An Ontology for Active and Passive Aerial Drone Threat Automatic Plan Recognition

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Aerial Semi-Autonomous Agile Asymmetric Threats

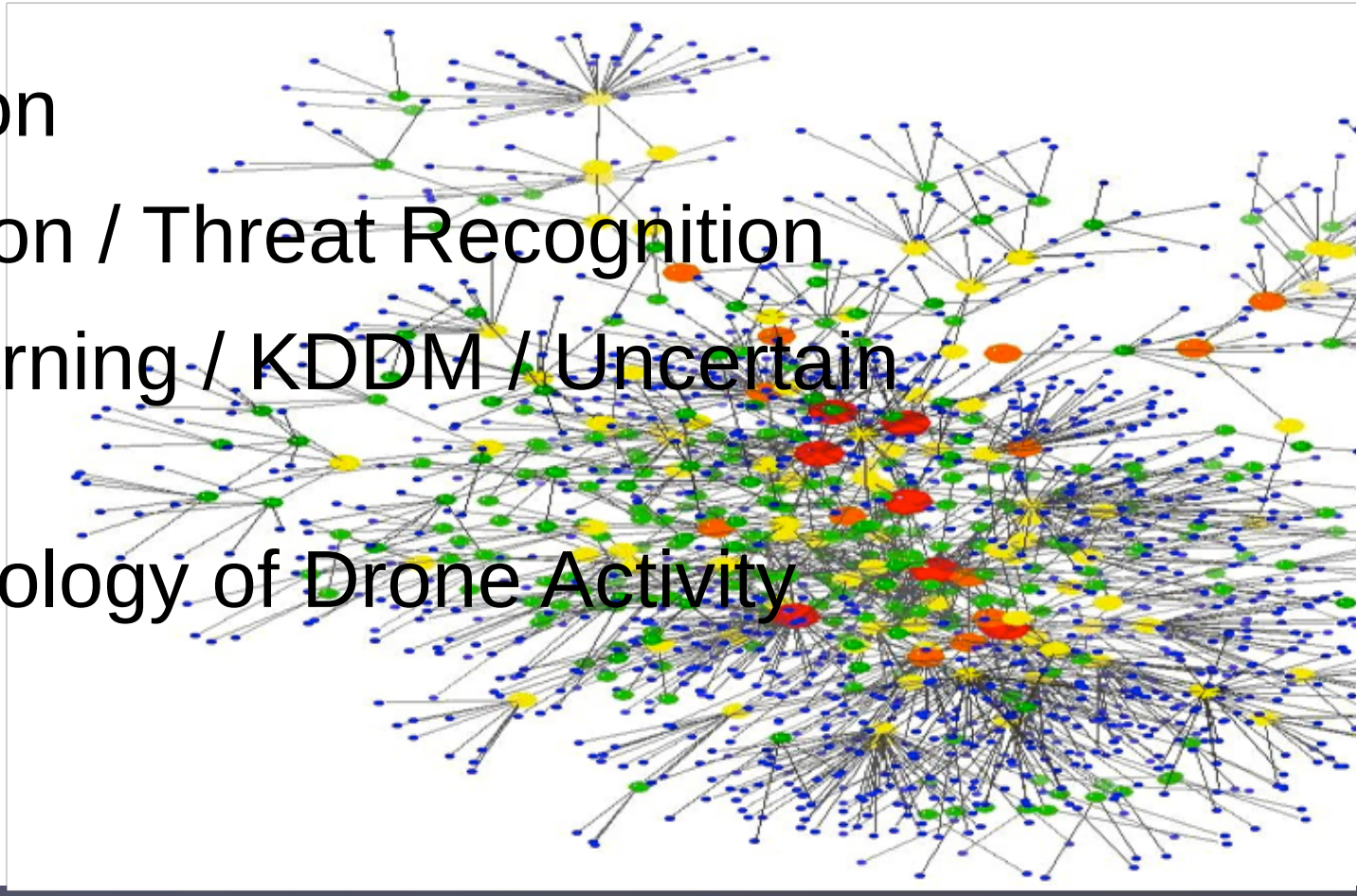
- Offense favoring
- Low cost / low tech / + multiagent coordination
- Hard to sense / ban / defeat
- Growing capability
  - Payload
  - Prevalence
  - Multimodal guidance: GPS, real-time vision, pre-programmed vision, laser, etc.

