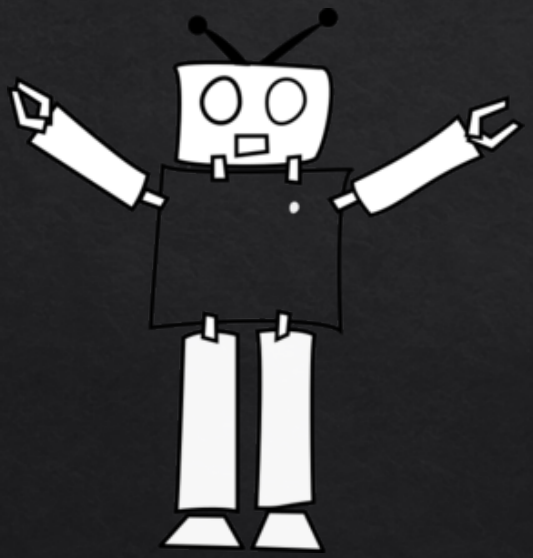
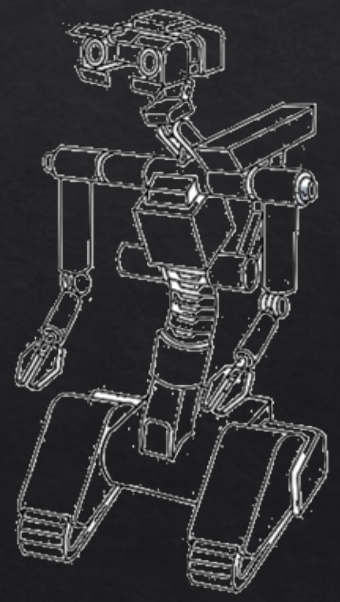
Machine Learning to the Rescue

A Workshop for the Infrastructure Competition





Joint Rescue Forces history

The Joint Rescue Forces are active in the RoboCup Rescue Simulation league since 2008.
It is a cooperation between researchers from different universities.

- Francesco Amigoni, Politecnico di Milano, Italy
- Masaru Shimizu, Chukyo University, Nagoya, Japan
- Nate Koenig, Open Source Robotics Foundation, San Francisco, USA
- Tomoichi Takahashi, Meijo University, Nagoya, Japan
- Victor Spirin, Oxford University, United Kingdom
- Julian de Hoog, University of Melbourne, Australia
- Stephen Cameron, Oxford University, United Kingdom
- Arnoud Visser, Universiteit van Amsterdam, The Netherlands

Joint Rescue Forces history

The Joint Rescue Forces have made several contributions to the Infrastructure Competition:

- RoboCup 2016, - The Future of Robot Rescue Simulation Workshop
- RoboCup 2015, Hefei, China - A realistic RoboCup Rescue Simulation based on Gazebo
- RoboCup 2014, João Pessoa, Brazil - MRESim - A simulator for testing the behaviour of multiple robots exploring unknown environments.

Joint Rescue Forces history

The Joint Rescue Forces has published a large number of publications:

2016

- Raymond Sheh, Sören Schwertfeger and Arnoud Visser, "16 Years of RoboCup Rescue", KI – Künstliche Intelligenz, Volume 30, Issue 3, October 2016.
- Masaru Shimizu, Nate Koenig, Arnoud Visser and Tomoichi Takahashi, "A realistic RoboCup Rescue Simulation based on Gazebo", in RoboCup 2015: Robot World Cup XIX, Springer Lecture Notes on Artificial Intelligence series, volume 9513, 2016, pp. 331-338.

2015

- Mircea Trăichioiu and Arnoud Visser, "Hierarchical Decision Making for Search and Rescue Teamwork ", in the *Proceedings of the 27th Belgian-Netherlands Conference on Artificial Intelligence* (**BNAIC 2015**), Hasselt, Belgium, November 5-6, 2015.
- Victor Spirin, Julian de Hoog, Arnoud Visser and Stephen Cameron, "MRESim, a multi-robot exploration simulator for Rescue Simulation League", in *RoboCup 2014: Robot World Cup XVIII*, Springer Lecture Notes on Artificial Intelligence series, volume 8992, May 2015, pp. 106-107.
- Arnoud Visser, Nobuhiro Ito and Alexander Kleiner, "RoboCup Rescue Simulation Innovation Strategy", in *RoboCup 2014: Robot World Cup XVIII*, Springer Lecture Notes on Artificial Intelligence series, volume 8992, May 2015, pp. 661-672.

Scientific Impact of the League

Found 73 Results

Pooya Deldar Gohardani, **Siavash Mehrabi**, **Peyman Ardestani**:
RoboCup Rescue Simulation System 2016 Champion Team Paper. Robot Soccer World Cup (RoboCup): 565-576 (2016)
Category: **RoboCupRescueSimulation**
Keywords: **team description**

Masaru Shimizu, **Nate Koenig**, **Arnoud Visser**, **Tomoichi Takahashi**:
A Realistic RoboCup Rescue Simulation Based on Gazebo. Robot Soccer World Cup (RoboCup): 331-338 (2015)
Category: **RoboCupRescueSimulation**

Tomoichi Takahashi, **Masaru Shimizu**:
How Can the RoboCup Rescue Simulation Contribute to Emergency Preparedness in Real-World Disaster Situations? Robot Soccer World Cup (RoboCup): 295-305 (2014)
Category: **RoboCupRescueSimulation**

Arnoud Visser, **Nobuhiro Ito**, **Alexander Kleiner**:
RoboCup Rescue Simulation Innovation Strategy. Robot Soccer World Cup (RoboCup): 661-672 (2014)
Category: **RoboCupRescueSimulation**

CATEGORY PAPERS

CATEGORY	#PAPERS
RoboCupSoccer	145
RoboCupRescueSimulation	73
RoboCupSoccerSimulation	39
RoboCup@Home	27
RoboCupIndustrial	13
RoboCup	5
RoboCupJunior	4
RoboCupRescue	4

Machine Learning for the Rescue Simulation League

Luis Gustavo Nardin, Arnoud Visser and Sebastian Castro

b-tu

UNIVERSITEIT VAN AMSTERDAM

MATLAB

Call for proposals: RCF Support for Collaborations 2018

The RoboCup Federation (RCF) is pleased to announce this call for proposals to support collaborative activities in RoboCup.

