Topics in DATA Science

Computational Improvisation To Support First Response

Presenter: William A. Wallace

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Application of Data Science Research

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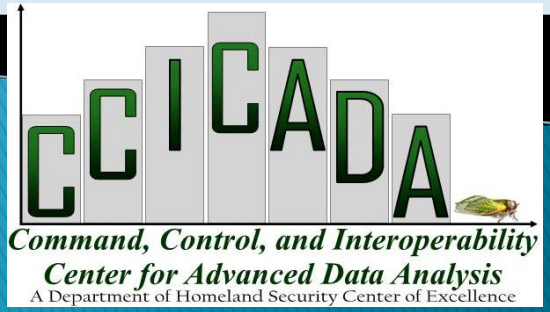
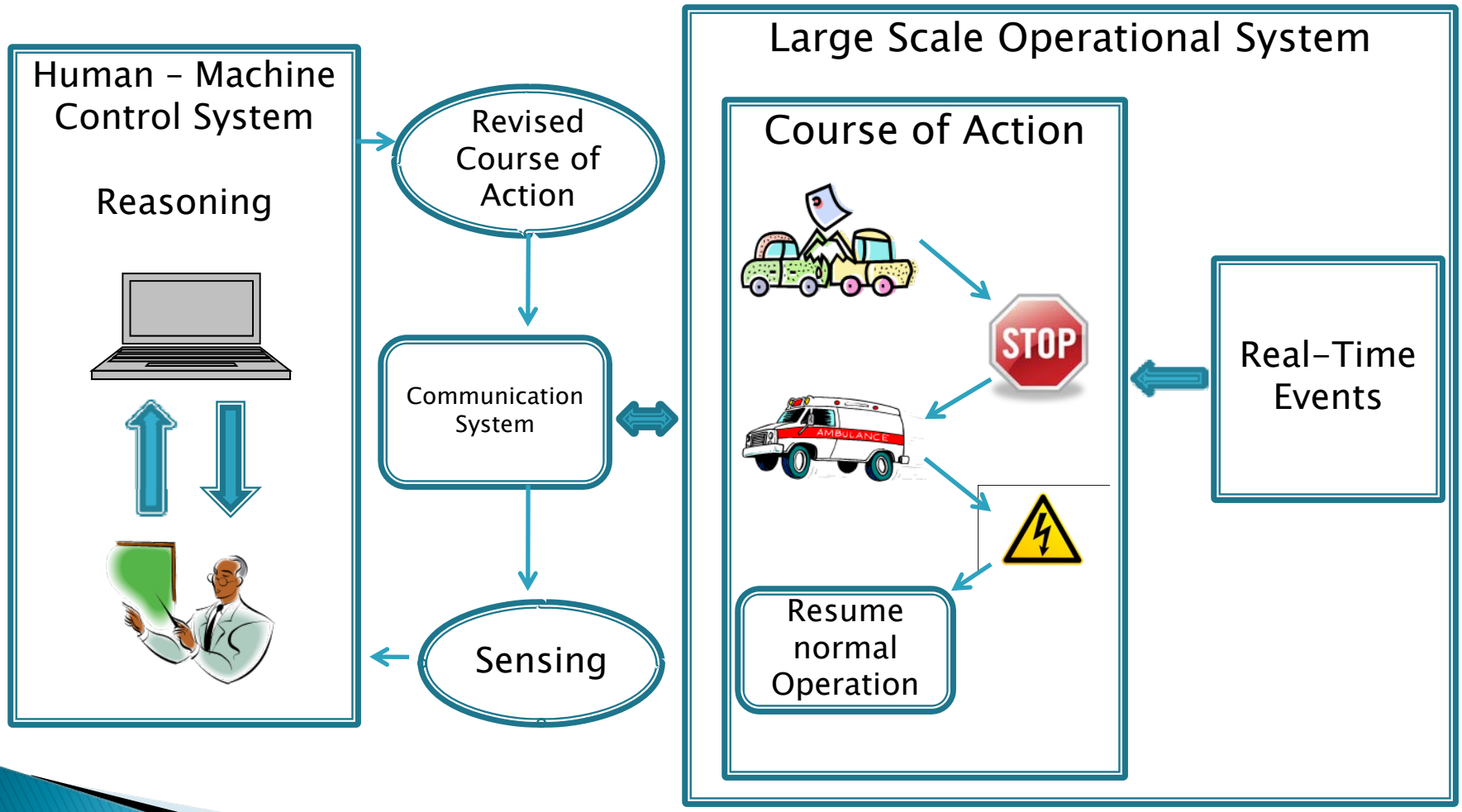


