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


2015


Scientific Impact of the League

Found 73 Results

Pooya Deldar Gohardani, Siavash Mehrabi, Peyman Ardestani:
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

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Machine Learning for the Rescue Simulation League

Luis Gustavo Nardin, Arnoud Visser and Sebastian Castro
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
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 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 \((x, y)\)

![k-Means Clustered Map](image)

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.

```java
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

Performance Evaluation

k-means Clustering

Time (ms)

Java
MATLAB
What Can You Do with Robotics System Toolbox?

- Built-in algorithms
- MATLAB code
- Simulink® models
- Networking (messages, services, etc.)
- C++ code generation
- Robot
- Simulator
- ROS node
Conclusions

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

- Problem solving
  - Path-planning (A* & 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.