RCF Support for Collaborations 2018 aims at funding short-term visits of faculty or students (Bachelor, Master, or PhD level) to other institutions for the development of joint teams, interchange and integration of research from different sources, etc. The goal is to enable collaboration between RoboCup researchers at different institutions to foster progress of RoboCup and its leagues.

Examples of proposals in this category are (but not limited to):

Student exchange between RoboCup Teams (not applicable to Junior students)

Faculty exchange between RoboCup Teams

RoboCup camp and workshop attendance

Machine Learning with MATLAB

Download ebook

You have a complex problem involving a large amount of data and lots of variables. You know that machine learning would be the best approach—but you've never used it before. How do you deal with data that's messy, incomplete, or in a variety of formats? How do you choose the right model for the data?

Sounds daunting? Don't be discouraged. A systematic workflow will help you get off to a smooth start.

Download the ebook to go step by step from the basics to advanced techniques and algorithms:

Section 1: Introducing Machine Learning

Learn the basics of machine learning, including supervised and unsupervised learning, choosing the right algorithm, and practical examples.

Section 2: Getting Started with Machine Learning

Step through the machine learning workflow using a health monitoring app as an example. The section covers accessing and loading data, preprocessing data, deriving features, and training and refining models.

Section 3: Applying Unsupervised Learning

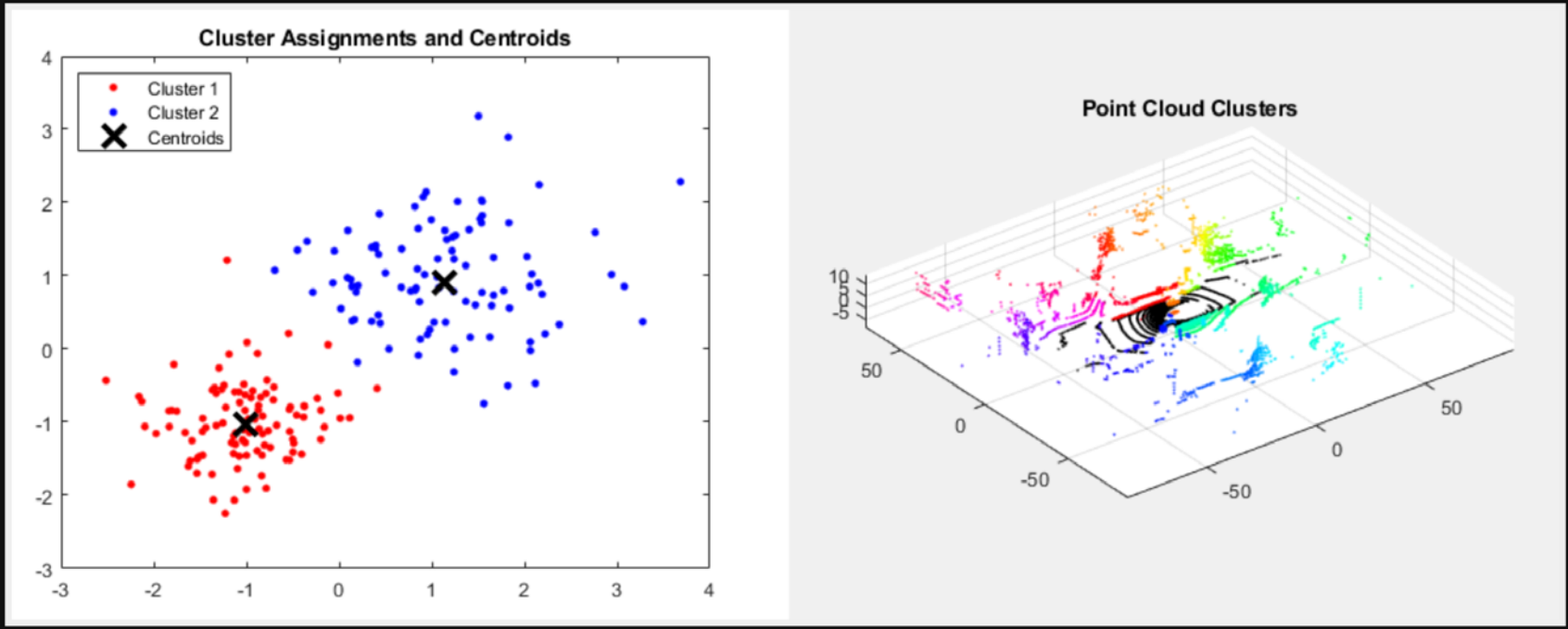
Explore hard and soft clustering algorithms, and learn about common dimensionality-reduction techniques for improving model performance.

