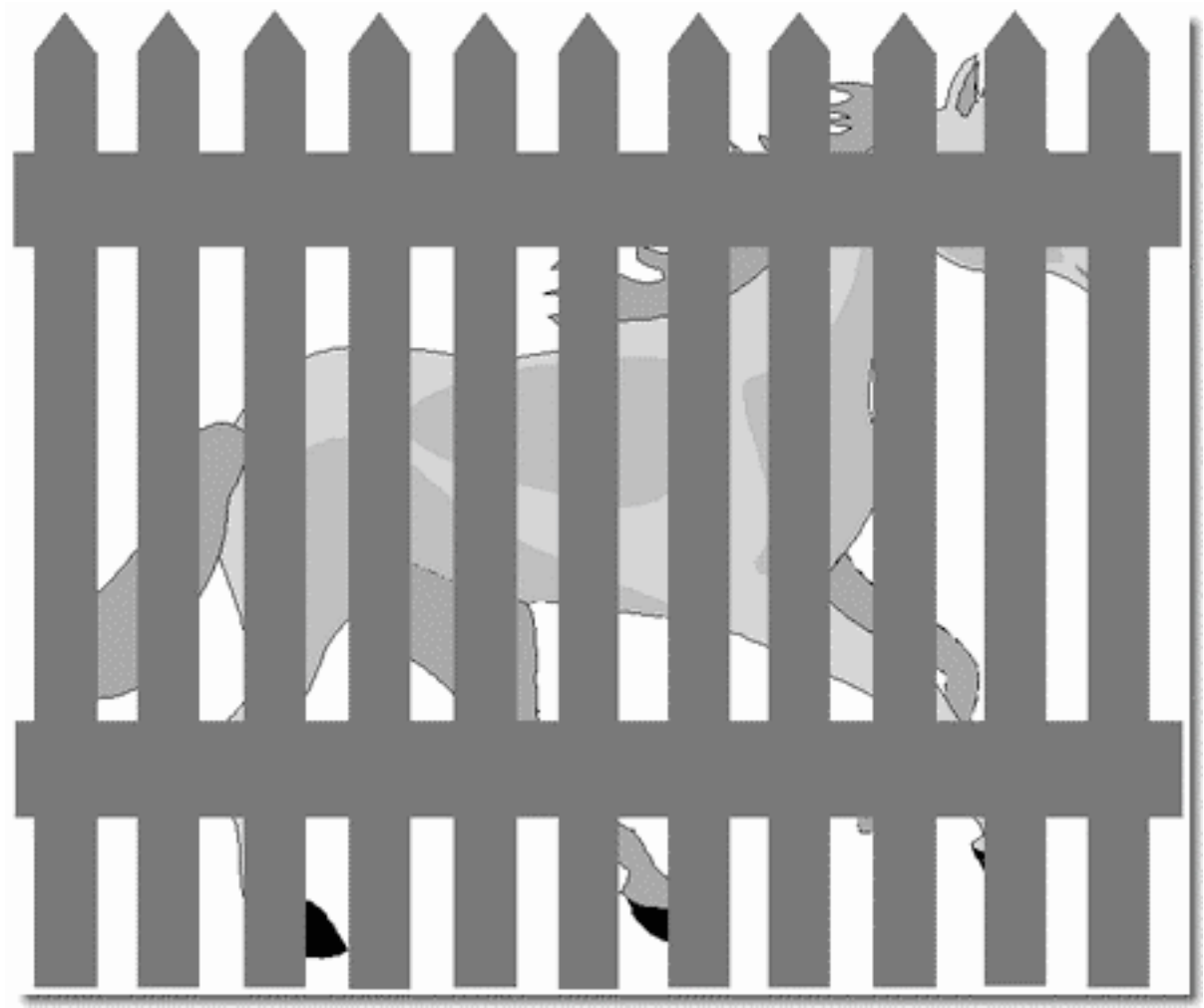
What are the letters?



