



# MTU

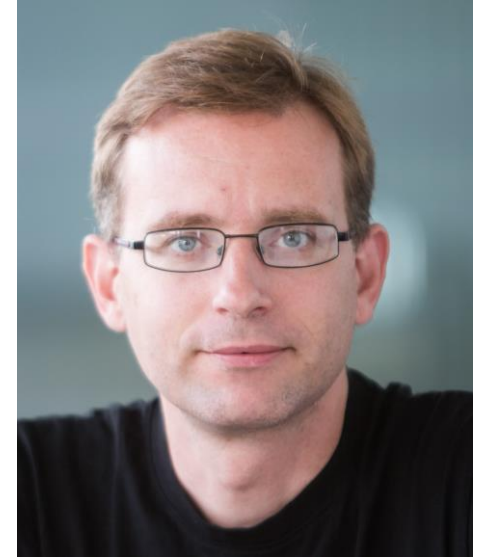
Ollscoil Teicneolaíochta na Mumhan  
Munster Technological University

# Machine Learning

Lecture 1: Introduction to the module

# Introduction

- Dr Christian Beder
  - Lecturer at the Department of Computing
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  - Office Room: B180A
- Qualification & Experience:
  - Lecturer in the CS department teaching AI subjects such as Machine Learning, Decision Analytics and Computer Vision
  - Researcher at CIT's Nimbus centre 2010-2019 working on large-scale collaborative European Research Projects
  - PhD in Photogrammetry 2006
  - MSc in Computer Science 2002



# What is Machine Learning?

- Machine learning is the use of statistical analysis of existing data to infer a relation between input and output with the goal of computing this relationship for new data
- Depending on the output data we distinguish
  - Classification
  - Regression
  - Clustering
- Depending on the input data we distinguish
  - Supervised learning algorithms
  - Unsupervised learning algorithms
  - Reinforcement learning algorithms

# What is Classification?

- Decide what category an object belongs to based on a set of measured features

Is it an apple or an orange?



→ "Apple"