Types of ML Problems (and Examples)

- **Classification:**
  - *Binary:* Detecting occupancy in a room
  - *Multi-class:* Detecting the type of animal in an image
- **Regression:** Predicting housing costs
- **Object detection:** Locating all pedestrians in an image
- **Generation:** Computer-generated music from input genre

Types of ML: Unsupervised Learning

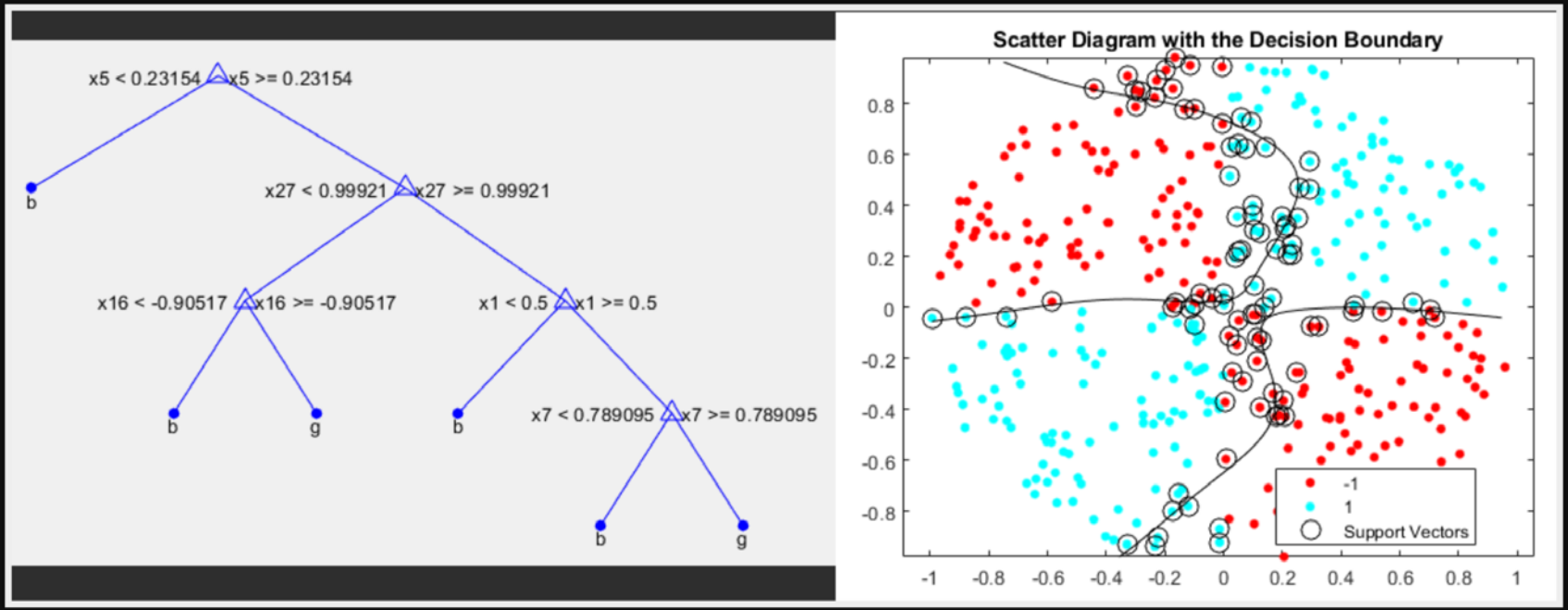
- Finding patterns from **unlabeled** data
- Machine develops its own insights and we have to make sense of them



Source: MathWorks Documentation

Types of ML: Supervised Learning

- Determining a model from **labeled** data
- Goal: Identify labels accurately on new, independent data