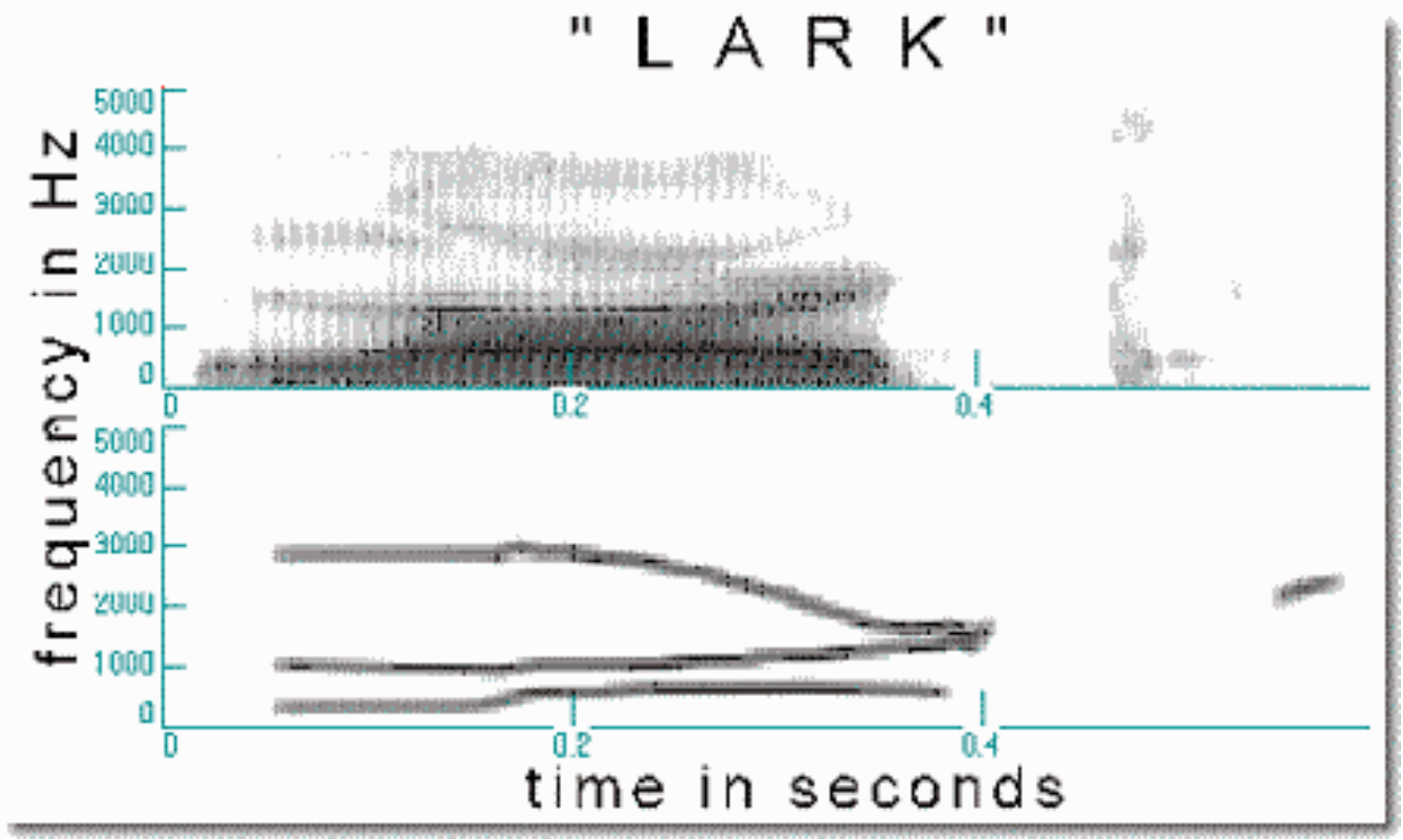
A

Picket-fence effect with speech

(from Bregman 'Auditory Scene Analysis')



