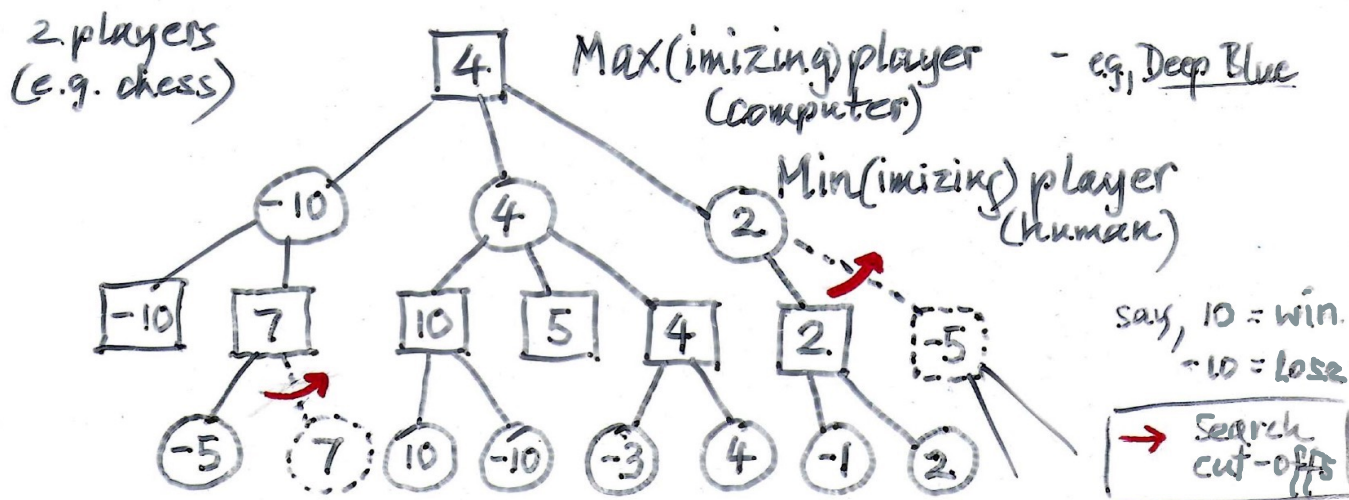


McDermott, ch. 2 - AI

A sampling of basic AI techniques - McDermott wants to show that cognition involves a wide variety of specialized techniques - no general method. He rejects general internal KR - notwithstanding NL...

• Game playing



Do people play like that? McDermott: Maybe yes; Chess experts: No!

Backgammon - checkers-like, but allowable moves depend on dice (\Rightarrow uncertainty)

NN-based system, TD-gammon, beats human players.

◦ are nonsymbolic methods better than symbolic ones?

McDermott: That's a false distinction! "GOFAT"

