Laboratory for Computational Cultural Dynamics

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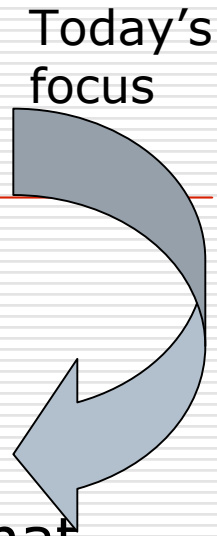
A partnership with sociologists, anthropologists, political scientists, linguists, and health care professionals.

Motivation

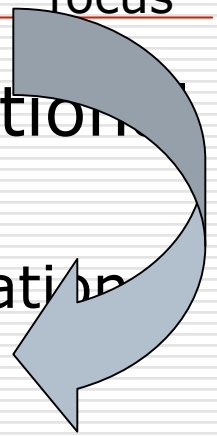


- Reasoning about cultures is critical for multiple applications:
  - War/Counter-Terrorism: how can we get different tribes/groups in a region to do what we'd like them to do?
  - Global Health: how do social/cultural behaviors contribute to the spread of infectious diseases?
  - Post-Conflict Reconstruction: how can we set up an infrastructure in a country that has gone through a period of internal (or other) war?

All of these factors affect us.

LCCD

Today's focus

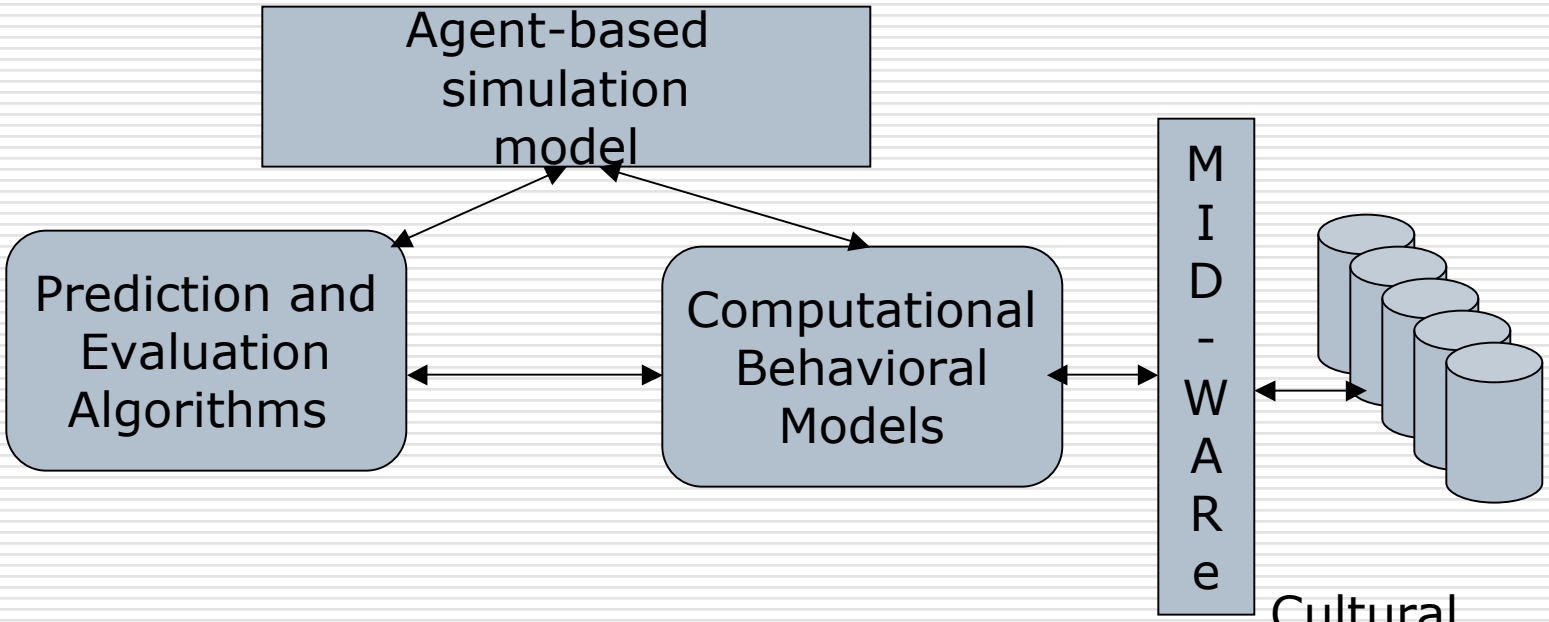


- Overall goal is to develop the computational infrastructure needed to help others
  - Wage effective war/counterterrorism operations
  - Ensure socio-economic-political change in foreign countries
    - E.g. Social security reform in foreign countries
  - Help reconstruct post-conflict or post-disaster societies.