How to defend against it?

- We assume the good guys have high tech
- We assume sensing will soon be pretty good
  - DroneShield auditory
  - DeDrone visual
  - CellAntenna radio
  - DroneZon LIDAR
- We assume defeat will eventually get there

How Can AI Help?

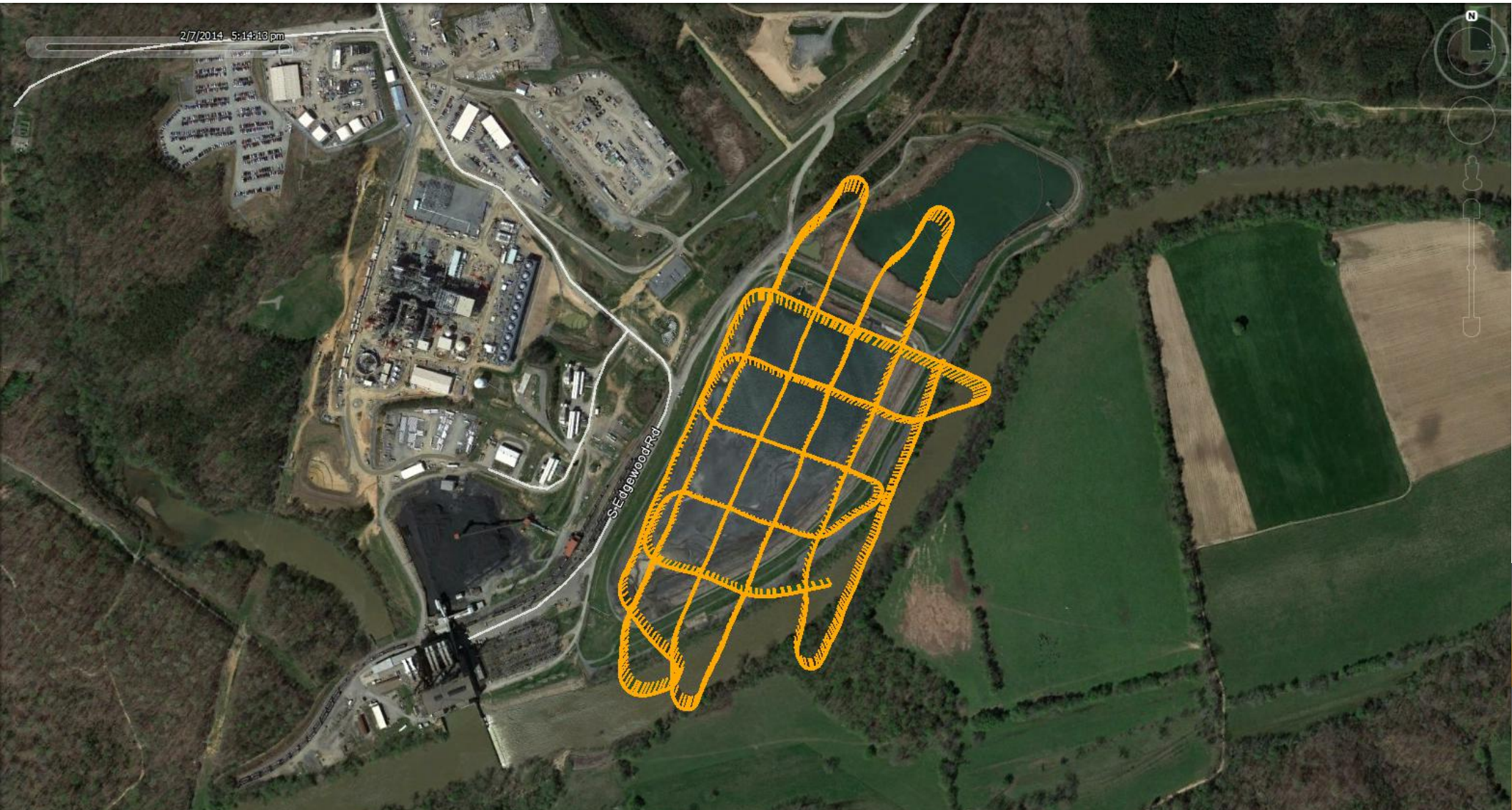
- Sensor Fusion
- Plan / Intention / Threat Recognition
- Machine Learning / KDDM / Uncertain Reasoning
- Need an Ontology of Drone Activity