Source: MathWorks Documentation

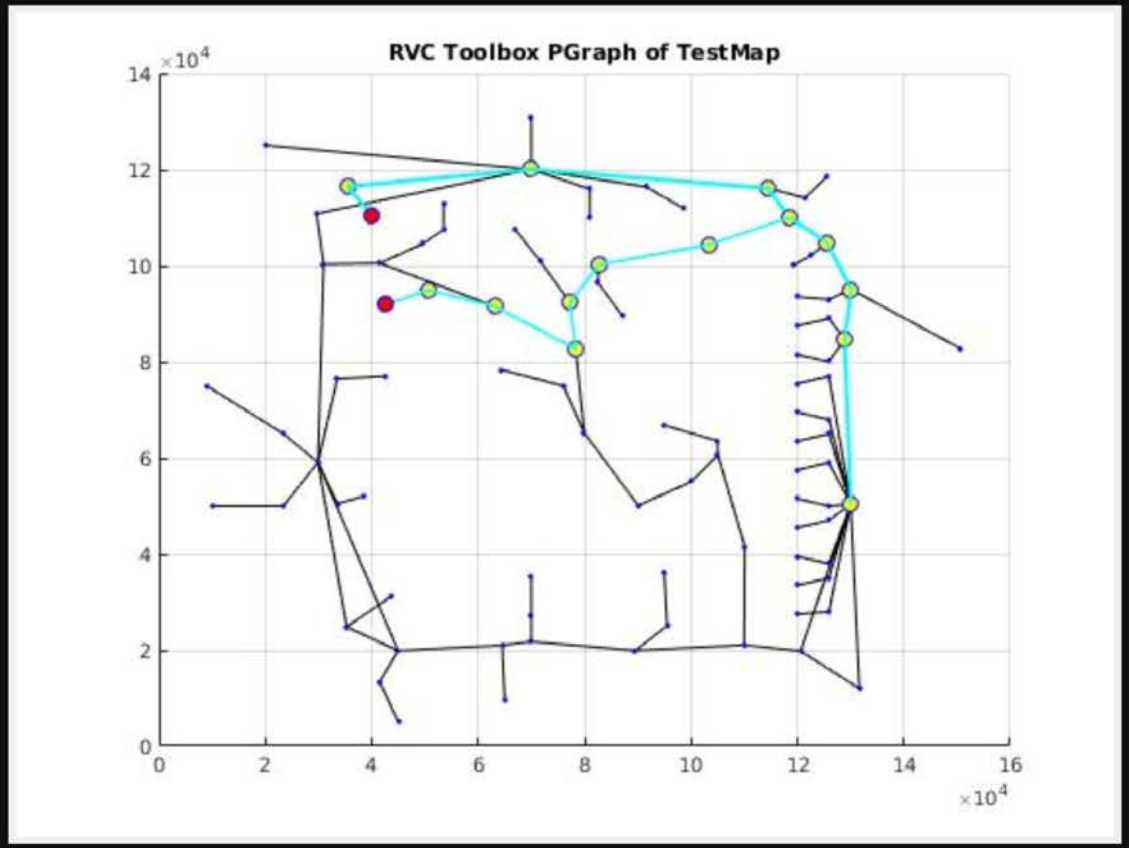
Rescue Simulation Challenges

- Task allocation with uncertainty
- Coalition formation
- Cooperation
- Distributed versus centralized control
- Communication

Courtesy Skinner & Ramchurn, AAMAS'10.

Path-Planning as Graph Search

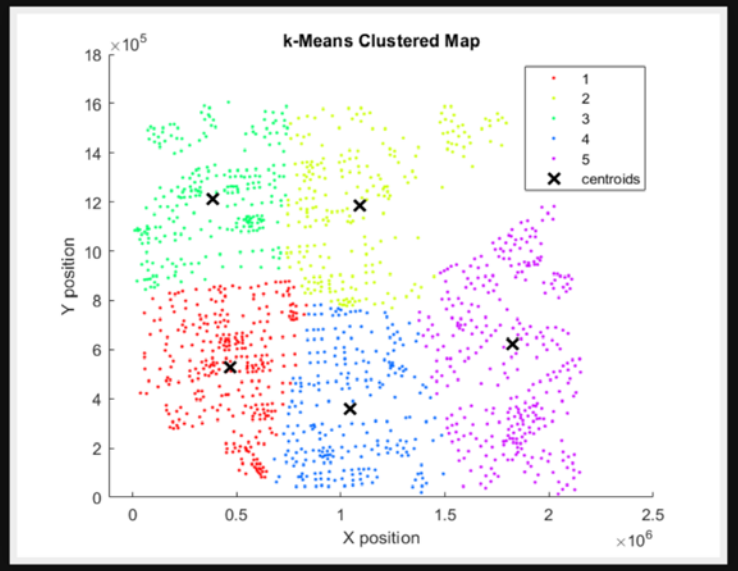
- You not only have to find one solution:



- You also have to decide what is the best solution.