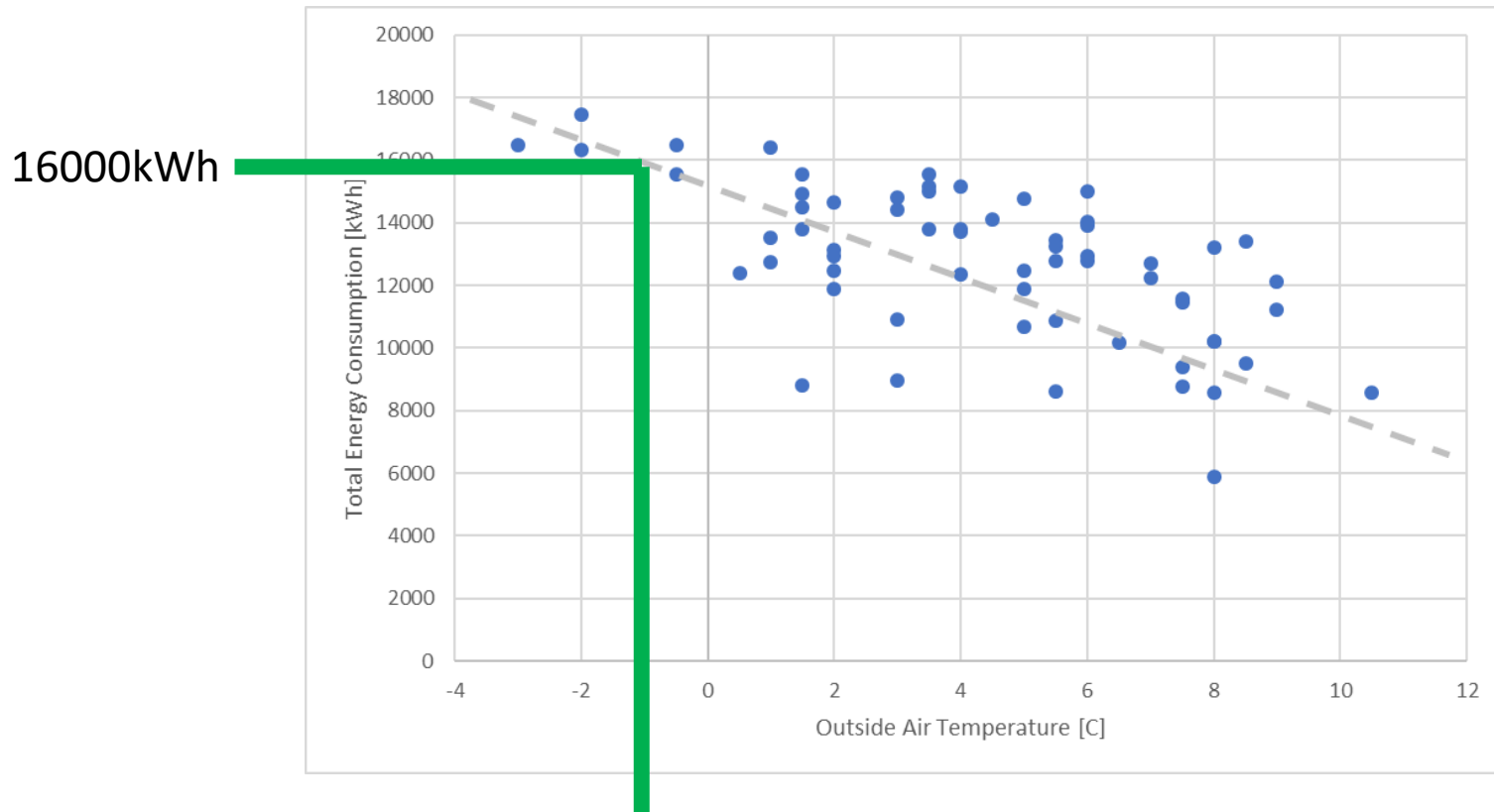


→ "Orange"



# What is Regression?

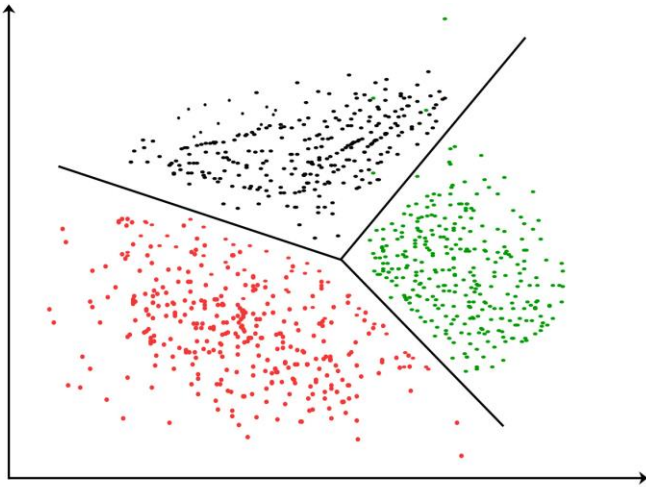
- Predict a numerical quantity or a relation between quantities based on a set of measurements



If it is -1 deg outside, what will my heating bill look like?

# What is Clustering?

- Determine which measurements in a dataset form a cluster, i.e. can be considered similar for some subsequent task



What looks similar?  
What does not?



# What is Supervised Learning?

- Supervised learning algorithms use labelled training data to determine a functional relationship between input and output
- Generating/obtaining this training data is not easy as somebody need to assign labels for a large dataset
- Can sometimes be crowd-sourced