Sinewave speech



Sinewave speech

Please say what this word is

sill
shook
rust
wed
pass
lark
jaw
coop
beak

Bayes' rule

$$P(E|D) \propto \underbrace{P(D|E)}_{\substack{\text{how data is} \\ \text{generated by} \\ \text{the environment}}} \times \underbrace{P(E)}_{\substack{\text{prior beliefs} \\ \text{about the} \\ \text{environment}}}$$

E = the actual state of the environment

D = data about the environment

Bayesian inference

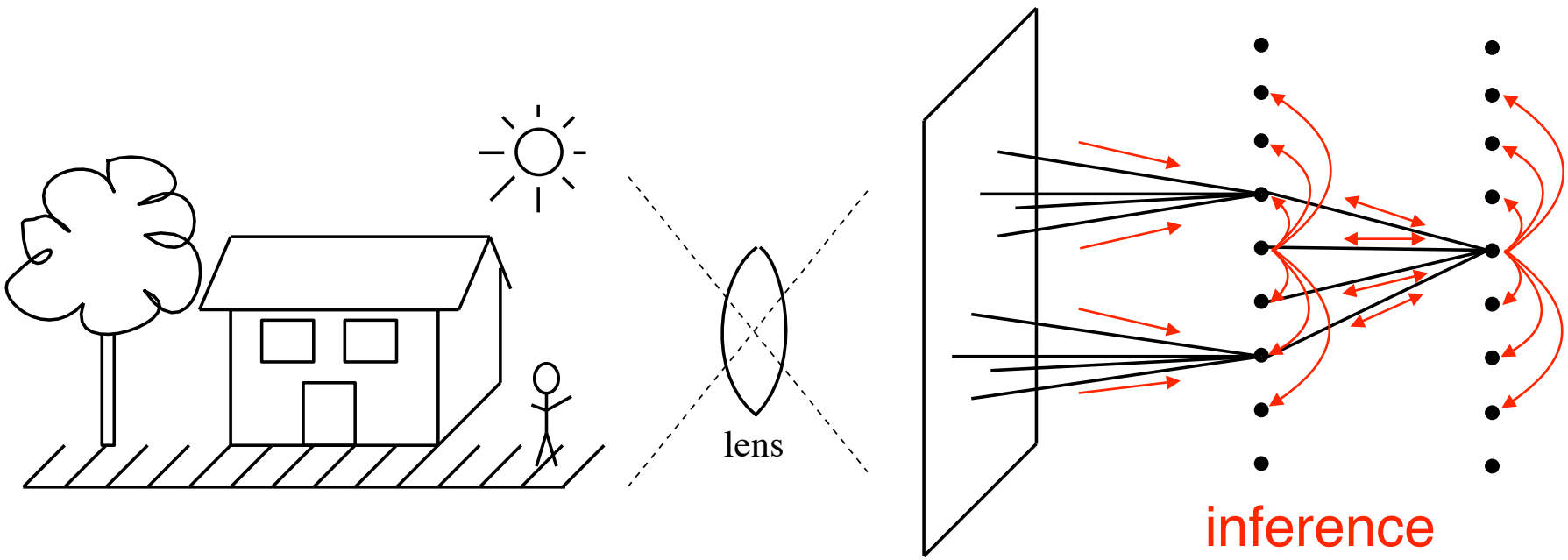
image generation

prior knowledge

$$P(H|D) = \frac{P(D|H)\,P(H)}{P(D)}$$

?

