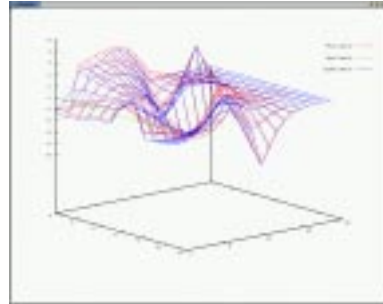# Knowledge Discovery in Awari Endgame Databases

695 Data Mining Project

Anita Petrinjak and Darse Billings

Introduction: Awari

- Awari – ancient African game

Introduction: Awari

- 4000 year old pit and pebble game
- Computers play Awari **much** better than humans
- Very fast search (Mpps, Bppm, 27-ply)
- Evaluation function is still very crude

Introduction: Awari

Softwari

- Roel van der Goot
- Applet: web.cs.ualberta.ca/~games/

U of A wins the
silver medal in
London

Awari Endgame Databases

- Endgame databases are **BIG** (Chinook)
- Awari endgame DBs are **REALLY BIG**
- Provides an **oracle** of perfect knowledge, but nothing explicit about *general strategy*
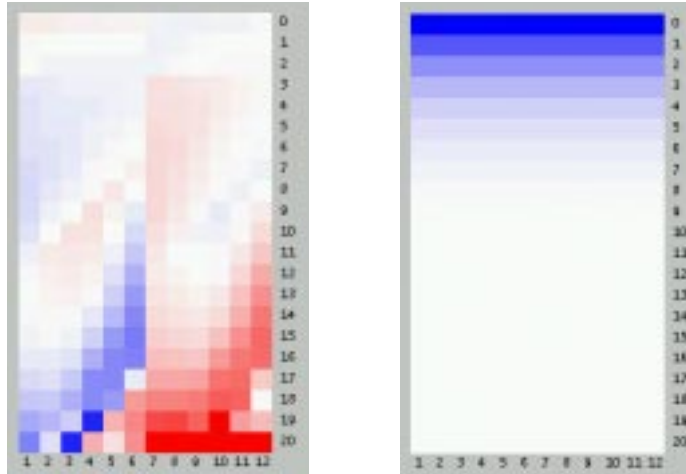

