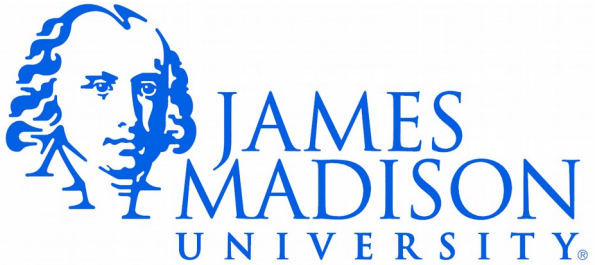
CS354



What Does "Robotics" Mean? (To Us)

- NOT electrical/mechanical engineering
- NOT industrial automation
- NOT developmental robotics (robotics as a platform for studying embodied learning)
- NOT tele-operated robots

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

What Does "Robotics" Mean? (To Us)

- 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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- Tools we will use to address the problems:
  - Probability Theory
  - Control Theory
  - Graph Search Algorithms
  - Signal Processing Algorithms

Why Study Robotics?

- We may, finally, be approaching a point where people routinely interact with autonomous mobile robots.*
  - Waymo Announces Driverless Taxi Service
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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.

Goals For The Course

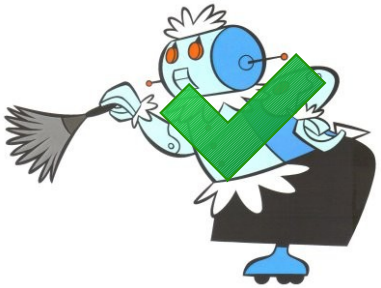
- We'll study robotics at two levels:
  - Theory: Understanding algorithms for solving robotics problems
  - Application: Writing robotics programs using ROS

Ethical Considerations...

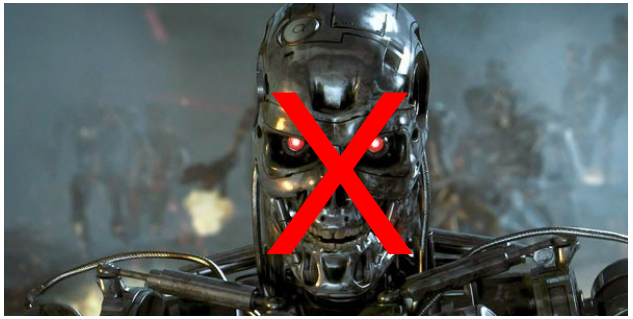
- In my opinion, the toughest ethical issues of this century will be related to increasing automation.
  - What would humans do if most work could be automated?
  - Who would benefit?
  - Who is responsible when robots cause harm?

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."

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- 2012 – 2015 DARPA Robotics Challenge
- 2017 First ROS2 release

http://wiki.ros.org/Robots/PR2
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http://www.turtlebot.com/
Creative Commons Attribution 3.0

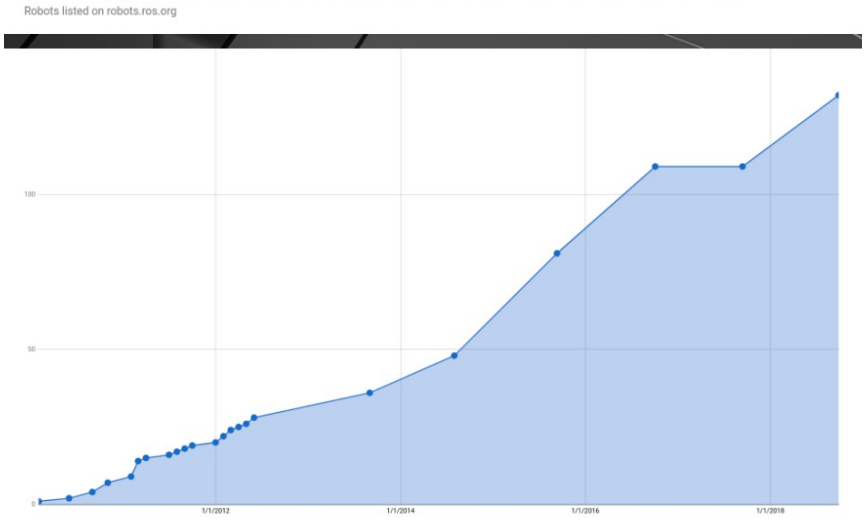
"Based on our observations at the competition and communications with team members, out of the 23 DRC Finals teams, we count 18 teams using ROS and 14 teams using Gazebo."

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

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

ROS Usage Metrics (July 2018)

- Approximately 1.6 million wiki views/month
- 4,806 academic papers have cited “ROS: an open-source Robot Operating System” (Quigley et al., 2009)
- Growth in supported robots:



http://wiki.ros.org/Metrics

Turtlebot 2

- Kobuki Base (Manufactured By Yujin Robotics)
- RGBD Sensor
  - Microsoft Kinect or
  - ASUS Xtion Pro Live
  - Intel R200
  - Orbbec Astra
- Notebook/Netbook
- Plates and Mounting Hardware
  - Open Source Design

http://www.turtlebot.com/

Programming in ROS

- Fully supported languages:
  - C++, Python, Lisp
- Some support(?)
  - Java, Ruby, Javascript, others...
- We'll focus on Python
  - (ROS uses 2.7)

ROS Tools

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

Course Mechanics...

Fair Warnings

- This class is inherently challenging:
  - Theoretical content differs from other CS courses
  - ROS has a steep learning curve
  - 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?