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From Part-Net to Neg-o-Net?

Extending Part-Net for multi-agent negotiation within FIRMA

What will be covered

- Summary of current Part-Net model
- Limitations of Part-Net when applied to FIRMA-type negotiation scenarios
- The Neg-o-Net model
- What value will Neg-o-Net add to FIRMA?
- How does this relate to digraphs?
- Are we on the right lines – comments?

Summary of Part-Net

- A population of many agents
- Each has a set of goals
- Each has a set of actions
- A single action achieves a single goal
- Actions can be executed immediately
- Agent interaction is dyadic only

Summary of Part-Net

- Agents use heterogeneous decision making strategies to achieve their goals
- Possible partnerships result from the exchange of actions to achieve goals
- For each agent a list of all possible partners are found in the population
- Each agent then orders its list based on its decision strategy

Part-Net Summary

- Each agent traverses its list of possible partners until it finds a mutual partner
- The way the list is ordered determines the strategy of the agent
- Each goal has a value indicating relative importance
- Each action has a value indicating relative cost

Part-Net Summary

- Three decision strategies have been implemented by ordering the list of possible partners by:

- Hedonist – goal benefit value

- Utilitarian – goal benefit - action cost

- Miser – action cost

Part-Net Summary – An interesting result

- Strategy-mixed populations outperform strategy-homogenous populations (in terms of average net benefit)

- In homogenous and mixed populations a rough ordering of:

- Hedonist>Utilitarian>Miser is observed

Some simplifying assumptions in Part-Net

- *Common transparency of actions* - Actions always produce commonly known results
- *No action interaction* – Actions are distinct and do not contradict or interfere with each other
- *Actions are atomic* – A single action always achieves a single agent goal
- *No "indirect" partnerships* – three-way trading of actions not implemented

Neg-o-Net - Negotiation

- Negotiation is viewed as:

- A *multi-agent* process (not just dyadic)

- Grounded in the attempt, by agents, to induce desirable *actions* in others

- *Not* dependent on shared or even compatible goals

- *Not* requiring *action transparency*

Implications of assumptions

- Since *multiple* agents may negotiate over actions, a limited "market" is produced - a form of "action barter"

- If agent A desires action a1 but can only perform action 2 and B des. a2 but can only perf. a3 and C des. a3 but can only perf a1. Agents should identify such loops as a result of negotiation

Action independence

- Actions carried out independently may interfere and interact

- Agents may or may not have knowledge of this

- Agents may disagree on the effect of some action

Digraphs

- Each node describes a world state

- Arcs linking nodes are labeled with actions

- Arcs may also have endorsement(s) – support for the the belief that the action will lead to the new world state

Digraph – Neg-o-Net

- From a given node, each arc contains a value indicating the relative benefit of moving along the arc *from the current node*

- Each node lists the actions available to the agent from this node (action repertoire) with an associated cost value

- Each arc contains a logical sentence (including negation) specifying actions that are believed to perform the transition

Traversing Digraphs - The blunderbuss approach

- If it were computationally tractable *all* routes through the graphs could be traversed

- This would involve a depth-first search with all agents selecting *all possible subsets of actions* from their start points in their graphs

- This would continue until no further actions could be performed

Traversing Digraphs – The blunderbuss approach

- By examining all possible routes, useful observations could be made:

- Are certain nodes unreachable?

- Are certain nodes unavoidable?

- What routes satisfy the most agents (assuming some nodes are labeled as satisfactory or desirable) ?

The blunderbuss approach - problems

- Actions on arcs may be supplied by the environment (stochastic, unpredictable)

- The search space may be vast – even with modest sets of digraphs

- Blunderbuss is not really modelling an on-going process of negotiation but all possible negotiation possibilities

Traversing the Digraphs – The blunder approach

- Agents apply an extended form of Part-Net from each node

- Nodes immediately reachable treated as goals, benefit = desirability value associated with the connecting arc

- Multi-Party negotiation is implemented – not just partnerships

The less-blunder approach

- To reduce blunder and make decisions more intelligent would require the extension of the "goal horizon" beyond immediate nodes

- If nodes have an associated comparable *desirability value* then the "goal horizon" can be extended up to tractability

- However, if not, then extension of the "horizon" becomes a problem

- Simply adding desirability values on *arcs* is not necessarily going to produce the desired result

Neg-o-Net - open issues

- Do agents have incomplete or incorrect knowledge of other agent action repertoires?
- When environmental events are *not* the consequences of agent actions – how is this represented?
- How does *time* fit into the model?
- Can agents *verify* that actions are taken by others?
- How can this model meaningfully be applied to Scott's canonical sand pile model?

Neg-o-Net - Norms

- Norms may be viewed as overall goals that have been formed as a result of beliefs acquired not as a result of individual rational deliberation but social pressures and mechanisms

- In this sense, they are explicitly represented in the form of the digraph

What use is Neg-o-Net to FIRMA?

- Given suitable digraphs we could implement a process of negotiation
- We could experiment with various strategies and "goal horizons"
- The result would be possible negotiation sequences
- Could we insert real human agents (stakeholders) into the process?
- Could we show the sequences to stakeholders and ask if they were realistic?