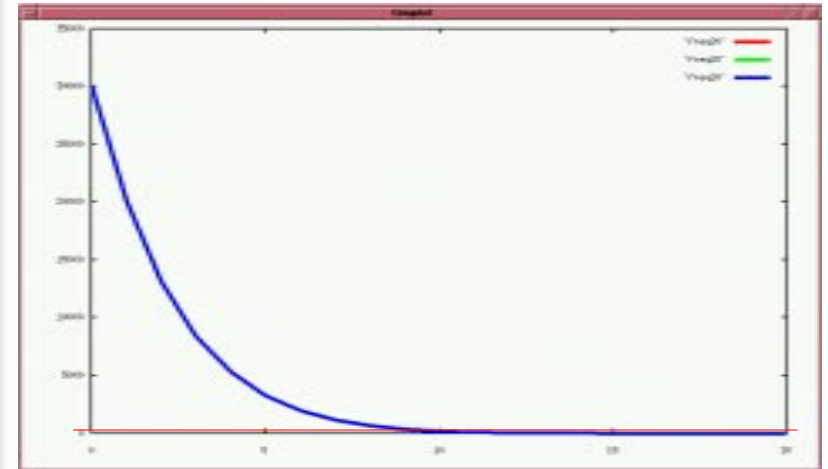Thomas Lincke's Endgame Applet

Knowledge Discovery

- Encorporating human knowledge in a game playing program is always tough, but we *don't even have* good domain knowledge for Awari
- Project Goals:
  - extract knowledge that can be used to construct a good evaluation function
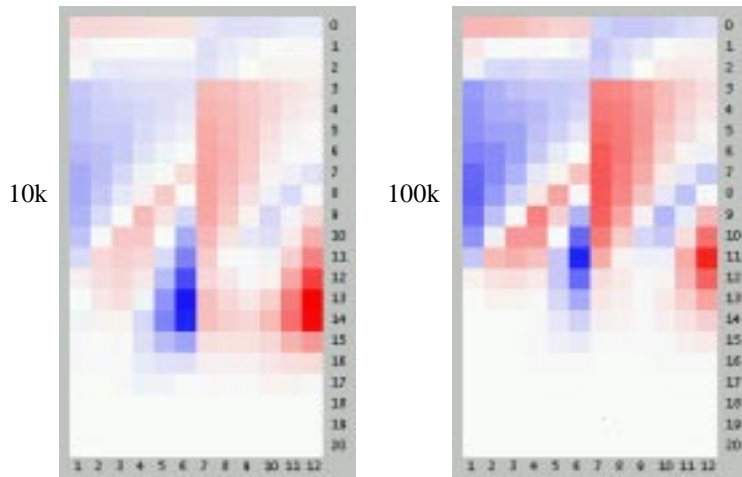 - add to human knowledge about Awari

Methods of Analysis

- A *feature* is a property (*eg*. balance)
- *Atomic feature*: pit i has j pebbles
- Association rule mining, where each position is a "basket" of 12 items
- We have **all possible transactions** with weights (*cf*. Negative assoc. rules)
- Tally all values → expected value (EV)

