Plan Recognition in Complex Spatial Domains

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Problem description

We are researching the problem of plan recognition in a complex real-world domain consisting of training battles conducted by actual troops at the US Army's National Training Center. These battles involve hundreds of participants, last several days, and take place over a very large geographical area. Our task is to identify from this data repeated patterns of movement which correspond to planned "maneuvers" — coordinated activities which generate identifiable patterns of movement that can be identified and used as a basis for prediction.

Figure 1 depicts the movements of agents in a training battle over a relatively short amount of time (approximately three hours).

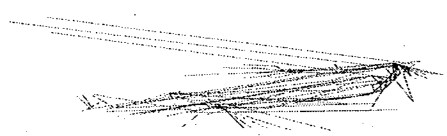

Figure 1: Complex agent movements

Both the inherent qualities of the domain and the realities of collecting data from the real world require assumptions fundamentally different from those usually made in plan recognition research:

- **Multiple agents** The step-by-step actions of individual agents are significantly less important than coordinated interactions among agents. This differs from other multi-agent research (e.g., Huber and Durfee 1995) which focuses on the plans of agents acting individually in the presence of others.
- **Incomplete and incorrect information** Data collection from the real world is inherently noisy, and this fact is compounded in large-scale domains.
- **Large-scale data** Depending on the length of activity in the domain and the rate at which information is sampled, there can be anywhere from tens to thousands of state descriptions generated *per agent.*

Approach

A solution to the problem of plan recognition as described here must be able to identify changing relationships between agents in the presence of noise but not have high computational or storage requirements. Our approach has been a layered one in which successively higher levels of qualitative representations are computed from the raw data, generating decreasing amounts of data which convey more focused information. Representations contain information about individual agents such as position and velocity (as in Mohnhaupt and Neumann 1991, for example), and are followed by relationships between pairs of agents, and finally, patterns of agent-pair relationships.

In our approach, the primitive patterns are the building blocks of more complex patterns which are formed from temporal combinations of events. This representation is recursive in nature, in that higher-level patterns are formed from combinations of other patterns or events. For example, a gathering maneuver consists of the event of units moving together followed by the event of them waiting at a location.

Another unique aspect of our research is that we are ultimately concerned with identification of *groups* of agents engaged in common patterns of behavior and that these group behaviors are formed from the different behaviors of individual agents occurring together. The key to our solution has been to detect patterns first among agent-pairs and then leverage this knowledge to form groups based on co-occurring actions.

Acknowledgements

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References

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