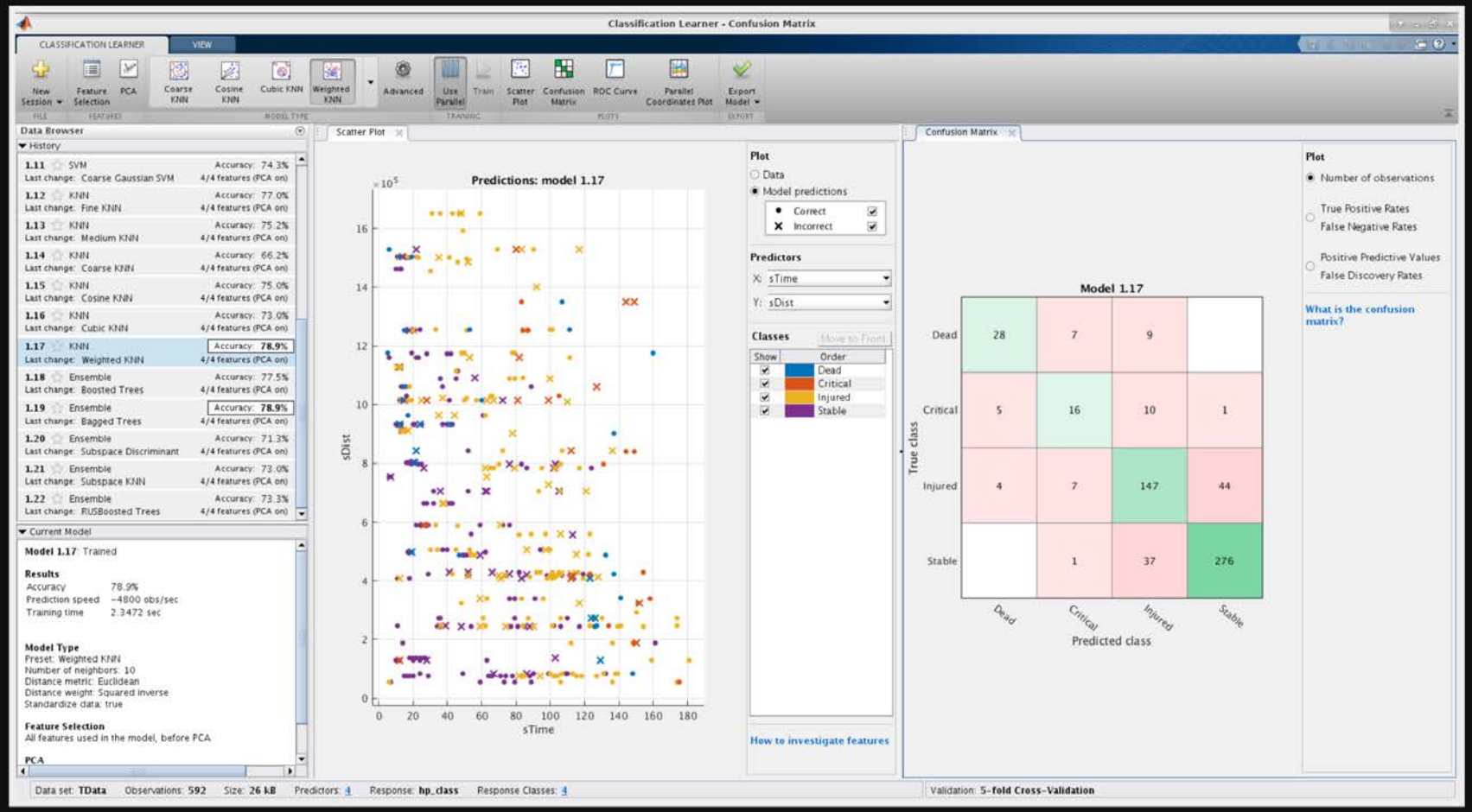
Clustering for Agent Simulation

- Teams use clustering during precomputation mostly for
  - partition the map by grouping buildings and roads based on their location (*x*, *y*)

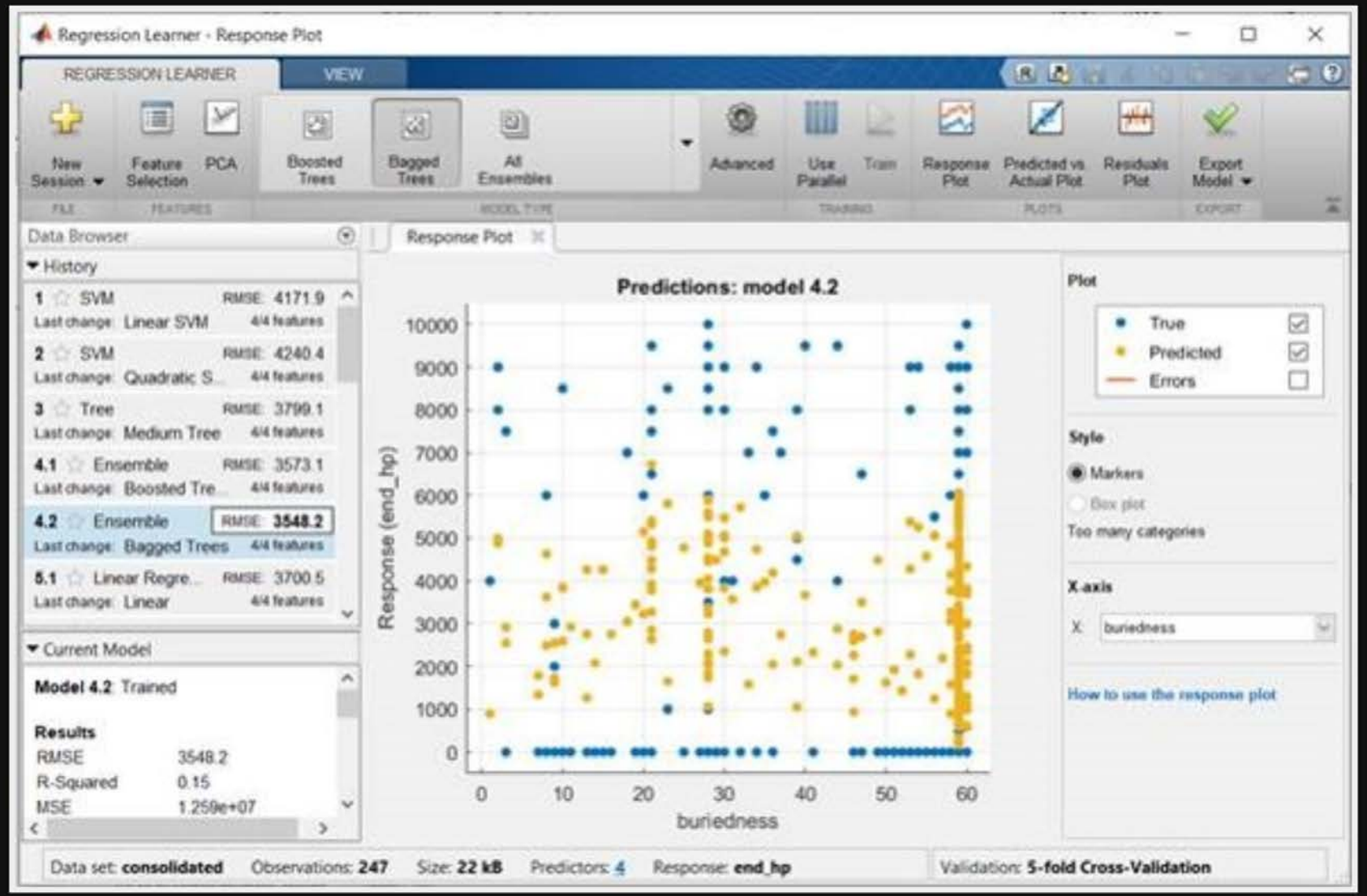


Commonly, Partition Clustering Methods are used, such as **K-Means++** or **K-Medoid**

Classification Learner



Regression Learner



Methodology

1. Generate data
2. Import data into MATLAB®
3. Train model in MATLAB®
4. Integrate into ADF
5. Refine the target selection model