LCCD Work with AFOSR

- AFOSR provides core funding for LCCD.
- Basic theoretical foundation to build applications that reason about different cultures (to some extent).
- Software platform based on the above theory for application development.
- Instantiate the above theory and system with a cultural context for the Pakistan/Afghanistan borderlands.
- Cultural Advisory Board
  - Current Deputy Minister of the Interior of Afghanistan
  - Former Pakistan Ambassador to UK
  - A well known film-maker about Afghanistan tribes
  - Former State Dept. offical stationed in Pakistan
  - + Other well known authors about Pak/Afghan tribes

LCCD Architecture (parts)



Predict possibilities
Assess possibilities
Find best response (or Good enough)

Likelihood Rules
Utility Functions
Goals

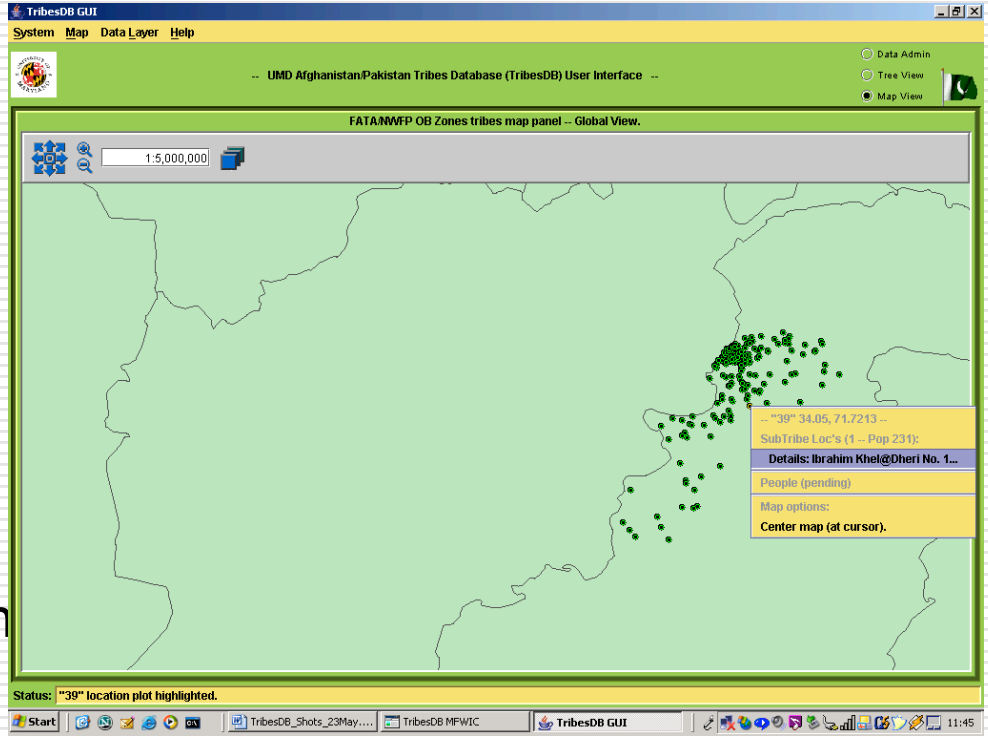
Cultural
Contextual DBs
- Demographic
- Economic
- Political
- News sources
- ETC.