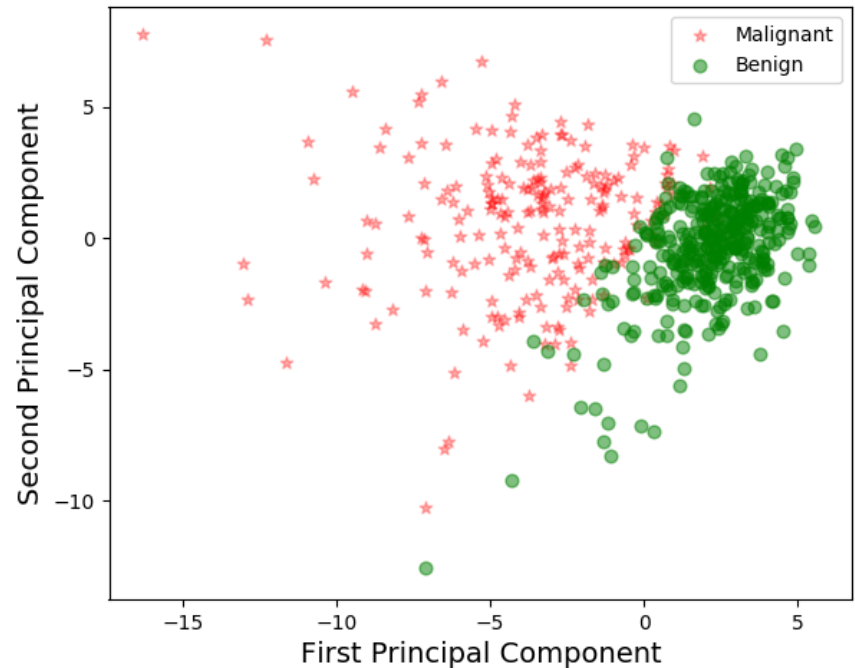


Workers at the headquarters of Ruijin Technology Company in Jiaxian, in central China's Henan Province. They identify objects in images to help artificial intelligence make sense of the world. Credit...Yan Cong for The New York Times



# What is Unsupervised Learning?

- Discover patterns in the data without labels based solely on similarity between data-points
- Example are dimensionality reduction and clustering





# What is Reinforcement Learning?

- Learn a strategy based on observed rewards
- Requires experimentation with the environment
- Very well-suited for synthetic environments, such as computer games, that can be tried and repeated without cost



# Learning outcomes

Module descriptor

<https://courses.cit.ie/index.cfm/page/module/moduleId/13881>

- LO1: Apply machine learning methodologies to facilitate pre-processing, dimensionality reduction and model selection.
- LO2: Select and apply appropriate machine learning algorithms to datasets from a specific application domain.
- LO3: Analyse and evaluate the performance of machine learning algorithms.
- LO4: Develop a machine learning algorithm for solving a real-world problem.
- LO5: Implement and apply optimization algorithms for solving complex problems with a high dimensional search space.

# More informal learning outcomes

- Understand what type of problems can be solved using machine learning.
- Be able to select the right approach to solve a given machine learning problem.
- Understand how to evaluate and visualise the performance of a machine learning algorithm to be able to assess and compare.
- Solve real-world problems using a machine learning method.
- Solve real-world problems using appropriate optimisation algorithms.

# Course breakdown & Assessment

Module descriptor

<https://courses.cit.ie/index.cfm/page/module/moduleId/13881>

- 2x1h lecture / week (**Tue 4pm-5pm & Fri 9am-10am**)
  - Presentation of theory and concepts
- 1x2h lab session / week split into two groups  
(A: **Wed 2pm-4pm**, B: **Thu 11am-1pm**)
  - Apply concepts seen in class
  - Work on assignments
- 100% Continuous Assessment
  - 30% assignment due in week 6 (21/10/2022)
  - 35% assignment due in week 9 (18/11/2022)
  - 35% assignment due in week 12 (09/12/2022)

# Module content

- L1-L2: Introduction
  - Examples of ML applications, categories of ML algorithms, typical design-cycle and data flow in a ML problem, issues with dimensionality and overfitting
- L3-L5: Tools
  - NumPy, Pandas, scikit-learn
- L6-L7: Data processing & methodology
  - feature extraction, noise/outliers, results visualisation and analysis techniques, cross-validation
- L8-L17: Supervised learning
  - Bayesian classification, Bayesian networks, decision trees, k-nearest neighbours, linear separation, support vector machines, multi-layer neural networks



# Module content

- L18-L20: Regression & optimisation
  - Parameter estimation, gradient descent, simulated annealing
- L21-L24: Unsupervised learning
  - K-means clustering, principal component analysis, generative adversarial networks

# Assignments

- A1: Bayesian classification (due: **21/10/2022**)
- A2: Supervised learning (due: **18/11/2022**)
- A3: Optimisation (due: **09/12/2022**)

All assignments comprise of

- Implementation of the algorithm, including data input/output and visualisation
- Technical description and basic evaluation
- Report on research and detailed evaluation