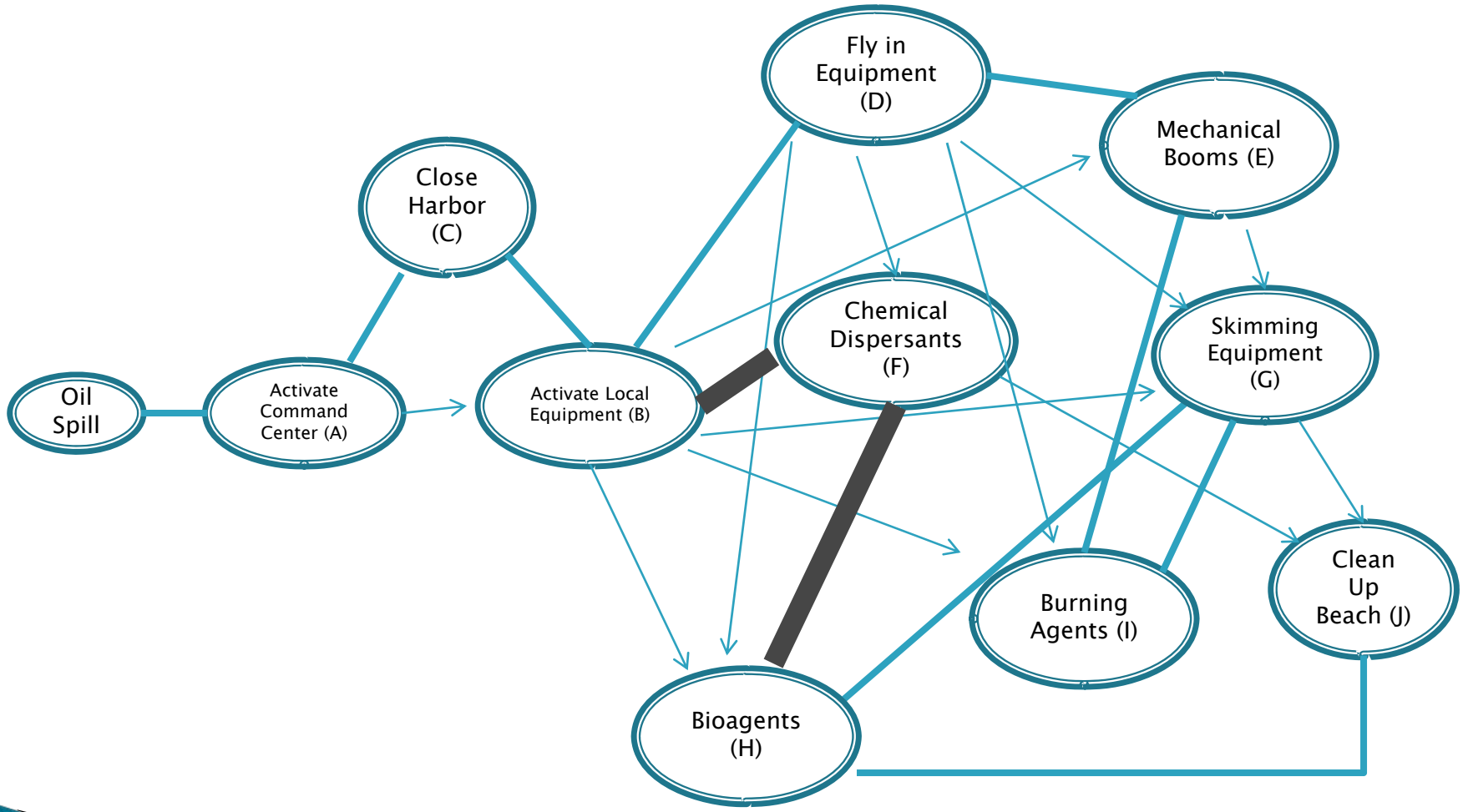
Photo provided by the Jersey City Fire Department