Integrate into ADF

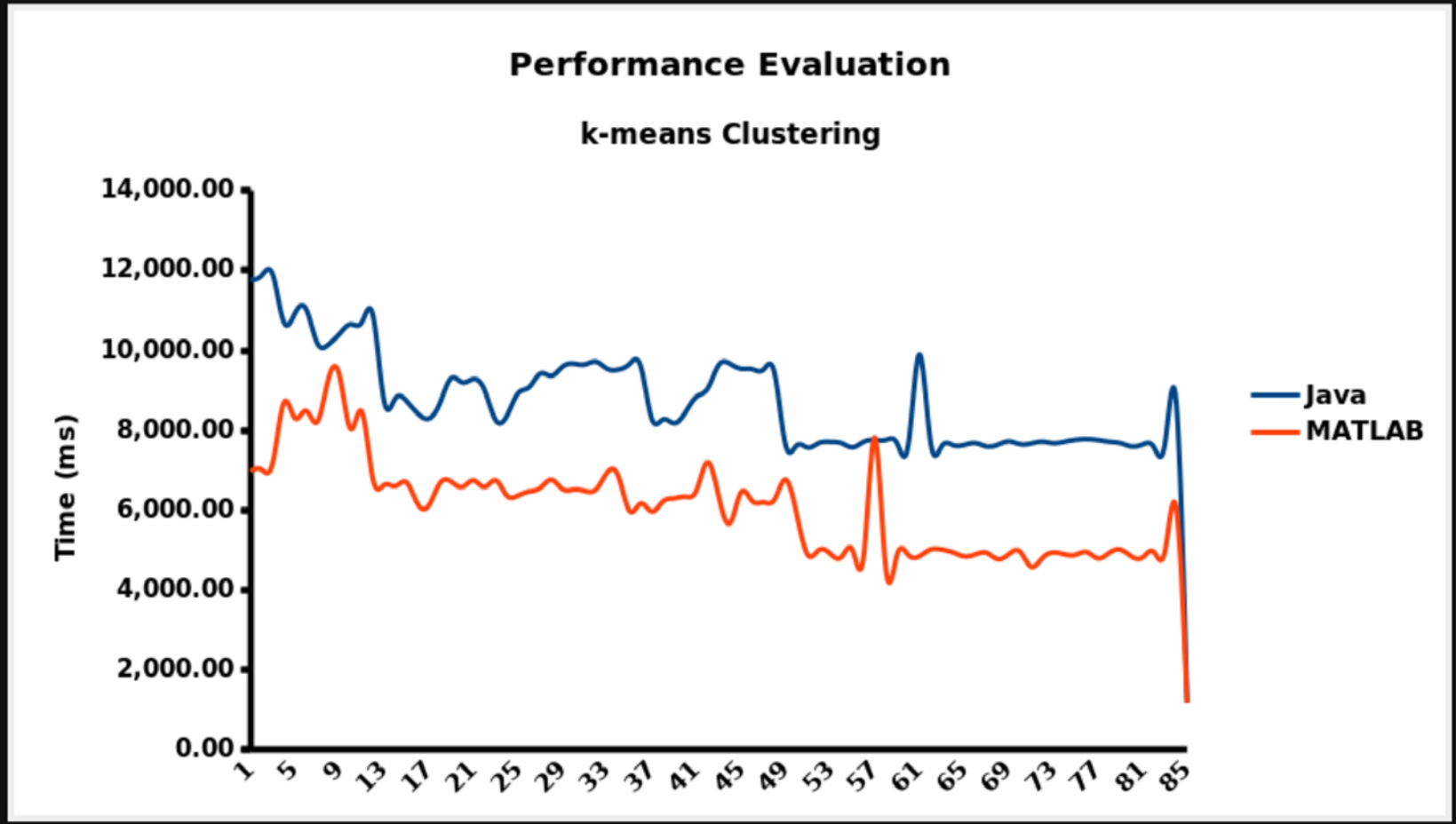
- The function can then be called inside the `calc` method of the `HumanDetector` class for the ambulance team agents

```
if ( MatlabEngine.findMatlab().length > 0 ) {
   MatlabEngine ml = MatlabEngine.connectMatlab();
   int sTime = rescueTarget.sTime;
   int sDist = rescueTarget.sDist;
   int sHP = rescueTarget.sHP;
   int sDamage = rescueTarget.sDamage;

   int value = ml.feval( "selectTargets", sTime, sDist, sHP, sDamage );

   ml.close();
}
```