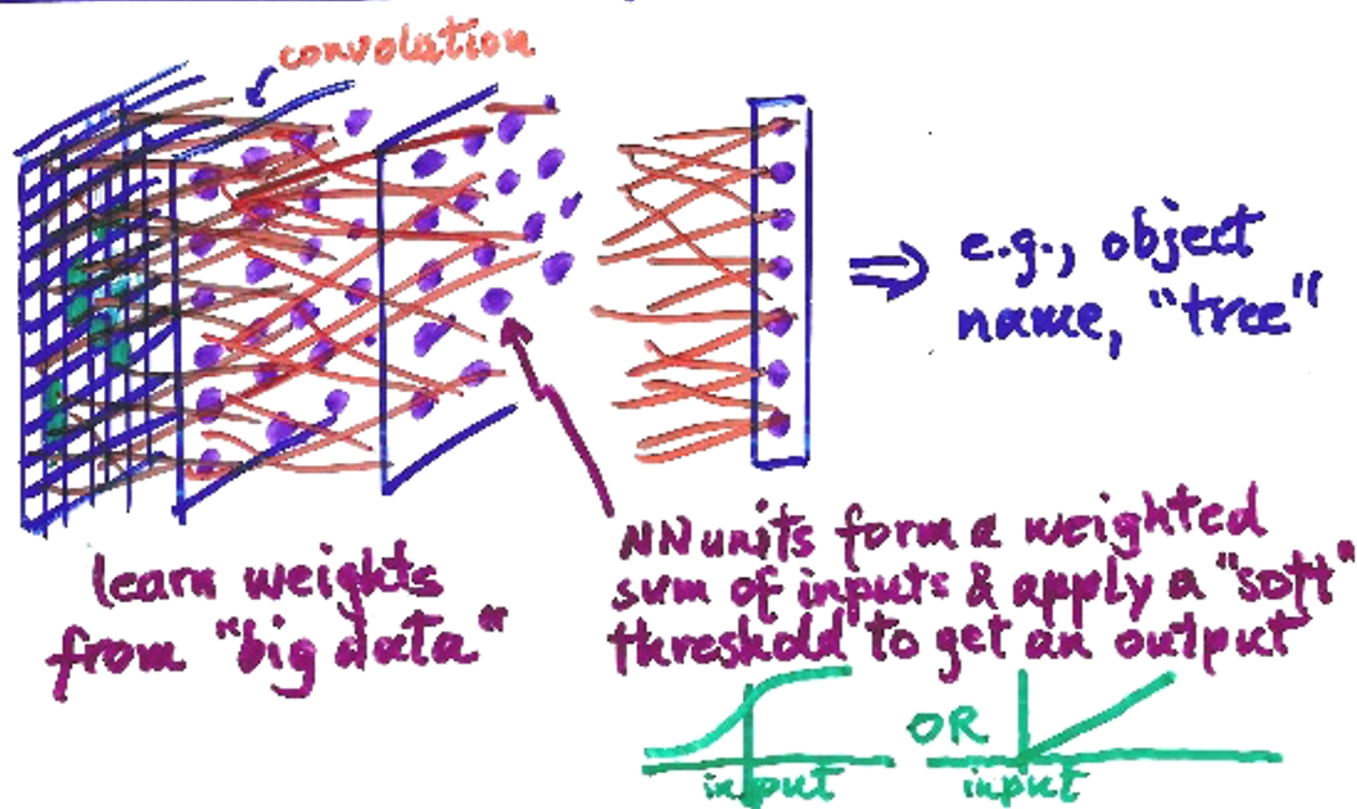
- many "GOFAT" symbols have no external meaning
- NN's are generally programmed on "symbolic" machines
- states of NN (or organic) systems can often be viewed as meaningful in relation to the world

Computer Vision

Engineering Approach



Machine Learning Approach



The vision & speech-enabled “David” agent (Georgiy Platonov, Ben Kane, et al.)



Note the Kinect cameras, which build up a geometric model of the blocks on the table, & these are in turn used to build a 3D model using “Blender” graphics.

“David” can answer spatial relation questions.

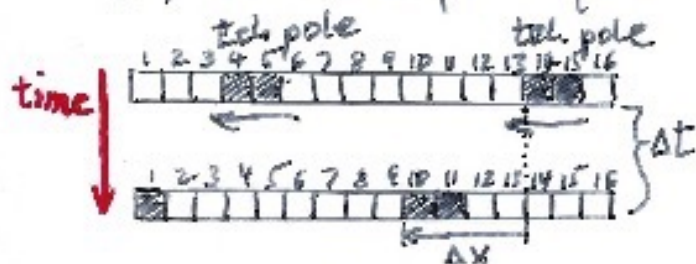
Model-building is still a somewhat unreliable process ...

McDermott, ch. 2, cont'd

• Computer vision

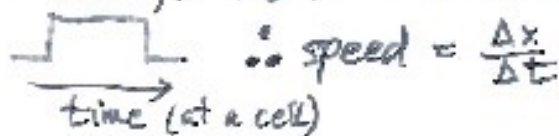
- point detectors, edge detectors, color/texture detectors
much as in our eyes; connect into curves, surfaces, ...
- correlation (depth perception)
- optical flow: self-motion, distance, object motion

1-D "retina" & optical flow

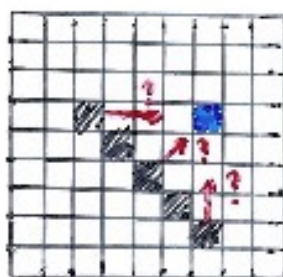


Motion estimation via correlation

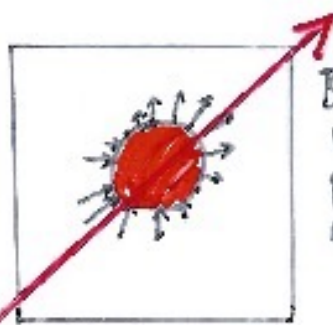
Profile of temporal changes
at cells 10, 11 same as at
cells 14, 15 Δt seconds earlier



2-D is harder! Consider small segment
of a long moving edge
Can't just look at individual pixels ...