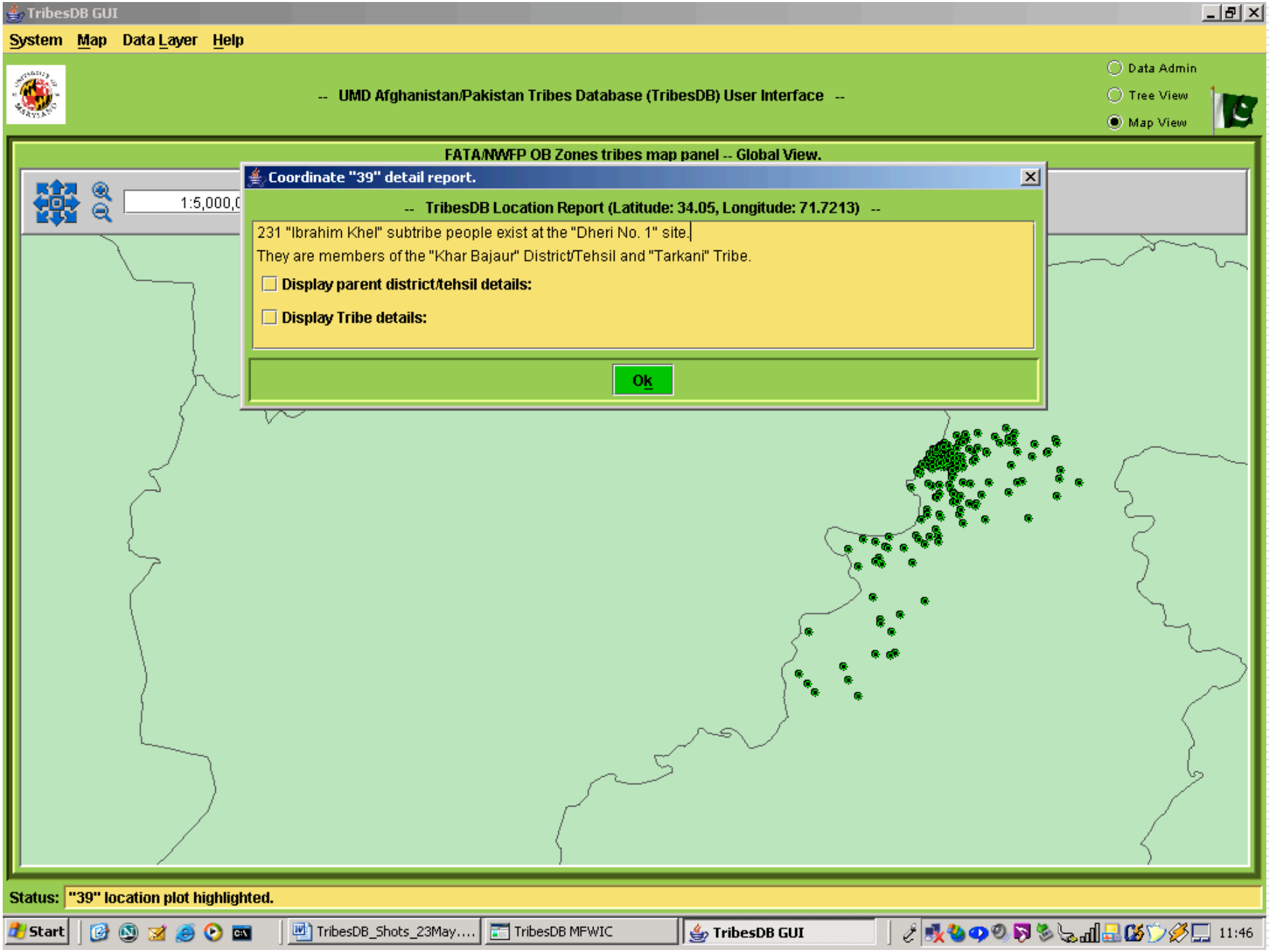
Cultural Contextual Database

- Set of DBs about background information on a given culture.
- Characteristics about data/problem
  - Comes from multiple sources: need to track pedigree. *Pedigree/reliability algebra.*
  - Inconsistency and Uncertainty are omnipresent. Draw inferences in the presence of incomplete and uncertain information. *Algebra/calculus to integrate information from multiple incomplete/inconsistent data sources.*
  - Data is obtained from heterogeneous sources. Even accessing these can be a challenge.
  - Assessing tone/opinion of select sources (e.g. news sources) can be an indicator.
  - Users need data in English, not SQL.

Cultural Contextual DB Work Underway

- UMD's PAT-DB (Pakistan-Afghanistan Tribes DB) is well under construction.
- Names
  - People
  - Tribes
  - Locations
  - Historical information
  - Alliances, etc.




TribesDB GUI
System Map Data Layer Help
-- UMD Afghanistan/Pakistan Tribes Database (TribesDB) User Interface --
Data Admin
Tree View
Map View
FATA/NWFP OB Zones tribes map panel -- Global View.
1:5,000,0
Coordinate "39" detail report.
-- TribesDB Location Report (Latitude: 34.05, Longitude: 71.7213) --
231 "Ibrahim Khel" subtribe people exist at the "Dheri No. 1" site.
They are members of the "Khar Bajaur" District/Tehsil and "Tarkani" Tribe.
Display parent district/tehsil details:
Display Tribe details:
Ok
Status: "39" location plot highlighted.
Start
TribesDB_Shots_23May....
TribesDB MFWIC
TribesDB GUI
11:46

Coordinate "39" detail report.