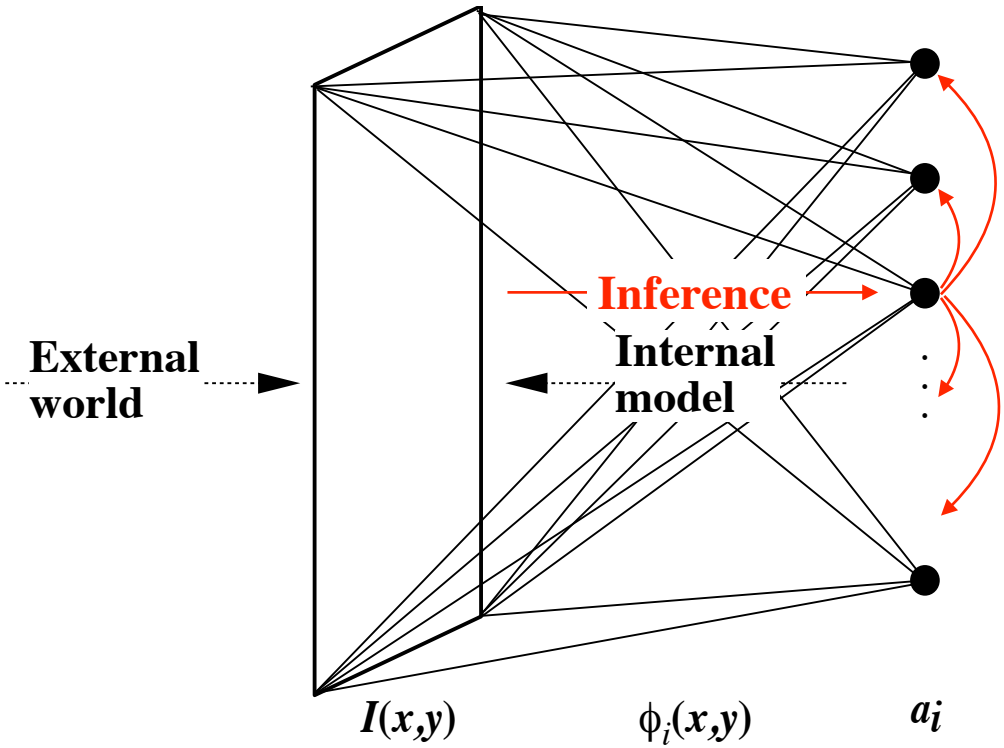
Perception as inference

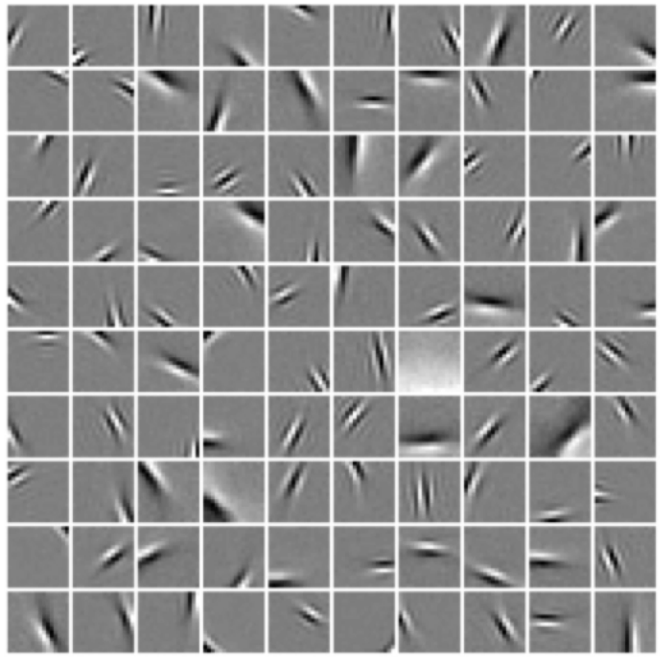


$$P(I|H) \times P(H)$$

$$\propto P(H|I)$$

Sparse coding model





$\phi_i(x, y)$

$$P(\mathbf{a}|\mathbf{I};\mathbf{\Phi}) \propto P(\mathbf{I}|\mathbf{a};\mathbf{\Phi})\ P(\mathbf{a})$$

$$\hat{\mathbf{a}} = \arg\min_{\mathbf{a}} |\mathbf{I} - \Phi\,\mathbf{a}|^2 + \lambda \sum_i C(a_i)$$

Not ~~$\hat{a}_i = g(\sum_{x,y} \phi_i(x,y)\, I(x,y))$~~