

CS354



What Does “Robotics” Mean? (To Us)

- NOT electrical/mechanical engineering
- NOT industrial automation
- NOT tele-operated robots

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- The focus of this class will be on programming autonomous, mobile robots.

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- We'll view robotics as a branch of AI that includes several problem areas:
 - Localization
 - Path planning
 - Mapping
 - Computer vision/perception
 - Forward/Inverse Kinematics
 - Task Planning
 - Control Architectures

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 - Control Architectures
- Tools we use to address these problems:
 - Probability Theory
 - Control Theory
 - Graph Search Algorithms
 - Machine Learning
 - Signal Processing
 - ...

Why Study Robotics?

- We may, finally, be approaching a point where people routinely interact with autonomous mobile robots.*
 - Waymo Taxi Service
 - Delivery Robots
 - Warehouse Automation

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*Maybe not. We are in a time of optimism, startups, “pilots”, demos, etc. There are still fundamentally hard unsolved problems standing in the way.

Intermission...

- Autonomous Locomotive!

Goals For The Course

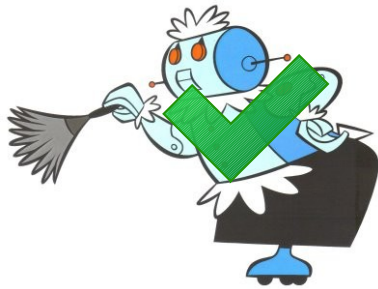
- We'll study robotics at two levels:
 - Theory: Understanding algorithms for solving robotics problems
 - Application: Writing robotics programs using ROS/ROS2

Ethical Considerations...

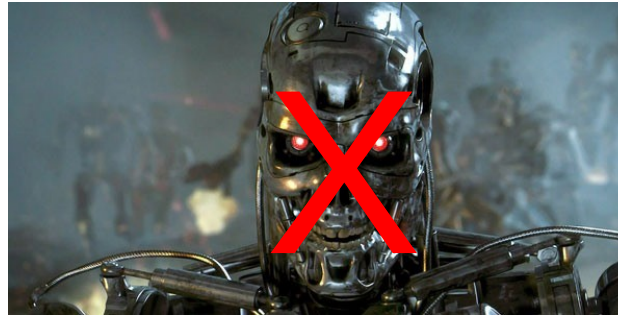
- In my opinion, the toughest ethical issues of this century will be related to increasing automation.
 - What would humans do if most work could be automated?
 - Who would benefit?
 - Who is responsible when robots cause harm?

Ethical Considerations...

- Let's approach this class with an eye toward improving human life:



<http://www.techtimes.com/articles/26032/20150112/mit-scientists-put-us-one-step-closer-to-robot-maids.htm>



<http://www.cinemablend.com/television/Terminator-Project-May-Head-Television-60924.html>

What is ROS?

“The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms.”

<http://www.ros.org/about-ros/>

History of ROS

- 2006 Willow Garage founded
- 2007 Willow Garage formally introduces ROS
- 2010 Willow Garage begins shipping PR2 robots



“Scott Hassan founded Willow Garage in late 2006 to accelerate the development of non-military robotics and advance open source robotics software.”

<https://www.willowgarage.com/pages/about-us/history>

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- 2011 Willow Garage introduces the Turtlebot as a low-cost alternative to the PR2 (Original design used the iRobot Create base)
- 2012 Open Source Robotics Foundation (OSRF) takes over ROS development
- 2012 Turtlebot 2 is introduced (Uses the Yujin Kobuki base)



<http://wiki.ros.org/Robots/PR2>
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<http://www.turtlebot.com/>
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- 2015 DARPA Robotics Challenge
- 2017 First ROS2 alpha release



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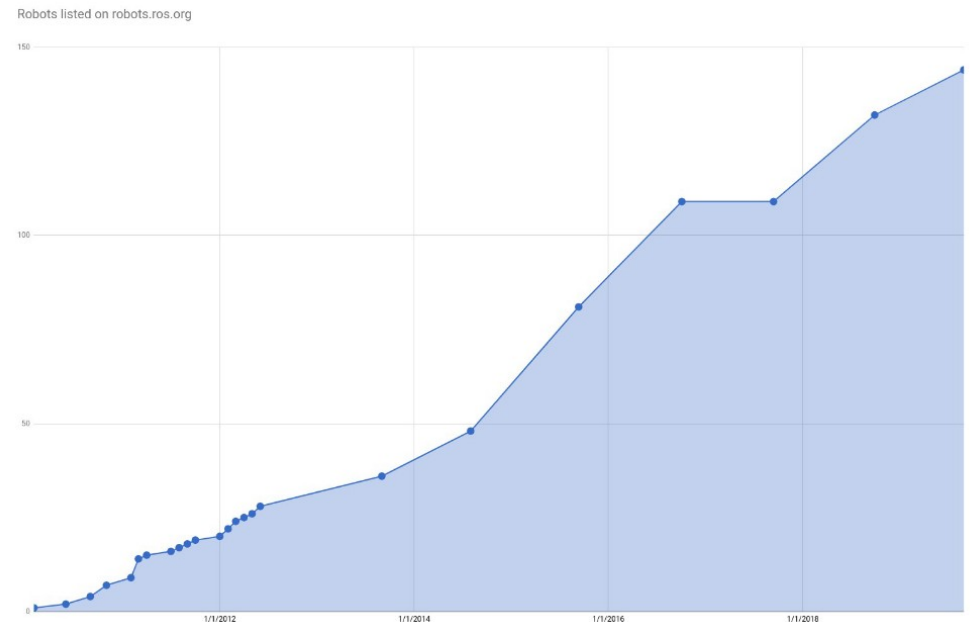
“Based on our observations at the competition and communications with team members, out of the 23 DRC Finals teams, we count 18 teams using ROS and 14 teams using Gazebo.”

<http://www.osrfoundation.org/ros-gazebo-at-the-drc-finals/>

ROS Usage Metrics (July 2018)

- 5,875 academic papers have cited “ROS: an open-source Robot Operating System” (Quigley et al., 2009)
- Documented ROS Robots:

<http://wiki.ros.org/Metrics>



Turtlebot 3

- 2d-Lidar
- Camera
- Raspberry Pi
- Open Source Hardware
- ROS/ROS2 compatible



<http://www.robotis.us/turtlebot-3-waffle-pi>

Programming in ROS2

- Fully supported languages:
 - C++, Python3
- We'll focus on Python

ROS2 Tools

- Rviz2 - Visualization
- Gazebo – Simulation
- Many command-line utilities

Course Mechanics...

Fair Warnings

- This class is inherently challenging:
 - Theoretical content differs from other CS courses
 - ROS2 has a steep learning curve and spotty documentation
 - If you don't already know Python, you will need to learn it
 - You'll need to get comfortable using the Linux/Unix command line

QUESTIONS?