Screenshot of a video from the U.S Fire Academy

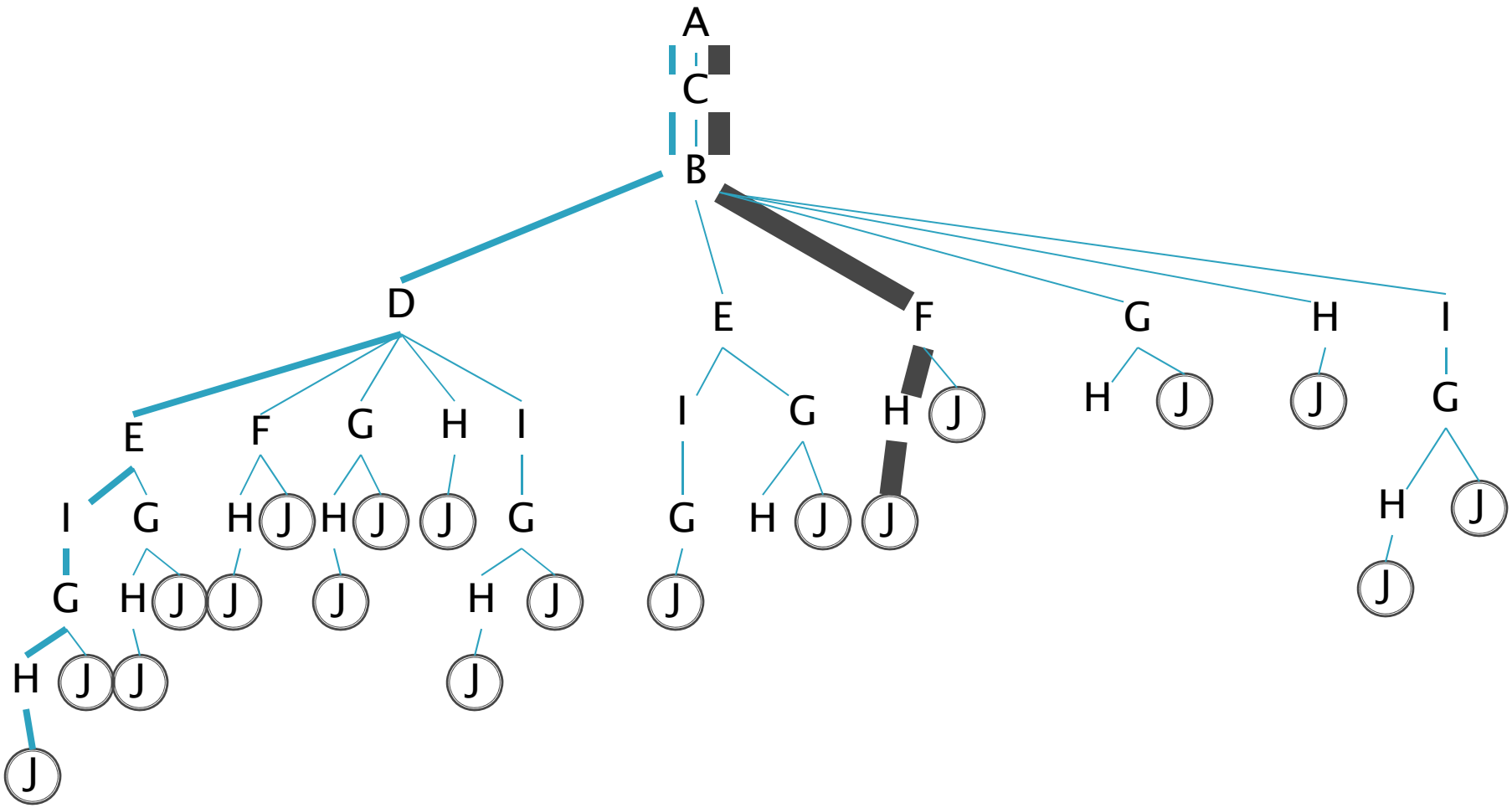
Decision Environment For Emergency Management