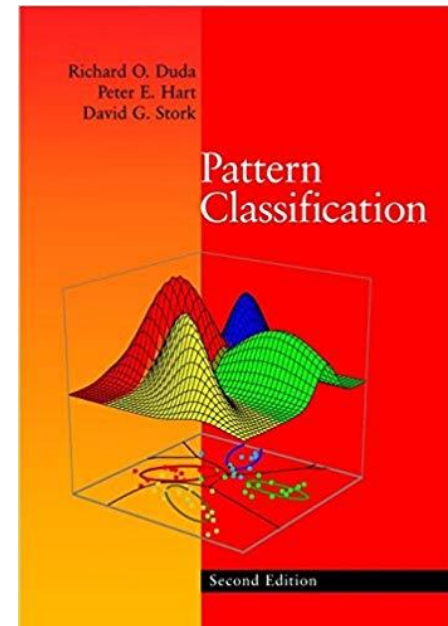
# Development environment

- All lab exercises and assignments will be developed in **Python3**
- The recommended IDE is Spyder and is part of the Anaconda package:  
<https://www.anaconda.com/>
- The Anaconda distribution also includes
  - NumPy <https://numpy.org/>
  - Pandas <https://pandas.pydata.org/>
  - and scikit-learn <https://scikit-learn.org/stable/>



# Recommended resources

- Machine Learning Lecture by Professor Andrew Ng at Stanford  
<https://www.youtube.com/watch?v=UzxYlbK2c7E&list=PLA89DCFA6ADACE599>
- Richard O. Duda, David G. Stork, Peter E. Hart  
Pattern Classification, Second Edition  
Wiley, 2001



# Example: Targeted advertising

Google

machine learning

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**MATLAB Machine Learning Guide | Basics To Advanced...**  
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# Example: Spam filters

**CORK INSTITUTE OF TECHNOLOGY**  
INSTITIÚD TEICNEOLAÍOCHTA CHORCAI

Quarantine Digest

**Christian Beder**  
[christian.beder@cit.ie](mailto:christian.beder@cit.ie)

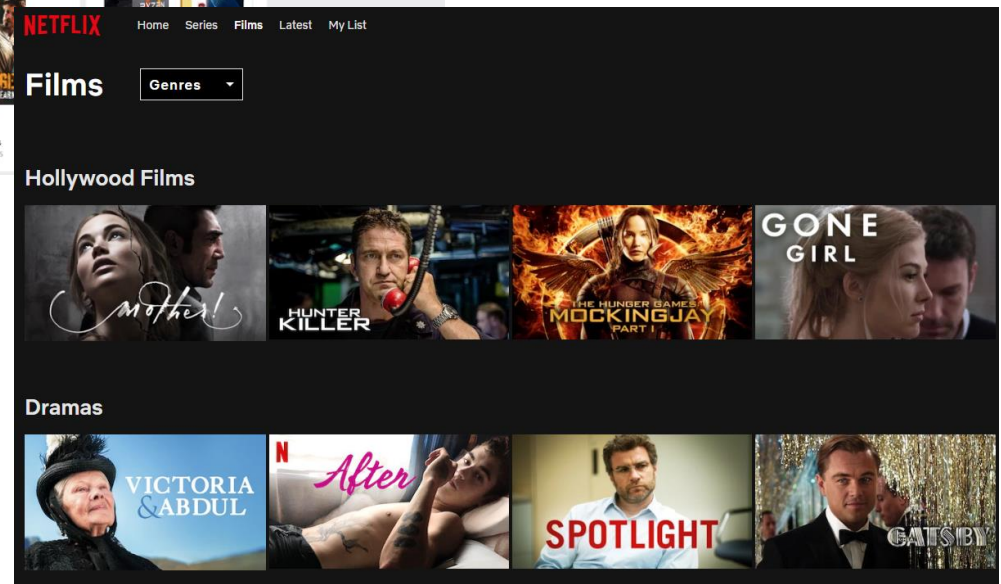
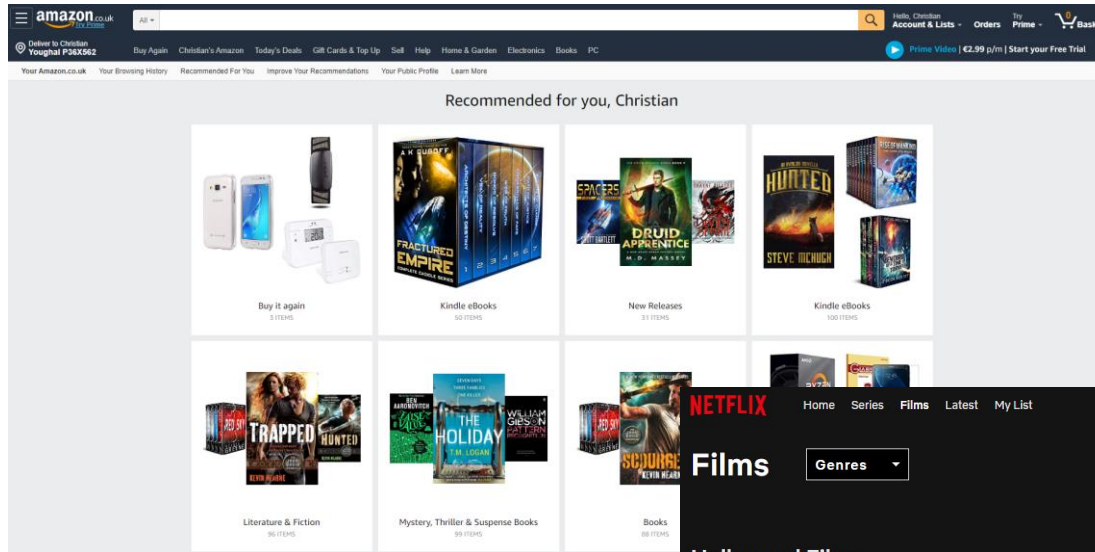
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"Shirley" <a href="mailto:aciabdillmq@adk.biz">aciabdillmq@adk.biz</a>	Re: Fiber Distribution Cabinet	05 Sep 19 - 07:27 AM	<a href="#">Preview</a> <a href="#">Release</a> <a href="#">Release &amp; Approve</a> <a href="#">Block</a>