Frequency of database values

Non-capture and capture positions

 - data filtering

Results

EV visualization and frequency
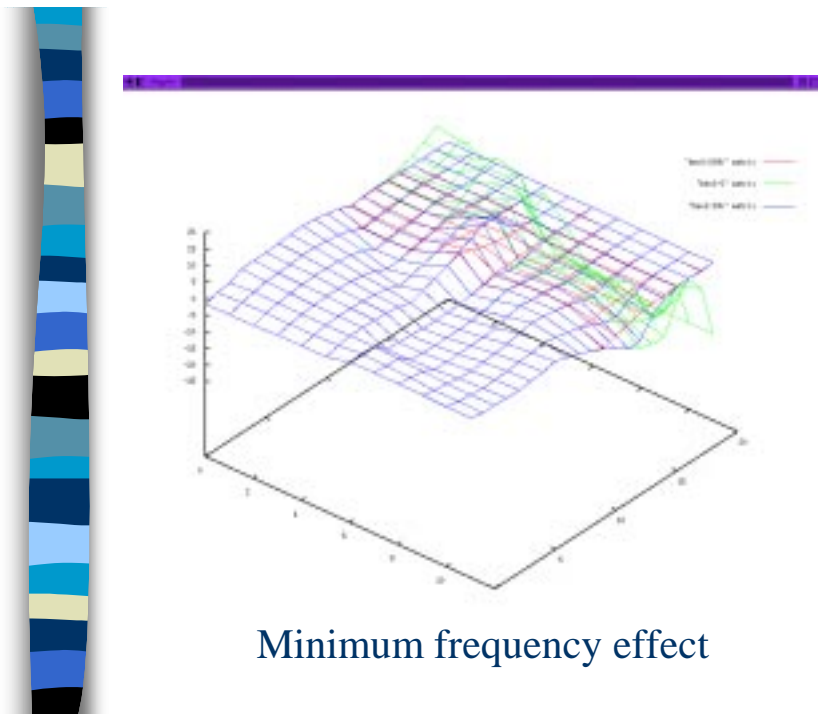

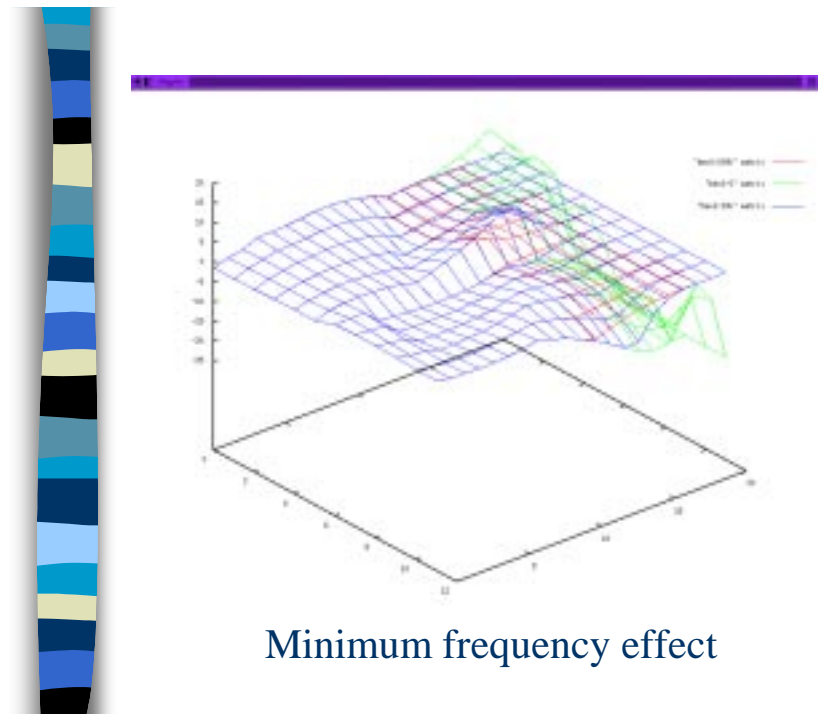## Frequency vs. number of pebbles

Minimum frequency (Bayesian)

10k 100k

3-d visualization of EV-1 data
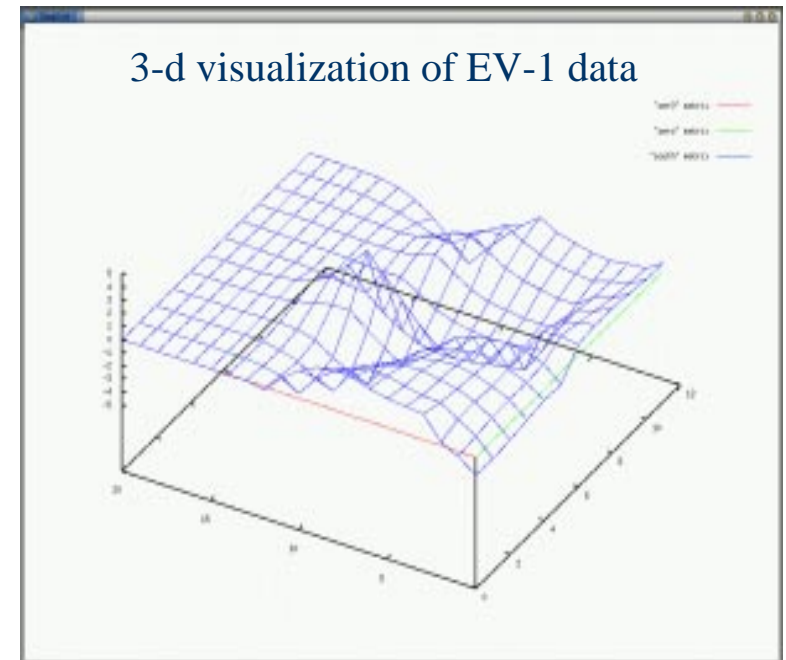
Minimum frequency effect