Topographical Graph of Oil Spill Response Plan



Tree Structure To Enumerate Paths In Graph of Oil Spill Response Plan



What if no planned actions are possible, i.e. can not traverse the graph?

⟸ Objective

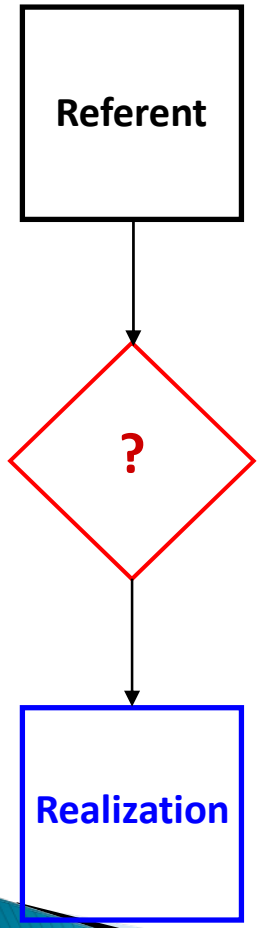
Resources ⟹

Screenshots from movie ***Apollo 13*** *(1995)*

Improvisation in Jazz

Result: computational model of improvisation in emergency management

Cognition in Improvisation



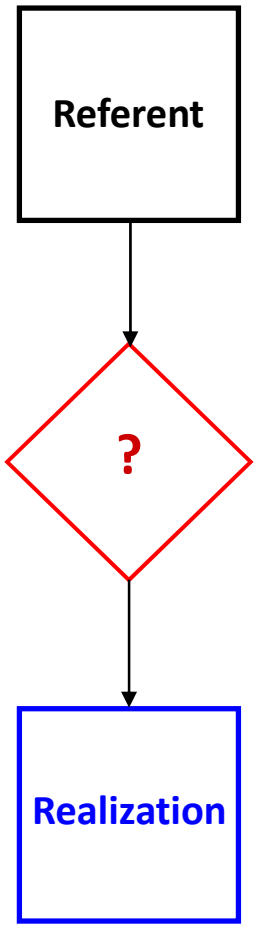
Referent

"a set of cognitive, perceptual or emotional structures (constraints) that guide and aid in the production of musical materials" *(Pressing, 1984)*

Realization

an actualization or operationalization of a referent *(Lord, 1960; Berliner, 1994)*

