Heterogeneous Group Control
DCIST CRA, RA2

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RA2 Overview

Autonomous, **R**esilient, **C**ognitive, **HE**terogeneous **S**warm (ARC**HE**S)

Modeling Framework (RA2.A1-3):

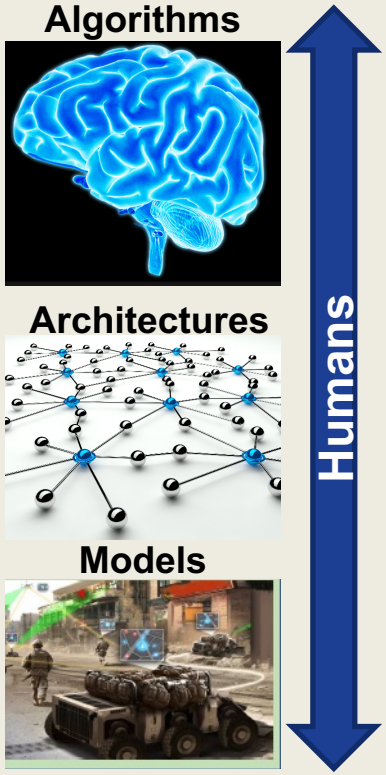
- Swarm capabilities & task requirements encoded as abstractions
- Group-level autonomy composed from abstractions

Architectures (RA2.B1-2):

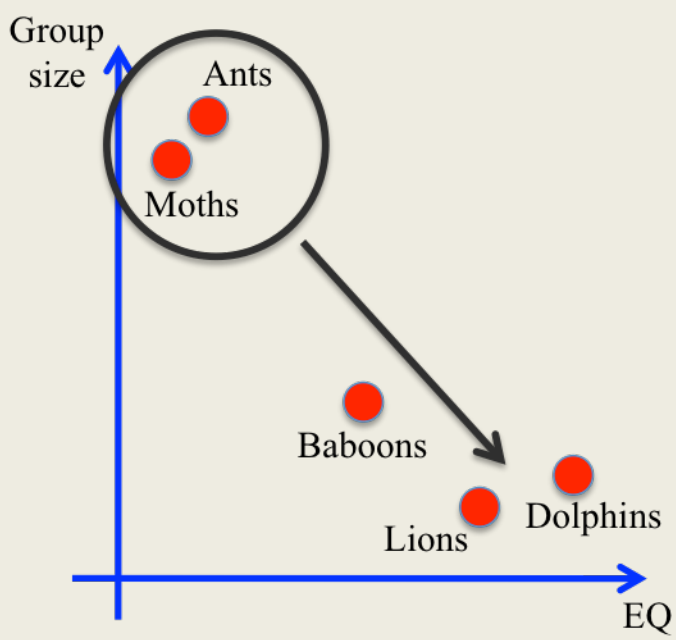
- Synthesize behaviors and interactions
- New interaction architectures for human engagement
- Diversity of communications strategies.

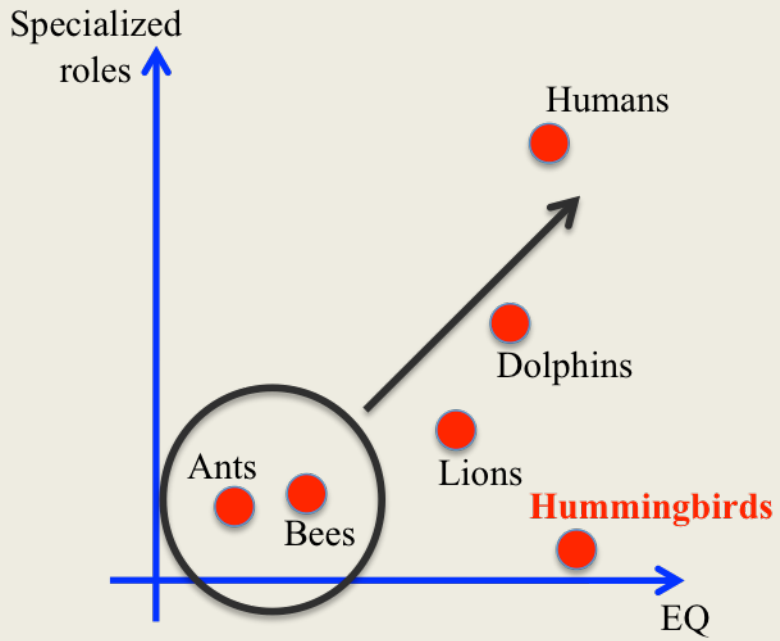
Algorithms (RA2.C1):