Minimum frequency effect

Minimum frequency effect

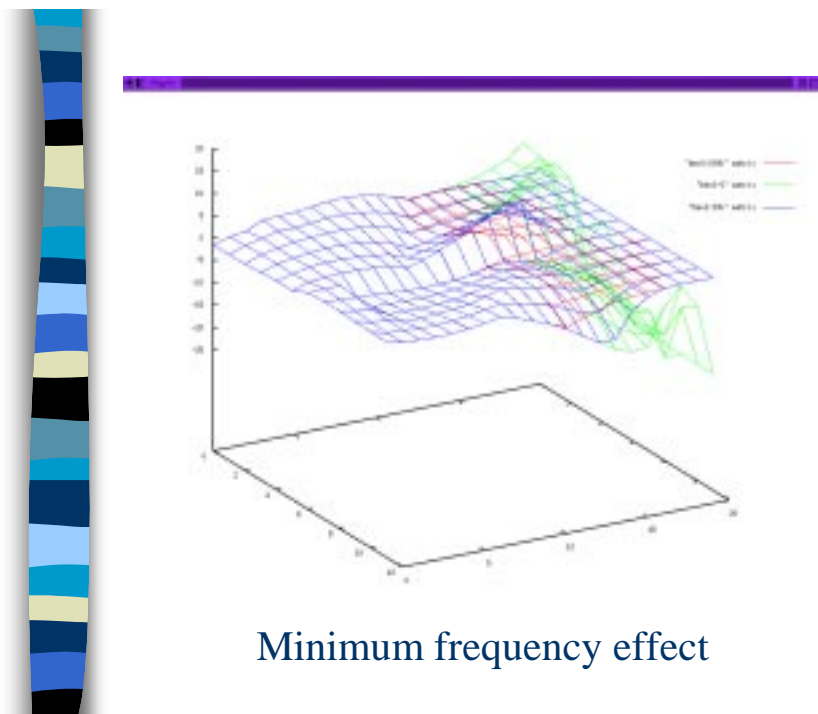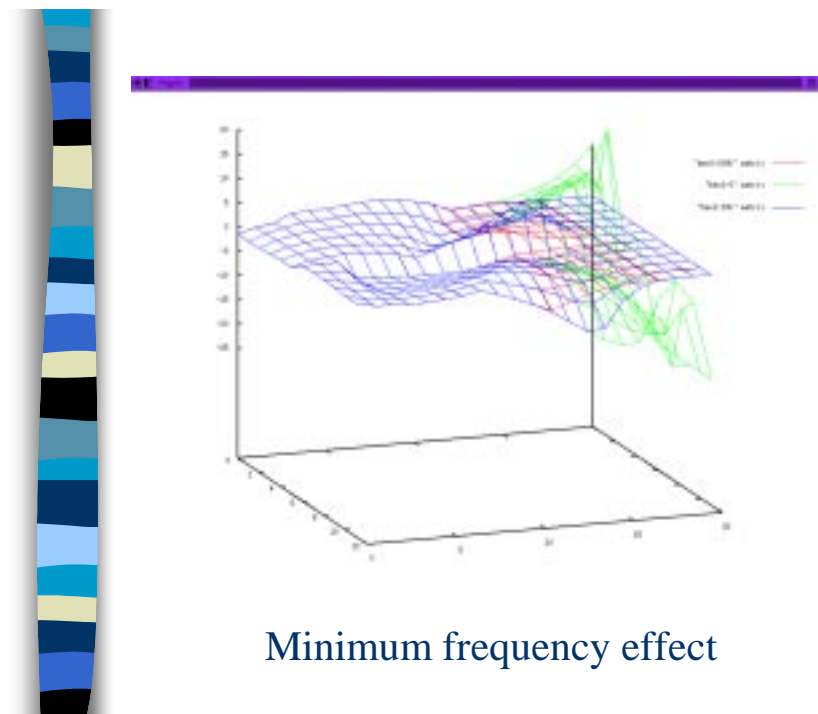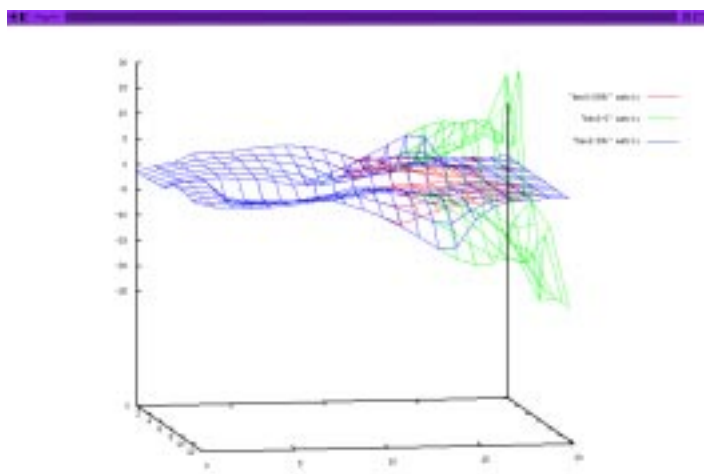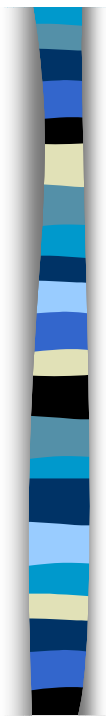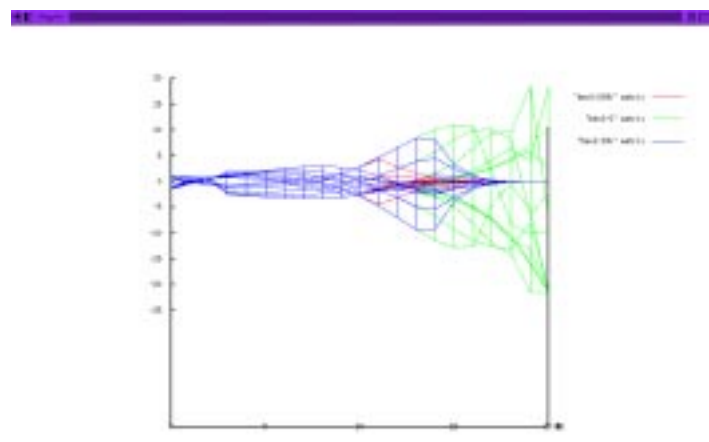