Model Function

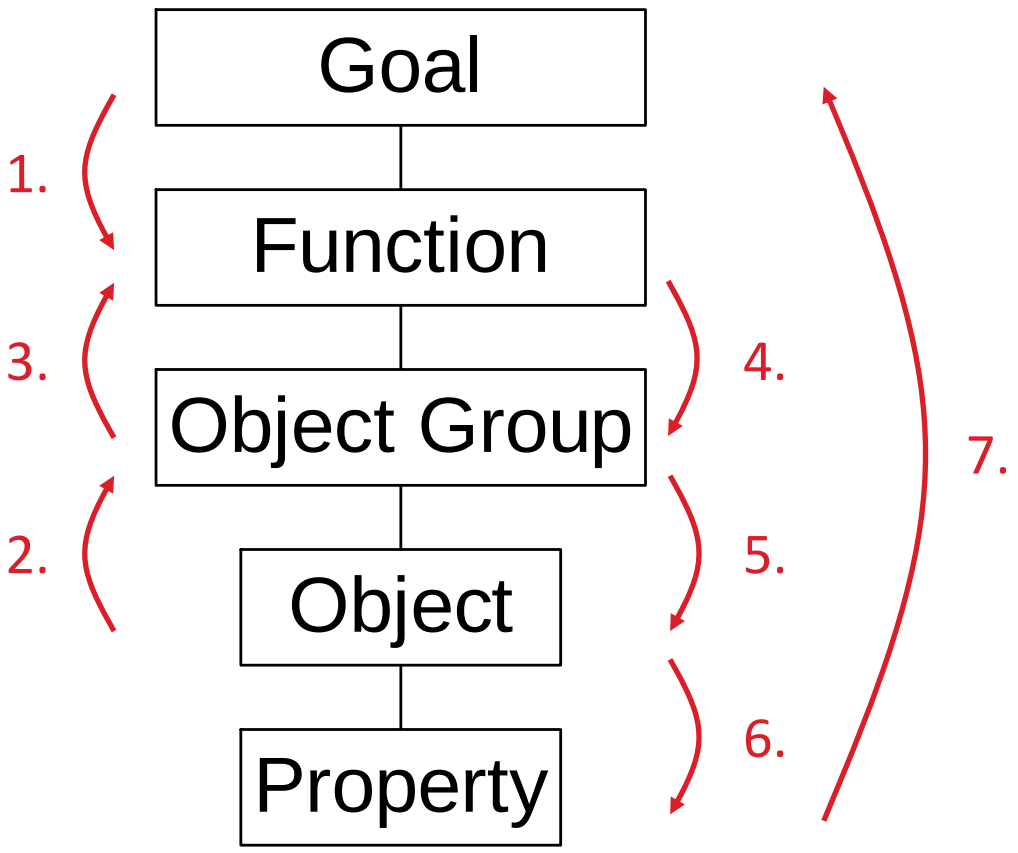


- Initialize with **courses of action** (CA) and goals (G)
- Execution of some CAs at *t* is blocked
- Identify replacement resources using
  - CA_i as referent
  - contextual factors (G_i, *t*)
  - agent's existing knowledge (ontology)
- Recommend substitute resources to group coordinator
- Group develops **realization**