Most Important Point

- Choosing an algorithm isn't going to help much without the right terminology
- Garbage in = Garbage out
- Wrong Big Data = Big Useless Data
- You can't reason about it if you can't express it
  - Even emergent concepts require the right inputs
  - Nothing wrong with helping the AI find the right stuff

What is this Drone Doing?



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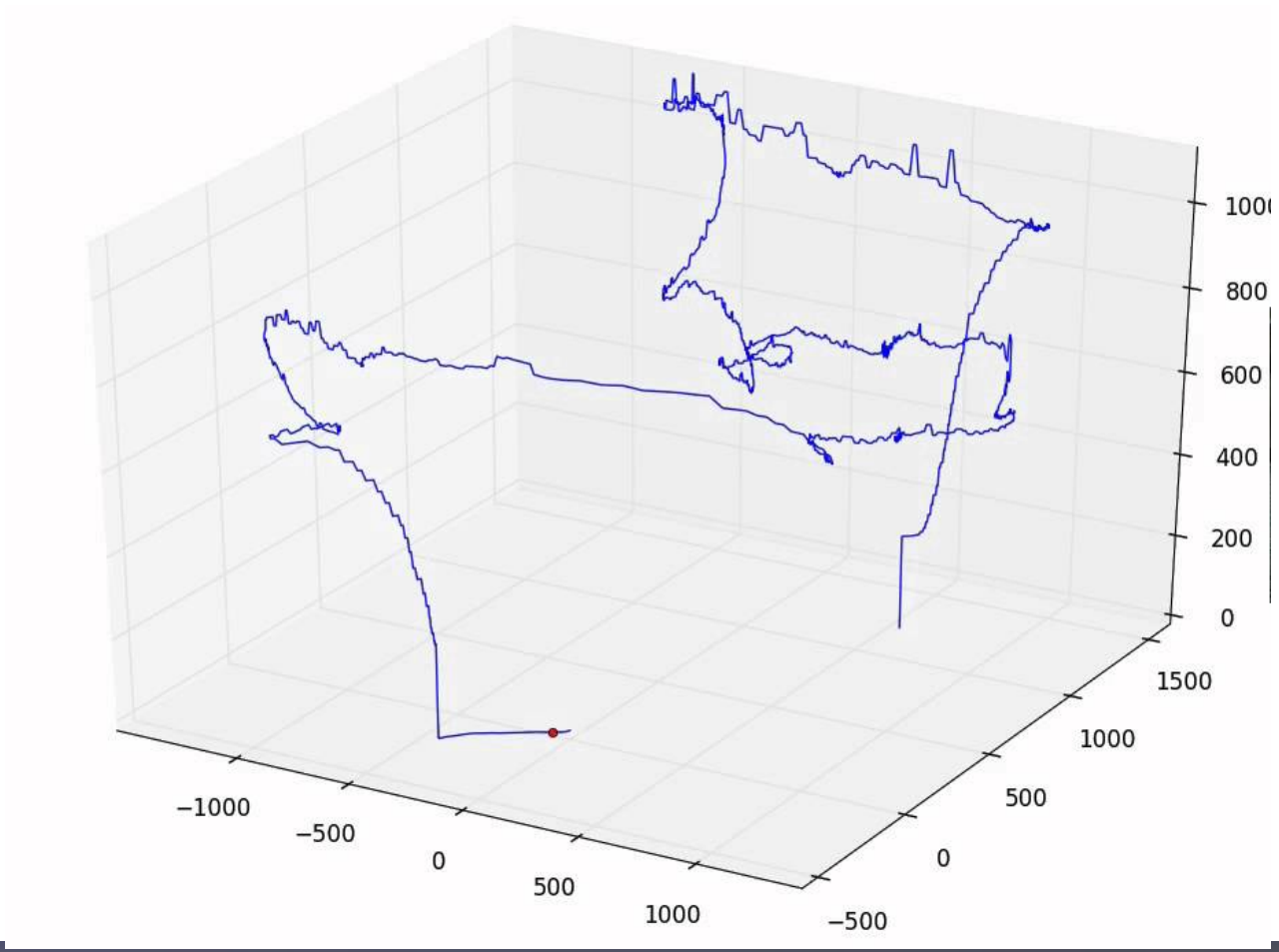