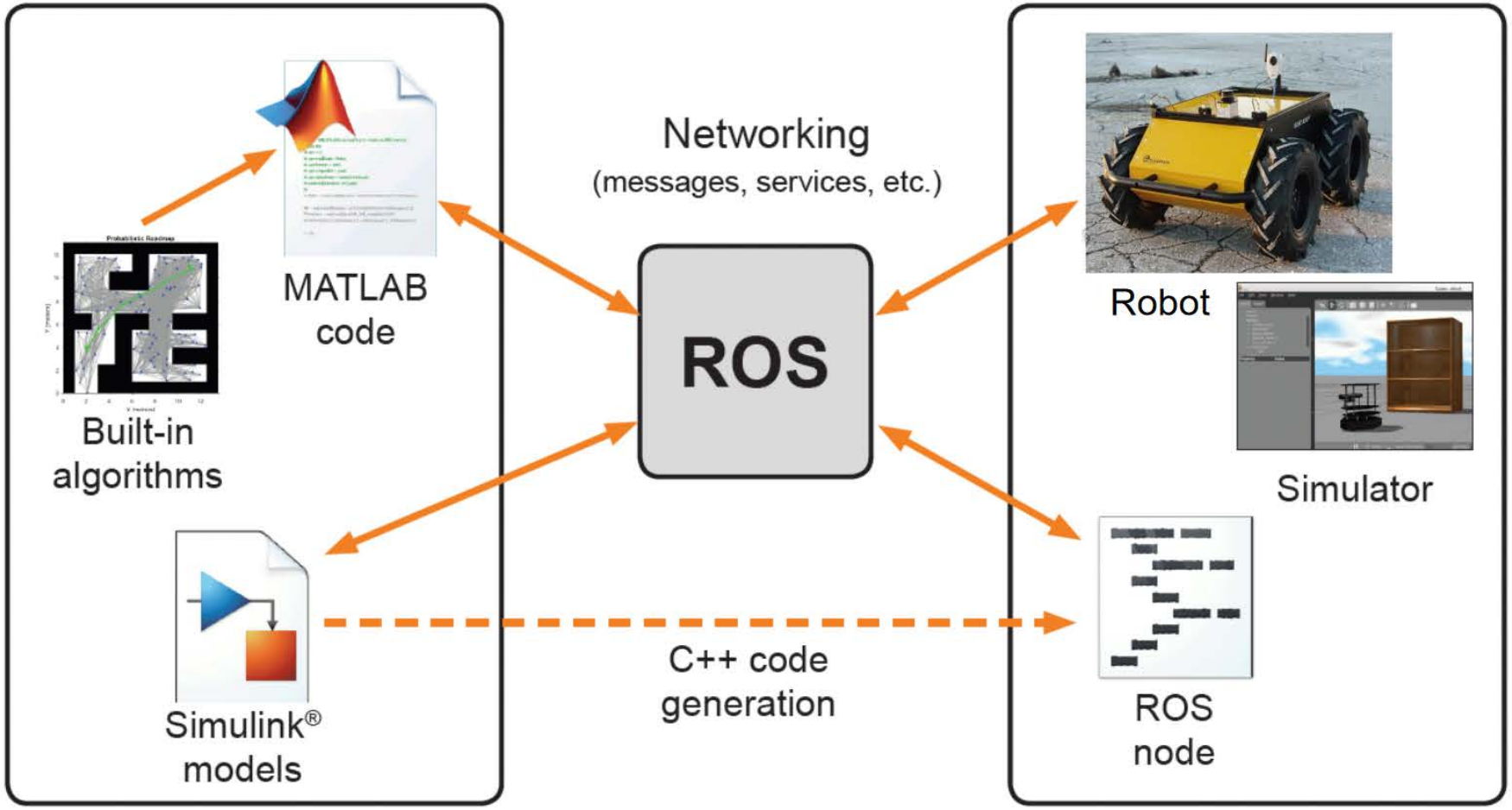
Important

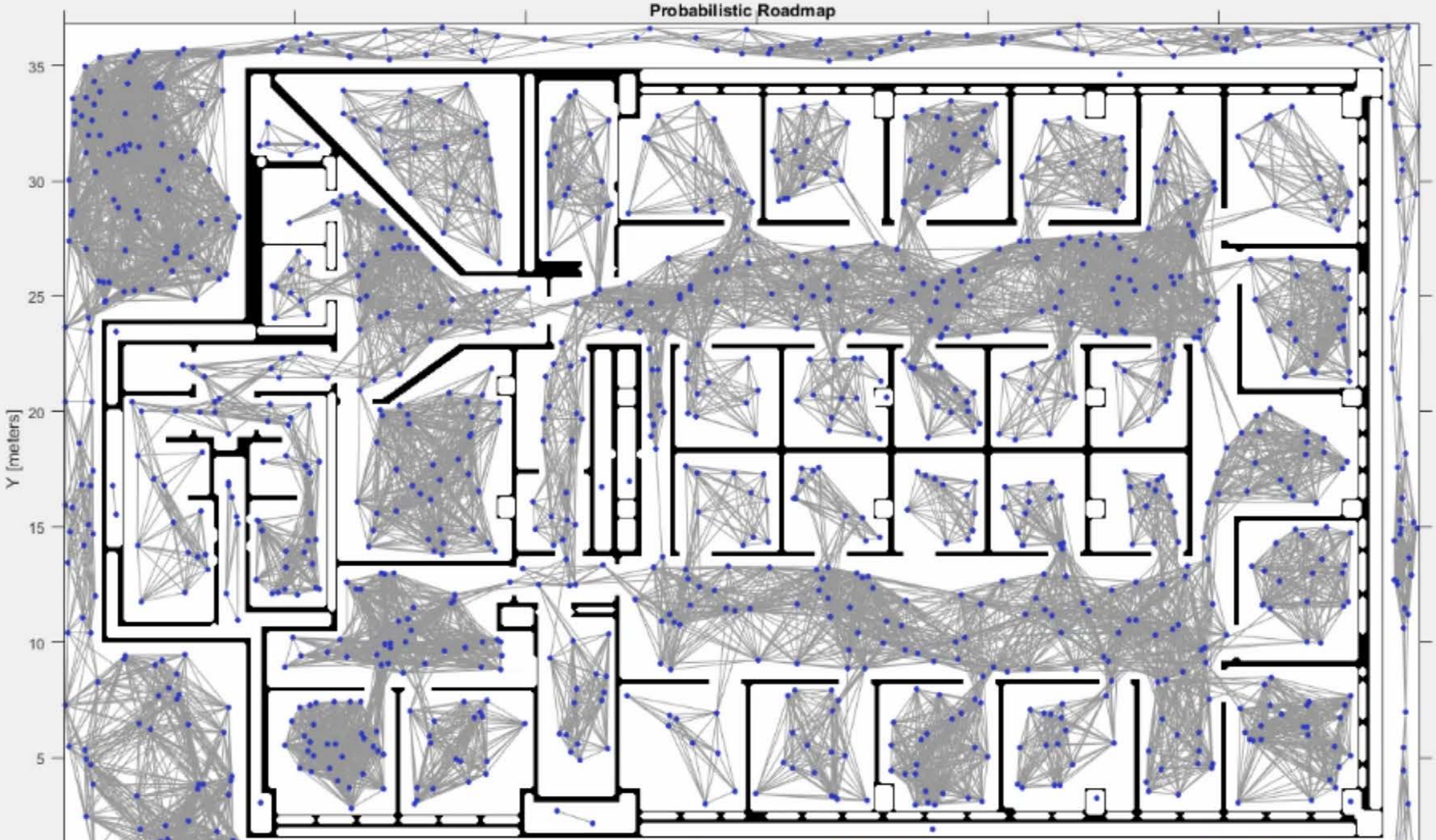
- Use `MatlabEngine.findMatlab()` and `MatlabEngine.connectMatlab()`
- Requires a MATLAB® session is Running and Shared (`matlab.engine.shareEngine`)

Clustering Performance



What Can You Do with Robotics System Toolbox?