- Realize coordination, cooperation & collaboration



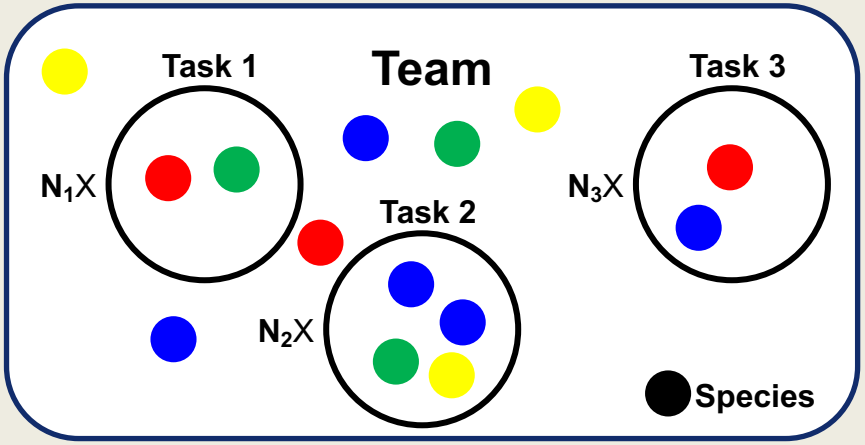
Lessons from Biology



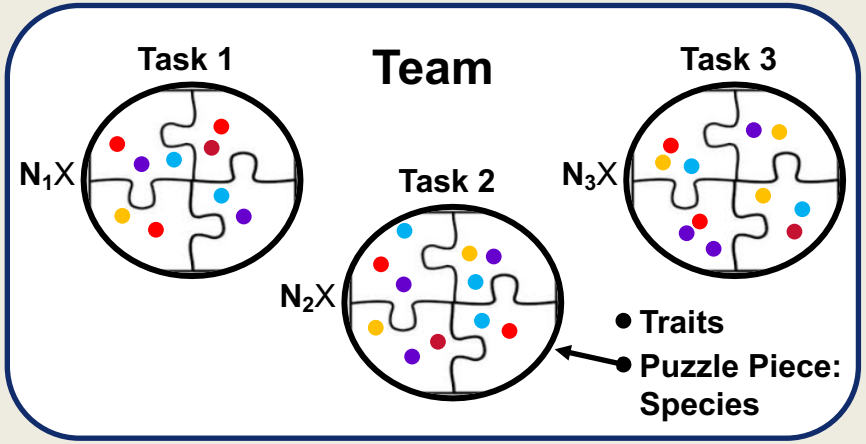


RA2 Outlook

- Homogeneity allows for coordination & cooperation; Heterogeneity allows for "true collaboration"
- Focus is on how to compose and recompose teams or teams of teams of autonomous, human (in a diversity of roles), and computing assets in order to accomplish a mission



Task-driven Planning (Set of Agents pre-defined). "You go to war with the Army you have." Online, real-time, deal with attrition.



Team-driven Planning (Set of Tasks predefined). Designing hierarchies & agents. What traits should the species have? Suited to the way Humans training.

Basics

- Heterogeneity of **Traits** in terms of sensing, actuation, computation communication, locomotion, roles
- **Agents (or Species)** include robots, humans (commanders, peers, bystanders, advisories), computational resources

- **Missions (or Tasks)** might include localization, mapping, object/target ID, ad hoc networking, tactile movements (deliver, amass, scatter, approach, follow, cordon, surveil). *Force Multiplication & Force Protection*
- **Objectives** might include agility, speed, robustness, cost, redundancy, responsiveness

RA2.A: Contextual Abstractions for Heterogeneous Groups

RA2.A1: Abstractions of Task Diversity (*Kumar*, Egerstedt, & Hsieh)

Objective: Develop abstractions of species (particularly non-humans) by decomposing them into a collection of composable traits. [Near term: perimeter defense, resilient comms]

RA2.A2: Modeling Human Traits (*Chernova*, Christensen, Egerstedt, Shah)

Objective: Develop abstractions of composable human traits, which accommodate general and evolving individualized profiles. [Near-term: shared human/non-human control and role discovery]

RA2.A3: Composable Autonomy in Heterogeneous Groups (*Egerstedt*, Ayanian, Hsieh & Kumar)

Objective: Develop means of mapping high-level mission requirements to abstractions (traits) used to synthesize action plans & task requirements. [Near term: target scenario]

RA2.B: Architectures for Synthesis of Group Behaviors & Interactions

RA2.B1: Human-Agent Collaborative Control of the Swarm (*Shah*, Bassett, Chernova, Egerstedt, & Tsiotras)

Objective: Interaction architecture that makes large scale swarms amenable to human control in dynamic, stochastic, and partially observable environments. [Near term: human data from use cases]

