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A Template-Based and Pattern-Driven Approach to Situation Awareness and Assessment

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Lessons Learned from Modeling Intelligent Synthetic Forces

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- **Intelligent, reactive behavior is not sufficient**
  - *Need perceptual attention/tactical situation awareness*
  - Need ability to plan
- **Planning is not sufficient**
  - *Need to monitor plan execution*
  - *Need strategic situation awareness*
  - Need ability to replan
- **Continuous planning capability is not sufficient**
  - Need to function as an organization
- **Divide and Conquer approach does not work**
  - *Situation awareness*, planning, execution, monitoring, replanning, collaboration are ***highly interdependent***

A Definition

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" Situation Awareness is

(1) the perception of the elements in the environment within a volume of time and space,

(2) the comprehension of their meaning, and

(3) the projection of their status in the near future."

M. Endsley, 1995 (as quoted in NRC study on Modeling Human and Organizational Behavior, Pew and Mavor, ed., 1998)

Levels of Situation Awareness

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- **Tactical**
  - *Perception* for information gathering
  - *Understand* current state (and near-term future)
  - ➔ Tends to be task-oriented, reactive, opportunistic
- **Strategic**
  - Identify knowledge goals; plan sensing actions
  - *Understand* future (and how it relates to goals)
  - ➔ Tends to be goal-oriented, deliberative, abstract

➔ A complete agent must have both

Creating Tactical Understanding

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- **Structural analysis**
  - ➢ What do I see?
    - Identify entity types and groups
      - ◆ Clustering based on type and distance
    - Encode and understand spatial relationships
      - ◆ Use K-D tree representation
  - ➢ How do I interpret what I see?
    - Hypothesize formations of entities
    - Hypothesize echelons (organizational hierarchy)
      - ◆ Pattern matching with respect to templates
- **Functional analysis**
  - ➢ What are they doing now?

Encoding Organizational and Spatial Relationship in an Extended kd-tree

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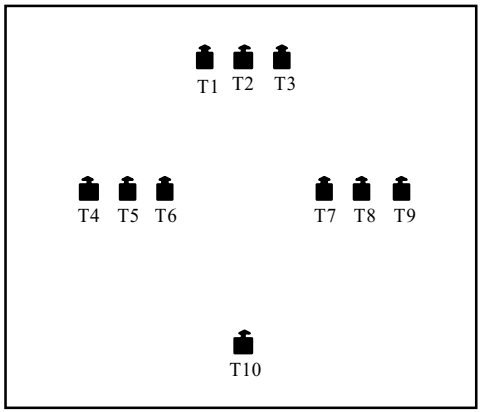
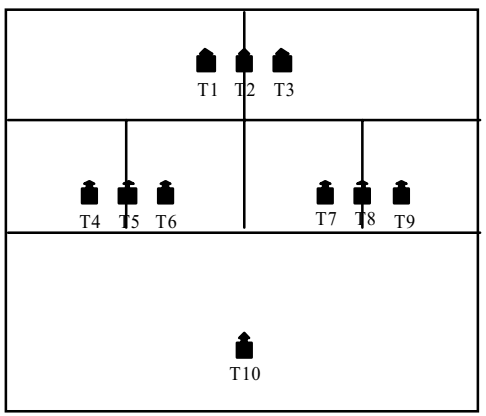
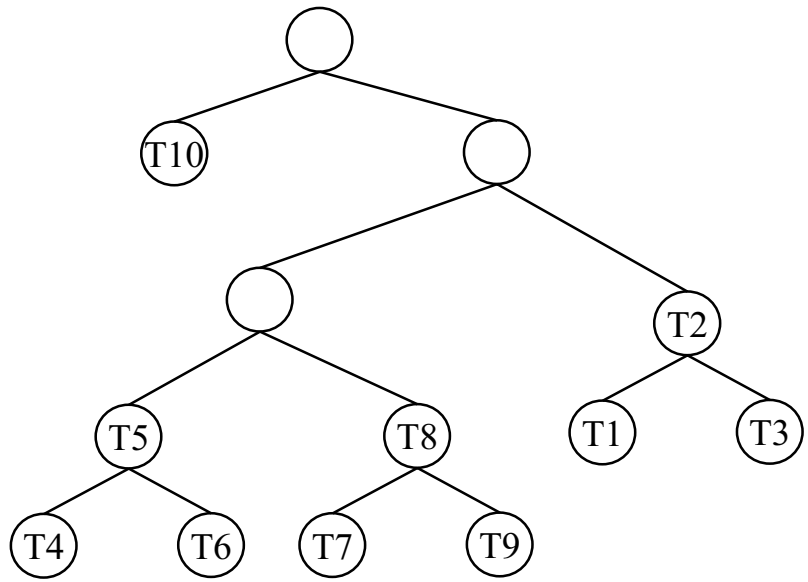
A formation of T80 tanks