Capture Data In Terms of Target

- Maintains-line-of-sight
- Responds-to-target-ambiguity-with-choice-hesitation
- Responds-to-blocking-with-vector-to-target-correction
- Deviates-from-others-on-site

Terminology w.r.t. Mission

- A. Reconnaissance
  - Maintains-line-of-sight
  - Maintains-watchful-min-distance-and-max-distance
  - Matches-changes-in-motion
  - Responds-to-blocking-with-angular-deviation
  - Responds-to-sensory-obscuration
  - Responds-to-target-concealment
  - Exhibits-ground-survey-pattern
  - Follows-target-intermittently

Terminology w.r.t. Mission

- B. Attack
  - Maintains-minimum-distance
  - Maintains-altitude
  - Maintains-straight-line-clear-path
  - Follows-target-constantly
  - Responds-to-blocking-with-robust-deviation
  - Responds-to-target-ambiguity-with-choice-hesitation
  - Exhibits-load-bearing-dynamics

Terminology w.r.t. Mission

- C. Intercept
  - Accelerates-to-vector-to-target
  - Approaches-constantly
  - Approaches-quickly
  - Dives
  - Responds-to-blocking-with-vector-to-target-correction
  - Responds-to-target-ambiguity-with-hesitation
  - Ignores-target-concealment

Terminology w.r.t. Mission

- D. Coordination
  - Maintains-formation
  - Maintains-angle-or-distance
  - Maintains-distance-to-target
  - Exhibits-sudden-parallel-acceleration
  - Exhibits-serialized-flight on-same-path
  - Exhibits-mutual-statistical-anomaly-of-motion
  - Exhibits-mutual-statistical-anomaly-of-configuration
  - Marks-target

Second Most Important Point

- Not a 3d coordinate terminology
- Observations in terms of CAPABILITY
- Active probing / Responses give information
  - Ground-level concealment / ambiguity
  - Air intercept
  - Occlusion / Interposing

Final Important Point

- Why Care? Why Not Shoot Them All Down?

- Assessment / Intelligence = Early Warning
  - Esp. against insider threats
- Multi-stage Attack
  - Understanding = Proper Response
- Due Diligence
  - Ethical / Legal CYB
- Future Ambiguity / Crowded Skies / Mobile Targets

Summary

- We Propose More Thought on
  - Practical Semantically Relevant Ontology
  - Active Revelation of Intentions
  - Esp. Multi-Agent Multi-Modal Threats

- Drone Behavior Analytics
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