Algorithmic Decision Theory and Risk-based Decision Making in the Maritime Environment

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Algorithmic Decision Theory

- Today's decision makers in fields ranging from engineering to medicine to the maritime environment have available to them:
  - Remarkable new technologies
  - Huge amounts of information
  - Ability to share information at unprecedented speeds and quantities

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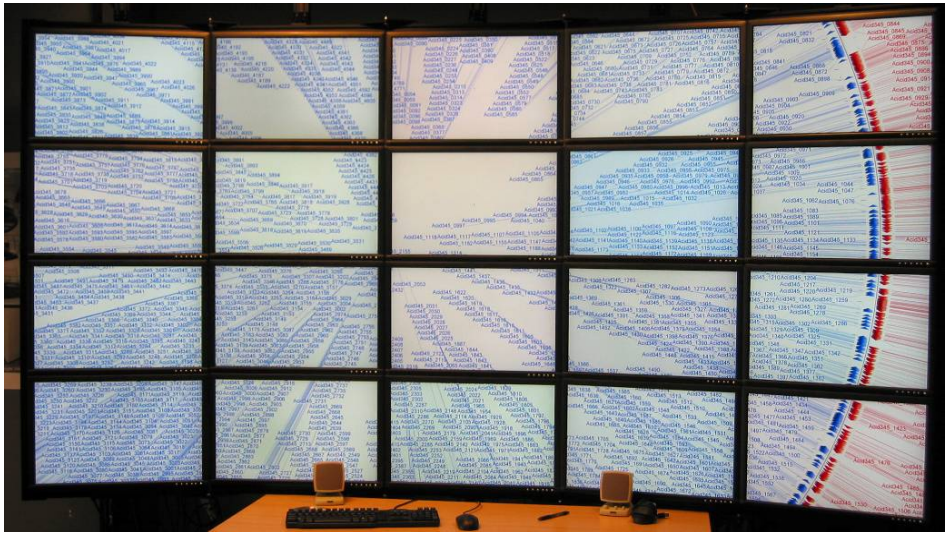
Algorithmic Decision Theory

- **These tools and resources will enable better decisions if we can surmount concomitant challenges:**
  - The massive amounts of data available are often incomplete or unreliable or distributed and there is great uncertainty in them



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Algorithmic Decision Theory

- **These tools and resources will enable better decisions if we can surmount concomitant challenges:**
  - Interoperating/distributed decision makers and decision-making devices need to be coordinated
  - Many sources of data need to be fused into a good decision, often in a remarkably short time

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Algorithmic Decision Theory

- **These tools and resources will enable better decisions if we can surmount concomitant challenges:**
  - Decisions must be made in dynamic environments based on partial information
  - There is heightened risk due to extreme consequences of poor decisions
  - Decision makers must understand complex, multi-disciplinary problems

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Algorithmic Decision Theory

- When faced with such issues, decision makers need the help of data-driven methods to support better decisions.
- One of the key roles for the CCICADA Center is the development of tools of data-driven decision support.
- Decision makers today have few highly efficient algorithms to support decisions.

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Algorithmic Decision Theory

- The new field of ***algorithmic decision theory (ADT)*** aims to exploit algorithmic methods to improve the performance of decision makers (human or automated).
- Long tradition of algorithmic methods in logistics and planning dating at least to World War II.
- But: algorithms to speed up and improve real-time decision making are much less common

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Algorithmic Decision Theory

•CCICADA researchers have been involved in creating the field of ADT and have applied it to a variety of problems of interest to the Coast Guard.

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Fisheries Law Enforcement

- Coast Guard District 1 developed a ***scoring system called OPTIDE to determine which commercial fishing vessels to board to look for violations.***
- The OPTIDE rule was built based on expert judgment and intuition.
- D1 asked CCICADA if their success rate in finding violations by boarding could be improved by use of sophisticated methods of ADT.
- Goal: refine the ability to determine the risk profile of vessels.

Fisheries Law Enforcement

- Our methods using machine learning and logistic regression give rise to scoring rules that hold promise for significant improvement over OPTIDE's success rate in finding fisheries violations upon boarding.
- We have also developed algorithms for addressing other goals of fisheries law enforcement:
  - Balanced deterrent
  - Balanced policing
  - Balanced maintenance of safe operations

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Resource Allocation in the Arctic

- Resource allocation in the Arctic is a persistent and complex challenge at the center of many Coast Guard missions, including:
  - navigational safety
  - oil spill response
  - search and rescue
  - traffic management

Barrow Sunset, 11-8-12
Photo credit: Martha Graboski, CCICADA, RPI

- The Arctic is an environmentally harsh and sensitive area with little commercial, maritime or safety infrastructure, and great distances to access resources in the case of a maritime, personnel casualty, or oil spill event.

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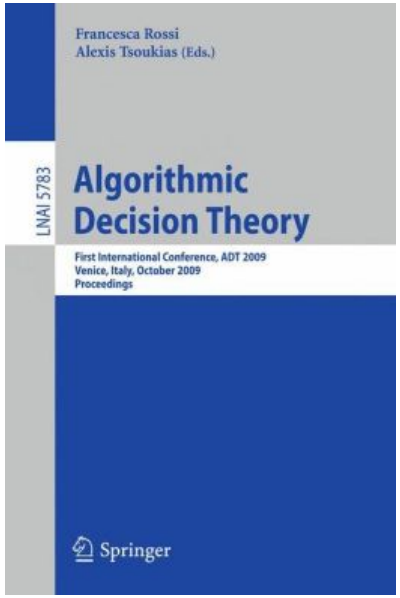
Resource Allocation in the Arctic

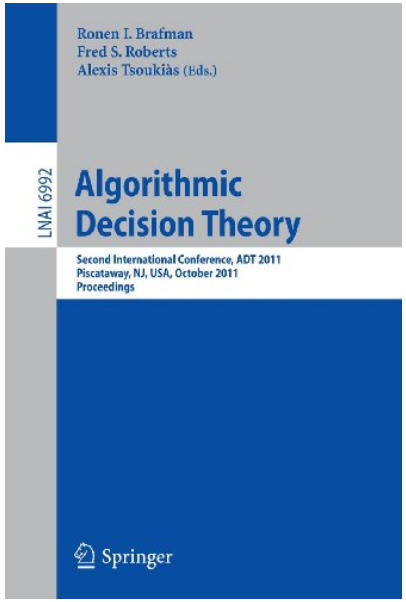
- It is all to easy to make incorrect resource allocation decisions in such a risky environment.
- DMARA Project (Dynamic Modeling for Arctic Resource Allocation): CCICADA is working with Coast Guard District D17 on applying ADT to resource allocation problems in the Arctic, beginning with oil spill response planning.

http://www.dhs.gov/xlibrary/photos/ snapshots/ stada-250x250.jpg

Algorithmic Decision Theory

- The new field of ADT builds on availability of massive amounts of data.
- It offers the possibility of using modern methods of data science to provide decision support in a variety of areas, and in particular in risk-based maritime decision making.





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