-- TribesDB Location Report (Latitude: 34.05, Longitude: 71.7213) --

231 "Ibrahim Khel" subtribe people exist at the "Dheri No. 1" site.

They are members of the "Khar Bajaur" District/Tehsil and "Tarkani" Tribe.

☑ **Display parent district/tehsil details:**

The "Khar Bajaur" district is subordinate to the "Bajaur" agency of the "FATA" order-of-battle zone.

Description: None listed.

☑ **Display parent agency details:**

"Bajaur" agency description:

The area of [the] Bajaur Agency is 590 square miles. It is a hilly area located on the North of Malakand Agency. The approximate population of the agency according to the latest census is 364,000. The main tribes are Utman Khel and Tarkani of which the major sections are Mamud and Salar Zai. It was created as an Agency from a remote subdivision of the Malakand Agency on [0]1 December 1973 with Headquaters at Khar. Before 1960 Bajaur was treated as an almost wholly inaccessible area and it was in that year that an Assistant Political Agent was appointed whose headquarters were outside the agency at Munda, in Dir District.[^4]

Aside: Extracted from study document page 15.

☐ **Display parent order-of-battle zone details:**

☑ **Display Tribe details:**

"Tarkani" tribe description:

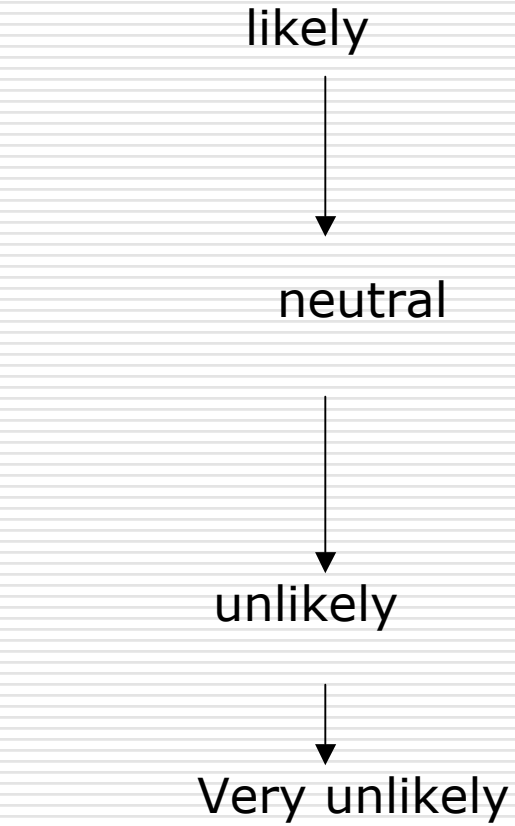
Pushtun tribe TARKANI, or TARKALANRI. Tarkani belongs to the Sarbani branch of the Pushtuns.

Ok

Provenance wrappers/reliability ontology

- Each data source has a provenance wrapper.
- Function $\chi(s,o)$ that specifies for a given object o and source s, the reliability of the information in object o according to source s.
- Output can either be on a qualitative scale or a quantitative scale.
- Algorithms to go from qualitative to quantitative and vice versa.
- Algorithms to learn and revise reliability periodically.
- Reliability ontology associates reliabilities with sources, subsources, etc.

Example qualitative levels



Computational Behavior Models

- Consists of three components
  - *Qualitative* deontic *likelihood rules*.
  - *Utility functions.*
  - *Goals.*
- Identify a set of plausible things that a decision maker might do that satisfy the rules and progress towards the goal as measured by the objective function.
- Builds on our past work on the IMPACT heterogeneous agent system (4 papers on this in AIJ since 1999, plus several others).

