AI in the today's news!

The New York Times

Once Again, Machine Beats Human Champion at Chess

By SYLVAN LOEB McCLAIN
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In the continuing quest to see if humans can outpace their electronic creations, the humans have lost another, perhaps decisive, round.

A six-game chess match between Vladimir Kramnik of Russia, the world champion, and Deep Fritz, a souped-up version of commercially available chess software made by Chessbase, ended today in victory for the computer, which won the final game and clinched the match, 4 games to 2.
Deep Fritz: Details

- Based on commercially available Deep Fritz 10 software from Chessbase (selling at $137.47)
- No specialized chess hardware as in IBM’s Deep Blue
- Multi-threaded
- Different search techniques

**Null-move heuristic** added to $\alpha$-$\beta$ pruning:
Skip a turn and do a shallow search

Recall: Neural Networks

$$v_i^m = g(\sum_j W_{ji} x_j)$$

$$x_j^m = g(\sum_k w_{kj} u_k^m)$$

$$E(W,w) = \frac{1}{2} \sum_i (d_i - v_i)^2$$

**Backprop rule for input-hidden weights $w$:**

$$w_{kj} \rightarrow w_{kj} - \varepsilon \frac{dE}{dw_{kj}}$$

$$\frac{dE}{dw_{kj}} = \left[ -\sum_m (d_i^m - v_i^m) g'(\sum_j W_{ji} x_j^m) W_{ji} \right] \cdot g'(\sum_k w_{kj} u_k^m) u_k^m$$
Application: Pattern Recognition

Recall: Recursive Bayesian Updating

\[ P(x | z_1, \ldots, z_n) = \frac{P(z_n | x, z_1, \ldots, z_{n-1}) P(x | z_1, \ldots, z_{n-1})}{P(z_n | z_1, \ldots, z_{n-1})} \]

Markov assumption: \( z_n \) is independent of \( z_1, \ldots, z_{n-1} \) if we know \( x \).

\[
\begin{align*}
P(x | z_1, \ldots, z_n) &= \frac{P(z_n | x, x_1, \ldots, z_{n-1}) P(x | x_1, \ldots, z_{n-1})}{P(z_n | x_1, \ldots, z_{n-1})} \\
&= \frac{P(z_n | x) P(x | z_1, \ldots, z_{n-1})}{P(z_n | z_1, \ldots, z_{n-1})} \\
&= \alpha P(z_n | x) P(x | z_1, \ldots, z_{n-1})
\end{align*}
\]

Recursive!
Application: Robot Localization and Mapping of Allen Center

(Work of Prof. Dieter Fox and students)

Recall: Bayesian Networks

| B | E | P(A|B,E)  |
|---|---|----------|
| T | T | 0.95     |
| T | F | 0.94     |
| F | T | 0.29     |
| F | F | 0.001    |

| A | P(J|A) | A | P(M|A) |
|---|------|---|------|
| T | 0.9  | T | 0.7  |
| F | 0.05 | F | 0.01 |
Application: Tracking a Person using GPS

Application: Robot Learning by Imitation

(Work of Prof. Fox, Prof. Kautz, and students)

(grad student David Grimes)
Imitating from Motion Capture Data

Motion Capture

Data from Motion Capture

Attempted Imitation

Bayesian Network for Stable Imitation and Learning

Idea: Use Bayesian network to capture consequences of actions (current body state, action) → Next body state

State $s = [\text{joint angles, gyro values, foot pressure values}]$

Action $a = [\text{position commands to motors for each joint}]$

\begin{align*}
    s_1 & \rightarrow a_1 \rightarrow a_2 \rightarrow a_3 \rightarrow \cdots \rightarrow a_{T-1} \\
    s_1 & \rightarrow s_2 \rightarrow s_3 \rightarrow s_4 \rightarrow \cdots \rightarrow s_T
\end{align*}

Infer actions $a_t$ given evidence $s_1, \ldots, s_T$ from teacher subject to stability constraints on gyro readings
Learning to Imitate a Human Action

Result after Learning

Human Action

Imitation
Recall: Classification Techniques

- Decision Trees
- Nearest Neighbors
- Neural Networks
- Etc.

Application: Brain-Computer Interfaces

- Classifying brain signals recorded at the scalp
- Detect which object a person wants from a set of objects
Deciphering choice from brain signals

Images of Objects

One Object Flashed at Random

Target object

Other objects

Brain response is different if flashed object is desired target object vs. non-target object

Example: Brain Responses Detected on Scalp

Target Flash

Non-Target Flash

Use supervised learning to classify brain response as target or non-target
Example Task: Fetching an Object

Command: “Go to kitchen”

Robot navigates to kitchen

Command: “Pick object X in camera image”

Robot picks selected object

Command: “Bring object to me”

Robot brings selected object

Brain-Actuated Control of a Humanoid Robot

Task: Use brain signals to command robot to fetch red (or green) object and bring it to one of the tables.

(work of students Rawichote Chalodhorn, Ravi Kiran, Pradeep Shenoy, and CJ Bell)
Brain-Actuated Control of a Humanoid Robot

Take-Home Final: Details

- Will be posted on website later today
- 5 problems, open book, open notes
- Focus mostly on post-midterm material
- Due Wednesday Dec 13 by midnight via email to Raj and Abhay
- Will involve a mix of problem solving and descriptive questions
  - E.g., Computing probabilities in Bayesian networks, explaining important concepts in AI (A* search, alpha-beta pruning, etc.)
Othello Tournament Update

Round 0
Completion Date
JawSome (100-38)
Othello Agent
Team-SQZ (128-9)
Black-Out
Radical (102-20)
sample_solution
myTeam
Senators
Broth Bean Bag
Dedmon's Revenge (86-31)
Drama
Hammer Bros
Wumpus (65-62)
Wumpus (65-62)
Wumpus3
Wumpus1 (65-36)

Round 1
29-Nov
JawSome
Team-SQZ (95-31)
Radical

Round 2
1-Dec
Team-SQZ (81-47)
Radical

Round 3 (Round-robin)
3-Dec
3A

But
ε

\[
\frac{\partial V}{\partial \theta} = \frac{\partial}{\partial \theta} \sum \frac{\partial (\sum W_i v_i)}{\partial \theta} \frac{\partial W_i}{\partial \theta} v_i \sum \frac{\partial v_i}{\partial \theta} x_i
\]
Have a great break!

Who glued my fingers?