Probabilistic Roadmap
Y [meters]
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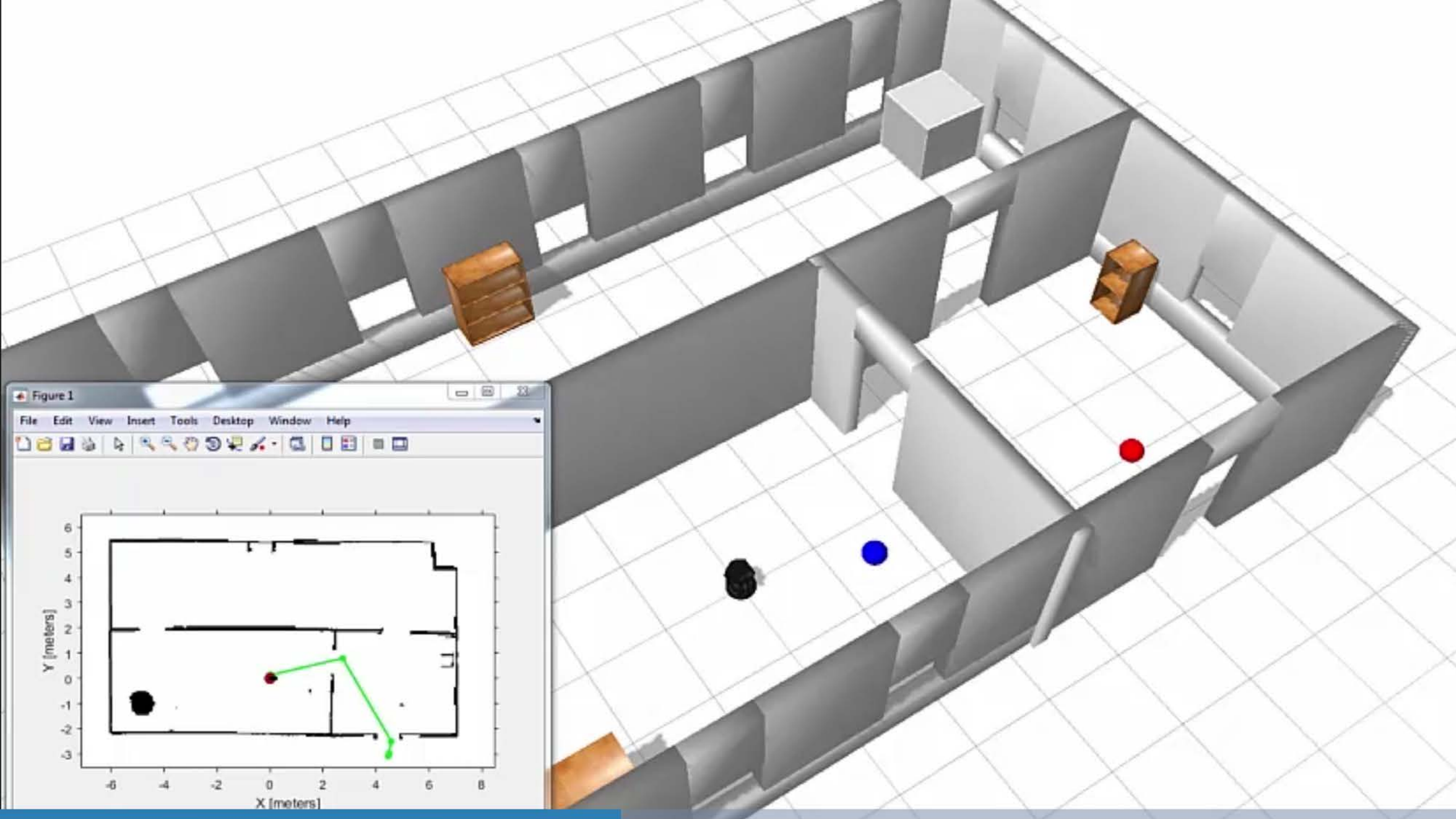
Figure 1
File Edit View Insert Tools Desktop Window Help
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-1
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-3
-6
-4
-2
0
2
4
6
8

Conclusions

In this workshop we have demonstrated the use of several AI and ML techniques:

- Problem solving
  - Path-planning (Astar, Dijkstra)
- Unsupervised learning:
  - Classification (k-means clustering of city blocks)
- Supervised learning:
  - Classification (k-nearest neighbour prediction of victim class)
  - Regression (bagged tree model of remaining HP of victim)

Code and presentation available on Github:

https://github.com/IntelligentRoboticsLab/Joint-Rescue-Forces/

http://staff.fnwi.uva.nl/a.visser/activities/MachineLearningForRescue/slides/

Future Works

- Assess different strategies for task allocation
- Compare different clustering algorithms
- Use JNI to access MATLAB® libraries
- Evaluate the feasibility of implementing a Rescue team in MATLAB®

Thanks

This workshop was created by the Joint Rescue Forces:

This initiative is part
of the RoboCup Federation Support for Collaborations program.

RoboCup Rescue