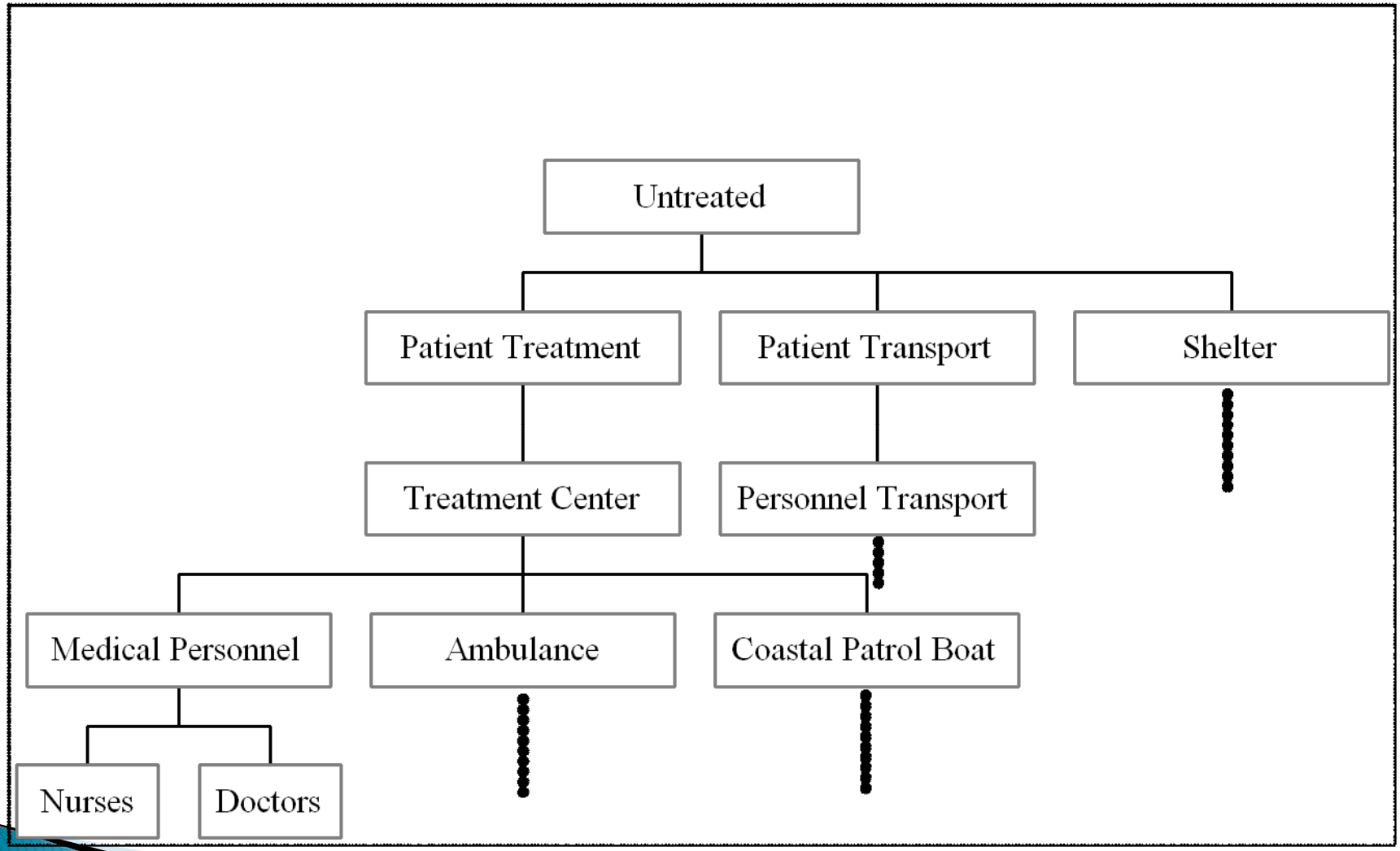
Ontology

0. **CA**, **G**

Decision Logic



Excerpt from Ontology



Referent-based Improvisations

CA_i	Original CA_i	Summary CA_i	Realization
1	Send pumper truck (*Ea*) to *G* pick up chem suits (*Ga*), then proceed to scene (*Z*) in order to control access (*G2*) and rescue trapped persons (*G3*)	*Ea* to *Ga* to *Z* for *G2* and *G3*	Substitute *Gb* for *Ga*
2	Send ambulance (*Aa*) to scene to treat injured persons (*G1*)	*Aa* to *Z* for *G1*	Substitute *Ja* (ladder truck) and *Pa* (med. pers.) for *Aa*
3	Send ladder truck (*Da*) to scene to fight fire (*G4*)	*Da* to *Z* for *G4*	Substitute *Ja* for *Ba*

Scores for All Resource/Goal Mappings

		Goal			
Index	**Resource**	**1**	**2**	**3**	**4**
1	Aerial ladder truck	7	70	13	16
2	Ambulance	**14**	**9**	**18**	15
3	Bus*	**1**	**2**	**3**	**4**
4	Chemical Protection Suits	**1**	0	**2**	10
5	CO_2	0	3	0	0
6	Coastal Patrol Boat	**6**	**9**	**18**	10
7	Gravel Truck*	**2**	**3**	**5**	**6**
8	Helicopter*	**1**	**2**	**3**	**4**
9	Medical Personnel	6	0	0	**8**
10	Oil Boom*	**0**	**0**	**0**	**1**
11	Police	5	0	4	2
12	Police Cruiser	5	3	6	9
13	Pumper Truck	6	5	9	11

where **Goal**
1=treat injured
2=control access
3=rescue trapped persons
4=fight the fire

Research in Data Science

- Traversing very large networks in real time
- Discovering resources that can be used to meet the goals
- Matching objects with property needed to satisfy goals
- Complete the networks with new actions
- Display the location and attributes of the resources for the new actions

Solution for CO2 Problem in movie *Apollo 13*

Procedures to make a new CO2 filter

Acknowledgments

- Collaborator: D. J. Mendonca
  - A Cognitive Model of Improvisation in Emergency Management, IEEE Trans. SMC, 37(4), 2007
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