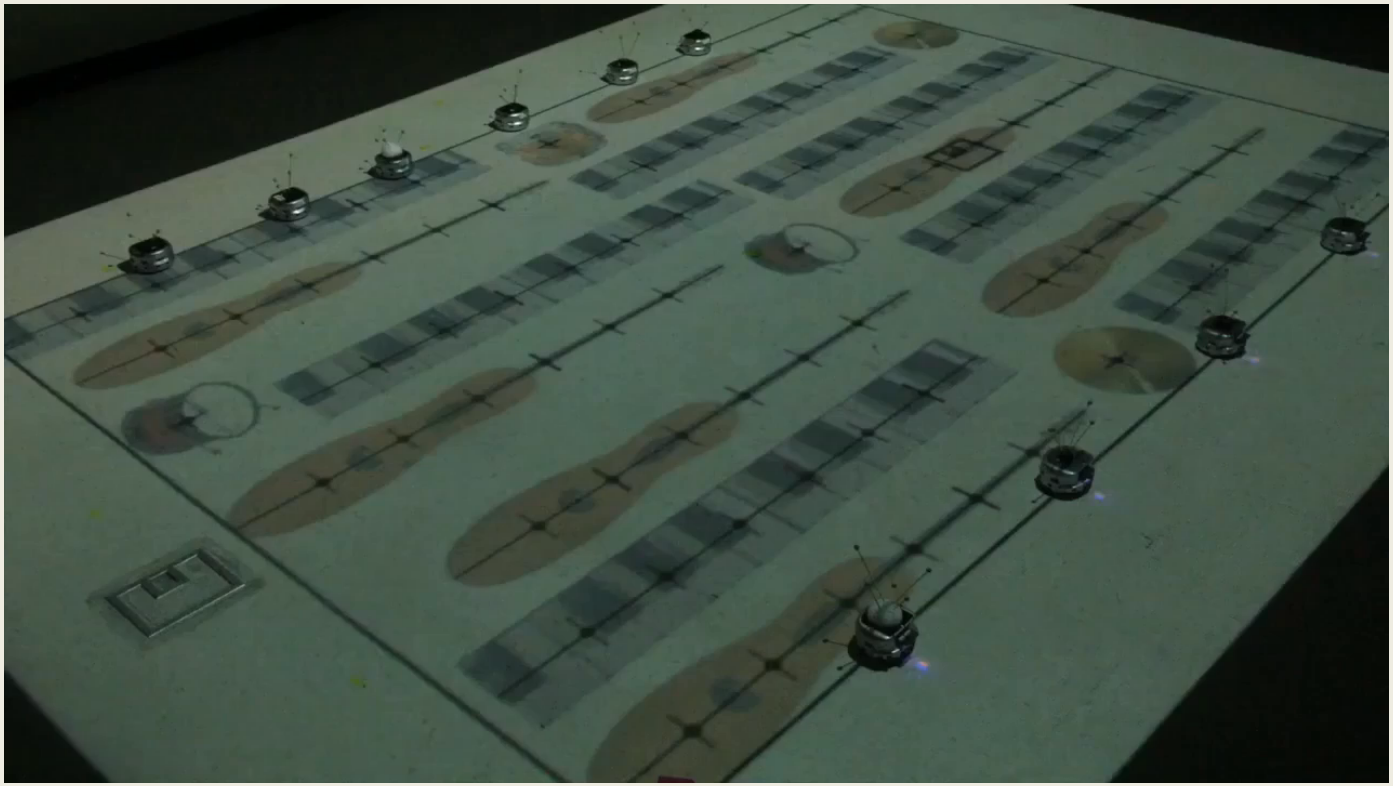
RA2.B2: Heterogeneous Hierarchical Autonomous Networks (*Ribeiro*, How, & Hsieh)

Objective: Develop the tactical cloud through the exploitation of heterogeneous communications strategies & computing capabilities. [Near term: test-bed definition and development]

RA2.C: Algorithms for Control of Heterogeneous Groups

RA2.C1: Task Assignment (*Hsieh*, Ayanian, Chernova, Kumar & Shah)

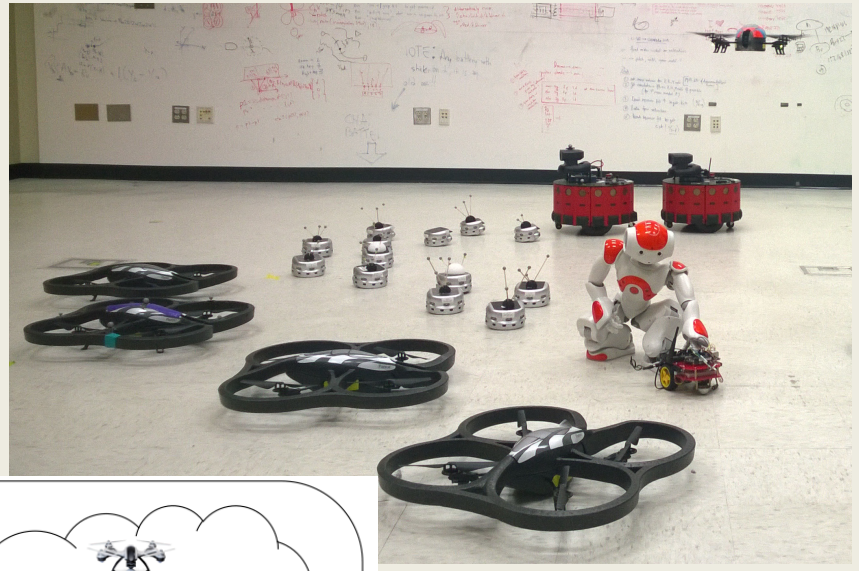
Objective: Given a formal framework of trait models, develop algorithms to realize coordination, collaboration, & cooperation b/t heterogeneous agents. [Near term: Cost metrics and connection to motivating scenarios]



RA2: To Conclude

Different roles

Heterogeneous robots



People and robots