



Optimizing Robotics with Machine Learning

June 2014

AICML at a Glance

- **Founded 2002**
- **Resides at University of Alberta**
- **One of the top Machine Learning research organizations in the world**
- **Since inception >110 technologies created**
- **115 heads**
 - 10 Professors (PIs)
 - 20 Lab Staff & Admin
 - 85 M.Sc., PhD. & PDFs

AICML at a Glance

AICML graduates go to:

Industry

- Google 
- eBay 
- Microsoft 
- Bloomberg 
- Facebook 
- 23andme.com 
- Amazon 
- Schlumberger 
- IBM 
- Bell Labs 
- Electronic Arts 
- Sandia National Labs 
- EMC, etc... 

Academic

- Carnegie Mellon University 
- MIT 
- Stanford 
- McGill University 
- University of Waterloo 
- Johns Hopkins 
- Rutgers 
- Princeton University 
- USC 
- UBC 
- Purdue 
- Mayo Clinic 
- Numerous others: Asia, Australia, Europe

AICML Purpose & Objectives

- **Academic Excellence**
 - Continuation of World-Class Research
 - Ongoing development of HQP
- **Commercial Translation & Impact**
 - Enable Alberta based companies/organizations to be more efficient and competitive through ML
 - Place AICML graduates in Alberta & Canada
 - Create foundation for healthy viable start-ups

Outcomes are Contingently Linked

AICML Strengths

What is AICML Known for?

- Big Data & Analytics
- Natural Language Processing
- Social Network Analysis
- Optimization
- Game Theory (i.e., capital markets, simulations, etc.)
- Reinforcement Learning

Challenges for Autonomous Operations

Challenges:

- **Computers don't understand ambiguity**
 - Sarcasm
 - Intent
 - ...
- **Real-time Data Processing**
- **Common Approach – locate place & time**
- **Machine Learning is about discovery**

At AICML we have people that can solve these challenges

What is Machine Learning?

- Machine Learning provides means to learn from large data, interpret the trends in the data and adapt to the data as opposed to static programs

Learn from experience – Adapt to environment

machine learning

- Medical image analysis
- Filtering data for analytics
- Control robot in unknown environment

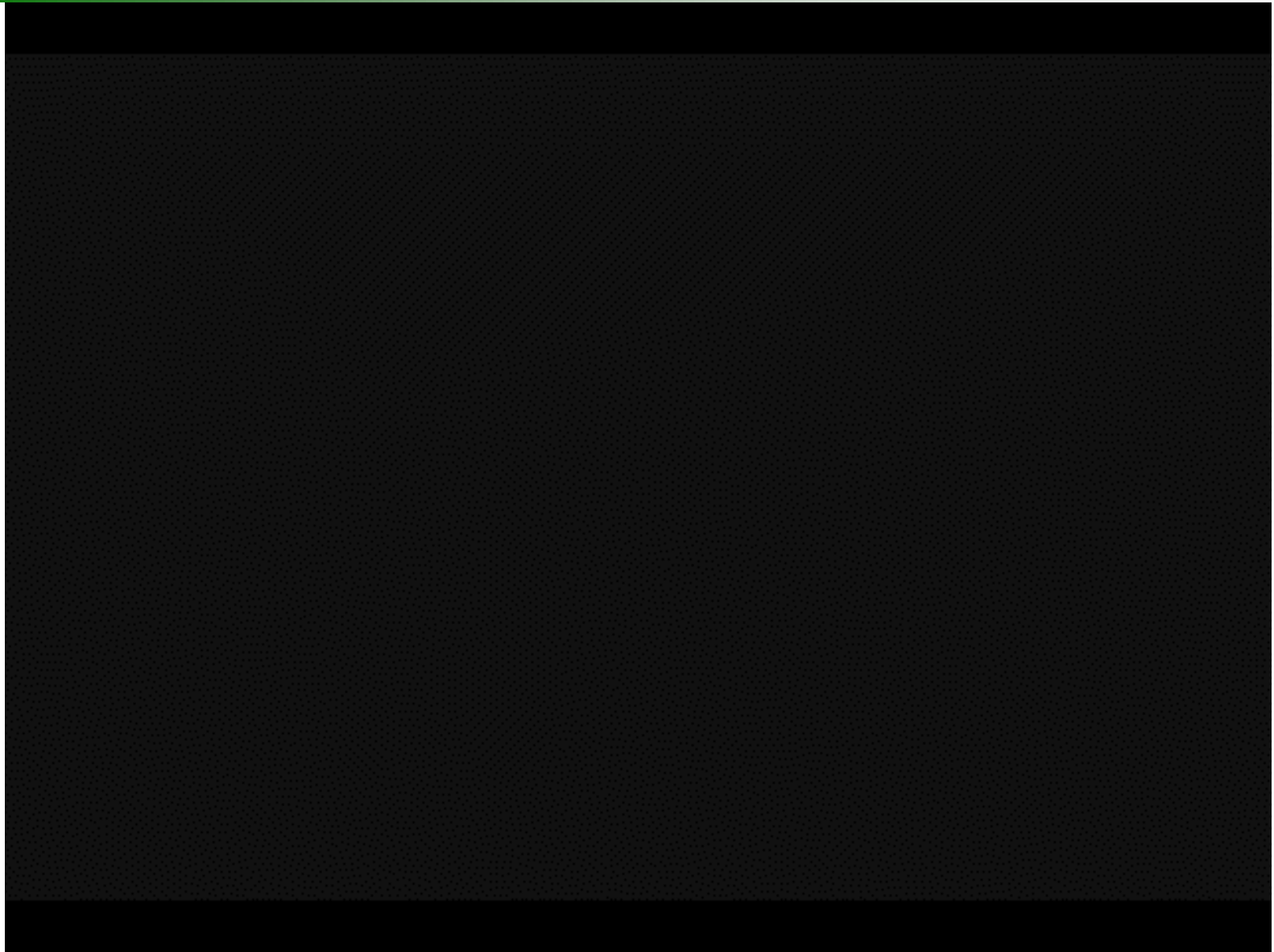


- Accounting program
- Querying a database
- Control welding robot in manufacturing

NOT
machine learning



Robots in Action



Reinforcement Learning In Action

Machine Learning & Robots



What Do Robots See



Man Machine Interfaces

Non-Adaptive vs. Adaptive Switching

Machine Learning – Game Theory

- **Checkers** (Chinook – Jonathan Schaeffer, et al)
 - 500 billion billion (5×10^{20}) possible positions
 - 18 ½ years of research & application
 - 2007 – top 10 scientific discovery of the year *Science*
- **Computer Poker Research Group (CPRG)**
 - ACPC – won 20 of 33 events since inception
 - Smallest game 1×10^{14} decision points
 - 50,000,000 hands played
 - Most CPRG members don't play poker

Machine Learning – Game Theory

- **Common traits**

- Incomplete information
 - Other participant's actions
 - Obfuscated information
- Massive amounts of data
- Large number of iterations over short period of time
- Human psychology & behavior
- Contingent actions – next best decision
- ...

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