A division of space



A kd-tree based data structure



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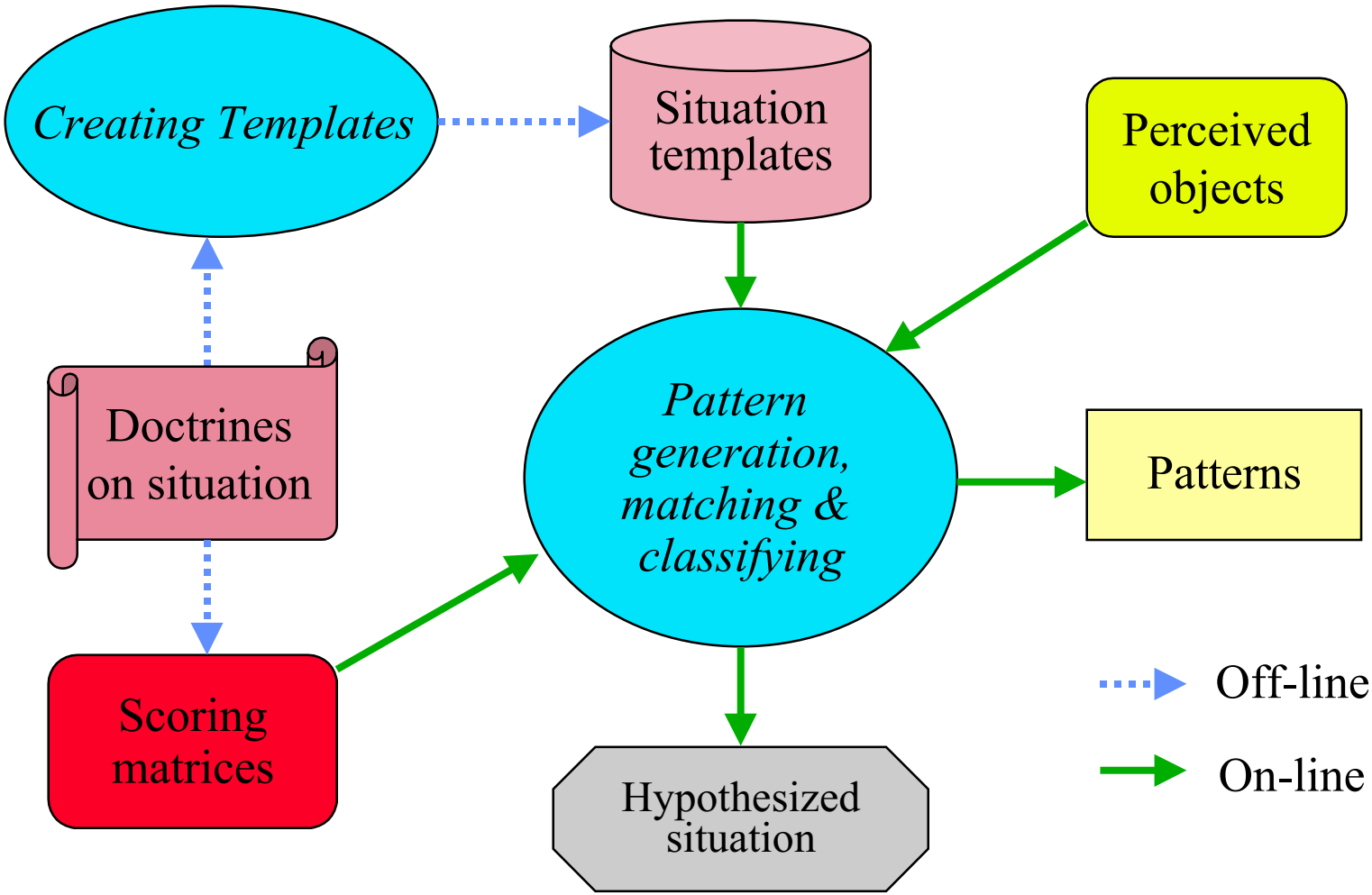
A Sketch of the Approach