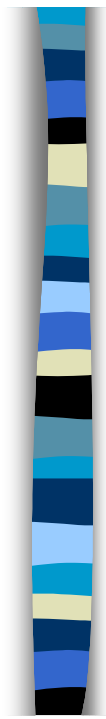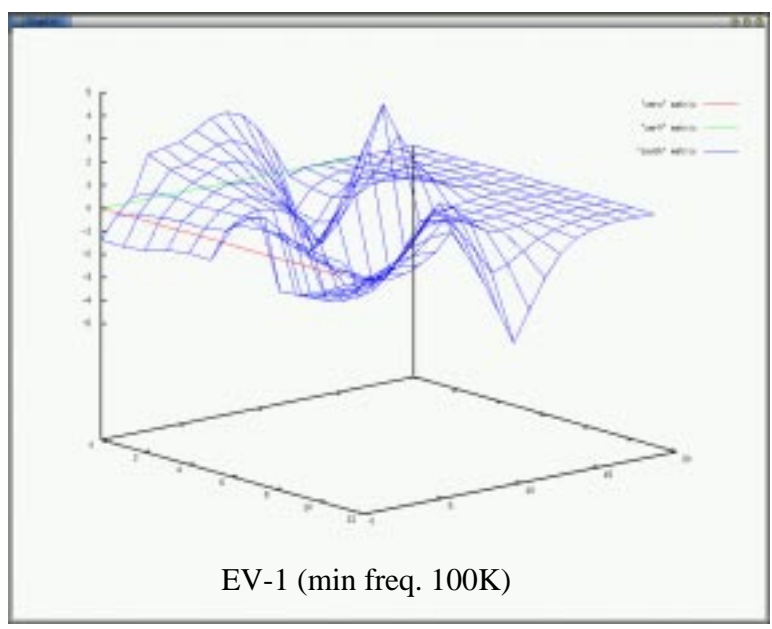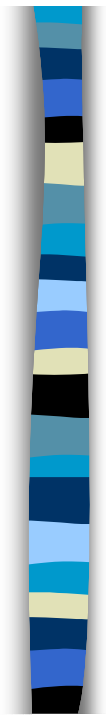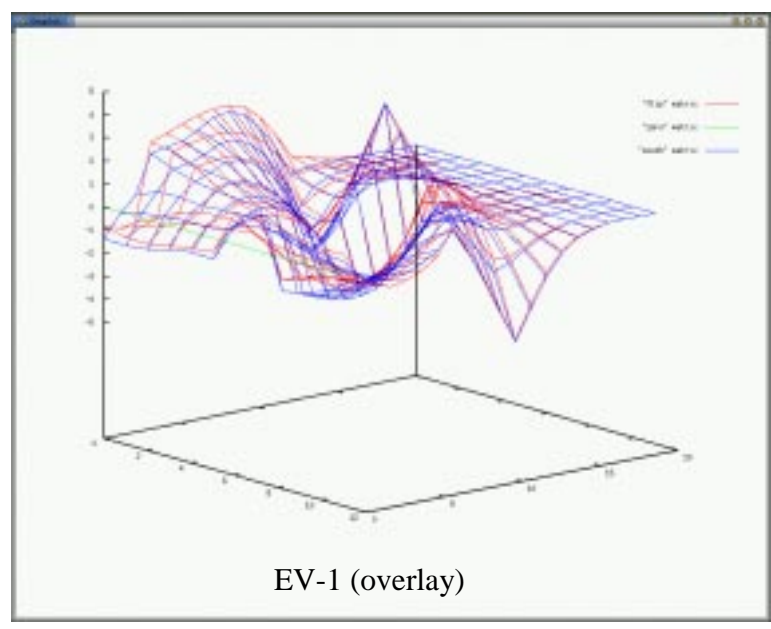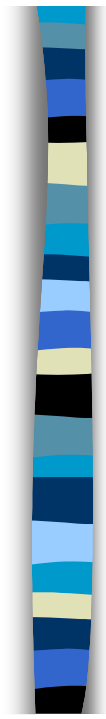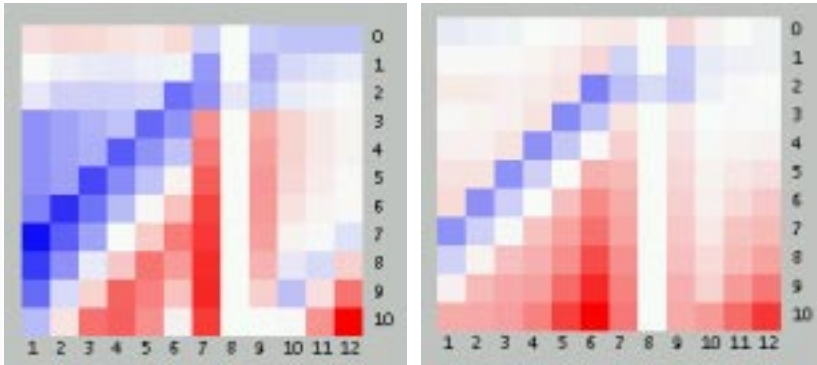