Need edge
motion,
in x & y
directions
 \Rightarrow normal motion



But normal motion
varies around the
periphery of a
moving shape ...

Also need to allow for combined effects of self & object motion
(in 3-D!)

• Vision & control for robots

- motion control, for many-degree-of-freedom systems
(taking account of kinematics, dynamics)
- vision - integrate depth maps (from stereo) from
many vantage points; object models for recognition
- problems with dead reckoning
- knowing where you are in a familiar world: correlating images,
allowing for small perturbations

Motion estimation for differentiable intensity

Optical flow in one dimension

Assuming we have fixed-shape, fixed-illumination objects moving along the 1-D "retina", using "I" for intensity at x at time t ,

$$I(x, t) = I(x + \Delta x, t + \Delta t) \quad (1)$$

By Taylor's theorem,

$$I(x + \Delta x, t + \Delta t) \approx I(x, t) + \frac{\partial I}{\partial x} \Delta x + \frac{\partial I}{\partial t} \Delta t \quad (2)$$

$$\text{By (1) \& (2)} \quad \frac{\partial I}{\partial x} \Delta x + \frac{\partial I}{\partial t} \Delta t \approx 0$$

$$\text{or} \quad \frac{\partial I}{\partial x} \frac{\Delta x}{\Delta t} + \frac{\partial I}{\partial t} \frac{\Delta t}{\Delta t} \approx 0$$

$$\text{or} \quad \frac{\partial I}{\partial x} v_x \approx - \frac{\partial I}{\partial t}$$

$$\text{or} \quad v_x \approx - \frac{\partial I / \partial t}{\partial I / \partial x}$$

In 2 or more dimensions, we have 2 unknowns, v_x & v_y , & still only one equation. So extra mathematical constraints are needed, e.g., correlations (maximize cross-correlations)

McDermott, ch. 2, cont'd

• Bayes' theorem (for mapping, etc.)

$$\Pr(\text{Hyp.} | \text{Obs.}) = \frac{\Pr(\text{Hyp.} \& \text{Obs.})}{\Pr(\text{Obs.})}$$



$$= \frac{\Pr(\text{Hyp.}) \Pr(\text{Obs.} | \text{Hyp.})}{\Pr(\text{Obs.})}$$



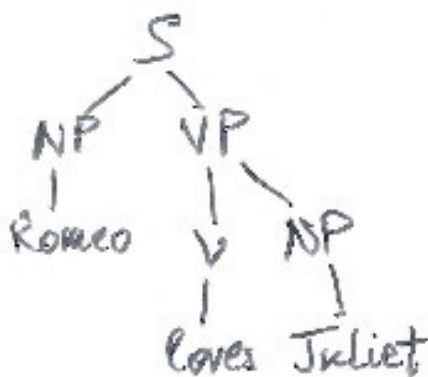
$$= \Pr(\text{Hyp.} | \text{Obs.}) + \Pr(\text{not Hyp.} | \text{Obs.})$$

With Hyp. = near Stop; Obs. = Round-Obj, Red, 8'up;
 Find $\Pr(\text{near-Stop} | \text{Round-Obj, Red, 8'up})$ vs, $\Pr(\text{near-Sold} | \text{Round, Red, 8'up})$.

Similarly for "where am I?" \rightarrow Prob(near-Wegmans | various building features)

• Language (previously discussed)

(McDermott thinks a general internal meaning representation doesn't exist...)



Phrasal rules

$VP \rightarrow V NP$
 $S \rightarrow NP VP$

Lexicon

Romeo : NP
 Juliet : NP
 loves : V

Semantic rules

$VP' = V'(NP')$
 $S' = VP'(NP')$

$Romeo' = Romeo$
 $Juliet' = Juliet$
 $V' = \lambda y \lambda x \text{loves}(x, y)$

• Math

Goedel-based arguments : confuse digital logic with logical reasoning
 Robbins algebras (W. McCune) - right identity "mind-numbingly literal" (McC)

• Architecture of mind : Lots of specialized techniques, no general internal KR, no general search; geniuses
 "no general learning" {general purpose} {fixed range}