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Overview of Procedures

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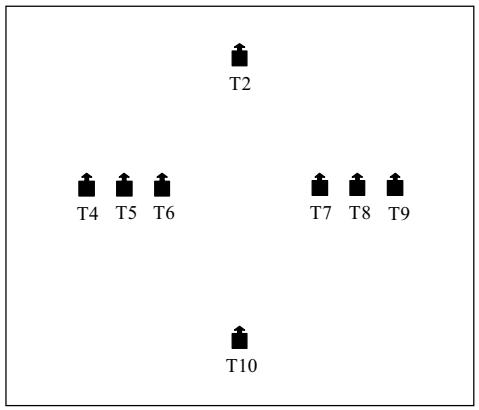
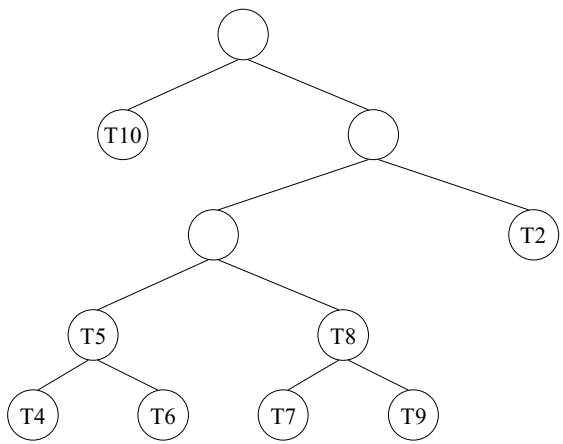
- **Construct a template database**
  - Access echelon information
  - Access formation information
  - Encode templates in extended k-d tree format
- **Build patterns of observed objects**
  - Pre-select relevant templates based on object types and quantities
  - Build one pattern of observed objects based for each template (its structure and parameters such as unit distances)
- **Find the best possible situation template**
  - Measure the similarity between a pattern and a template (based on the structure of two kd-trees)
  - Select the best matched template
- **Refine patterns based on situation hypotheses and by collecting more data**

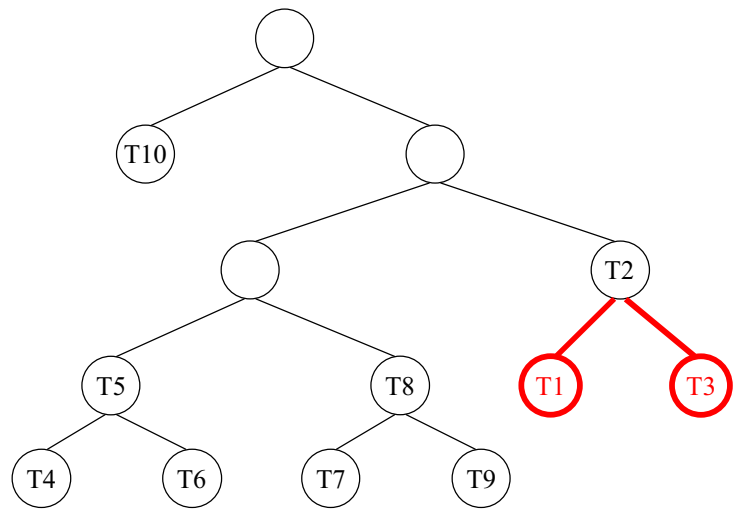
Application
Information Collection for Hypothesis Verification

Perceived objects





The best-matched template



- **Action: Search the area around T2**

Summary

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- **Work in progress**
  - Re-implementing clustering and pattern matching so that it scales well
- **Provides primitive way of understanding behavior of groups of others**
- **Want to extend to groups where there are no templates**
  - Hierarchical (multi-resolution) grouping
  - Spatial relationships and reasoning
  - Group behaviors evident