Qualitative Likelihood Rules

- Action atom a: p(X1,…,Xn)
- Expression of the form **OP** a where **OP** is one of:
  - **P – permitted**
  - **F – forbidden**
  - **O – obligatory**
  - **DO – does**
  - **W – obligation is waived**
- **Rules:** a IF <cond. on CC-DBs> & conjunction of action atoms.
- **Likelihood rules:** Replace "a" by "a:l" where l is a likelihood level.
- **FOR OUR O.R. FRIENDS: Likelihood rules are like constraints.**

Utility Functions

- Express the utility of certain actions in a given situation.
- Triple:
  - Condition C
  - Action atom A
  - Numeric Formula F
- F returns the value of doing A in a situation satisfying condition C.
- E.g.
  - C=tribal leader threatened with execution
  - A=any action that preserves honor of tribe
  - V=some high number

Goal-Utility-Triples

- Specify the value V of achieving goal G if the situation satisfies condition C.
- E.g.
  - G = save-tribal-leader
  - C = difference between terror group strength and tribal strength exceeds some bound.
  - V = some value

Recent work

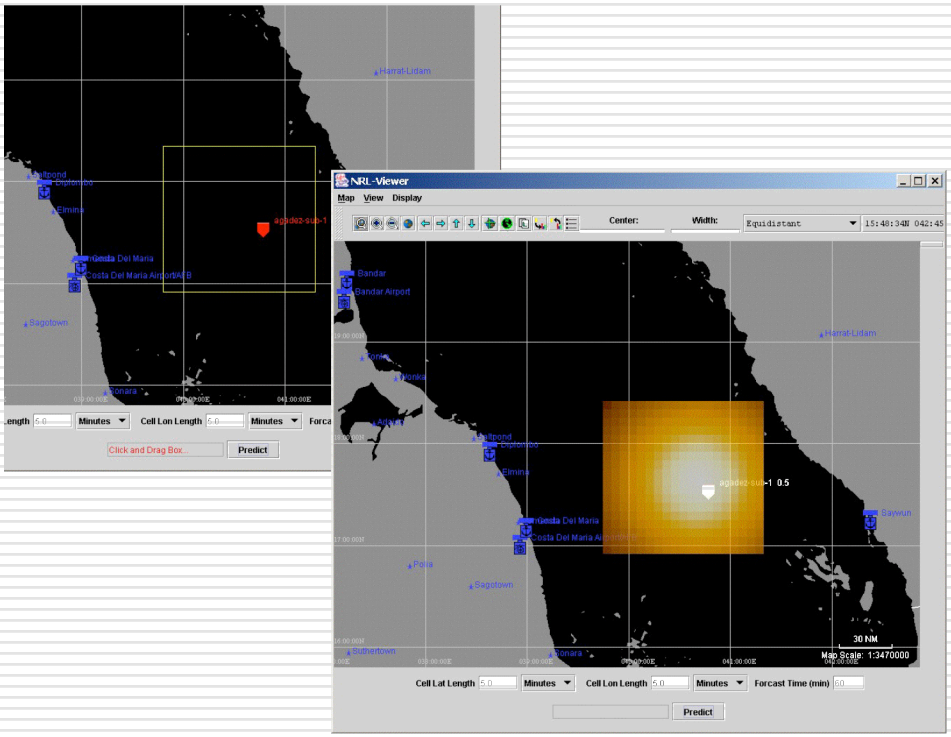
- Developed algorithms to find a set S of actions that optimize any given objective function and satisfy a set of deontic rules (without likelihoods). Also fast heuristic algorithms to find suboptimal solutions.
  - Stroe, Subrahmanian, Dasgupta - AAMAS 2005 *best paper award nominee. (4 nominees of ~530 papers).*
- Extended this when rules include time and uncertainty. *Dix, Kraus, Subrahmanian* – ACM Trans. On Computational Logic (to appear 2005).
- Builds on temporal probabilistic DB models
  - Dekhtyar, Ross, Subrahmanian – ACM-TODS 2001
  - Biazzo, et. Al. – IEEE-TKDE 2004.
  - Ross, Subrahmanian, Grant – J.ACM 2005

Prediction and Evaluation Algorithms

- We can also view this as a game tree problem where
  - Nodes represent situations
  - Edges represent moves that either we or an opponent can make.
- Search space can be enormous. Strategies we propose to follows:
  - Strategy based game trees. (Smith, Nau et.al. win World Computer Bridge Comp. 1997)
  - Abstraction and decomposition
  - Statistical simulation based on random hypotheses (of what the enemy might do)
  - Planning under uncertainty

Spatio-Temporal Prediction

- Joint with NRL, BBN, Lockheed and many others as part of the DARPA Co-ABS program.
- Predict when and where enemy submarines will be in the future.
- Similar system for vehicle prediction with the Army. (video available).



Conclusions

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