Minimum frequency effect

Minimum frequency effect

Minimum frequency effect

EV-1 (min freq. 100K)

EV-1 (overlay)

EV-2 data: pit_b = 2 pebbles

Raw data

EV-1 difference

Evaluation Function Results

result	frequency	1000
lose	64694821	334
draw	22897612	118
win	105944287	547
sum	193536720	1000
net	293523543	+1.52

eval-2	lose	draw	win	sum
lose	237	33	37	308
draw	37	20	32	90
win	59	63	477	600
sum	334	118	547	1000

mobility				
Correct:	553	Score:	387
Mean squared error:	25.14		

adjusted mobility				
Correct:	576	Score:	415
Mean squared error:	22.84		

eval-1				
Correct:	723	Score:	617
Mean squared error:	13.84		

eval-2				
Correct:	736	Score:	639
Mean squared error:	12.61		

Future Work

- Self-play games:
  - eval *vs* eval
  - eval *vs* database (count errors)
  - re-train on actual game positions
  - eval-1 on non-capture positions
- Other data mining techniques

Conclusions

- Successfully extracted knowledge from the Awari endgame database
- Built relatively good evaluation functions
- eval-1 and eval-2 also work well for unbalanced positions (*eg.* diff=3), and can be further improved
- Discovered knowledge enhances human understanding of Awari