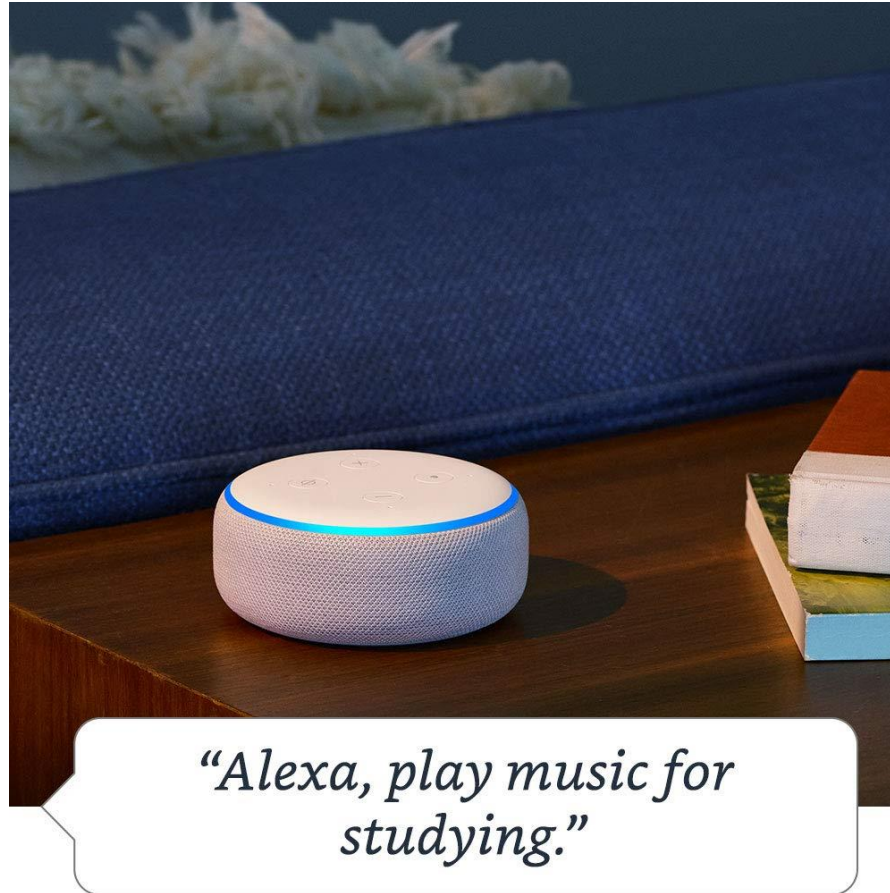
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# Example: Recommender systems



Machine Learning

Example:  
Speech recognition & natural language processing



# Example: Image understanding



# Example: Games


nature > news > article

a natureresearch journal

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## No limit: AI poker bot is first to beat professionals at multiplayer game

*Triumph over five human opponents at Texas hold'em brings bots closer to solving complicated real-world problems.*

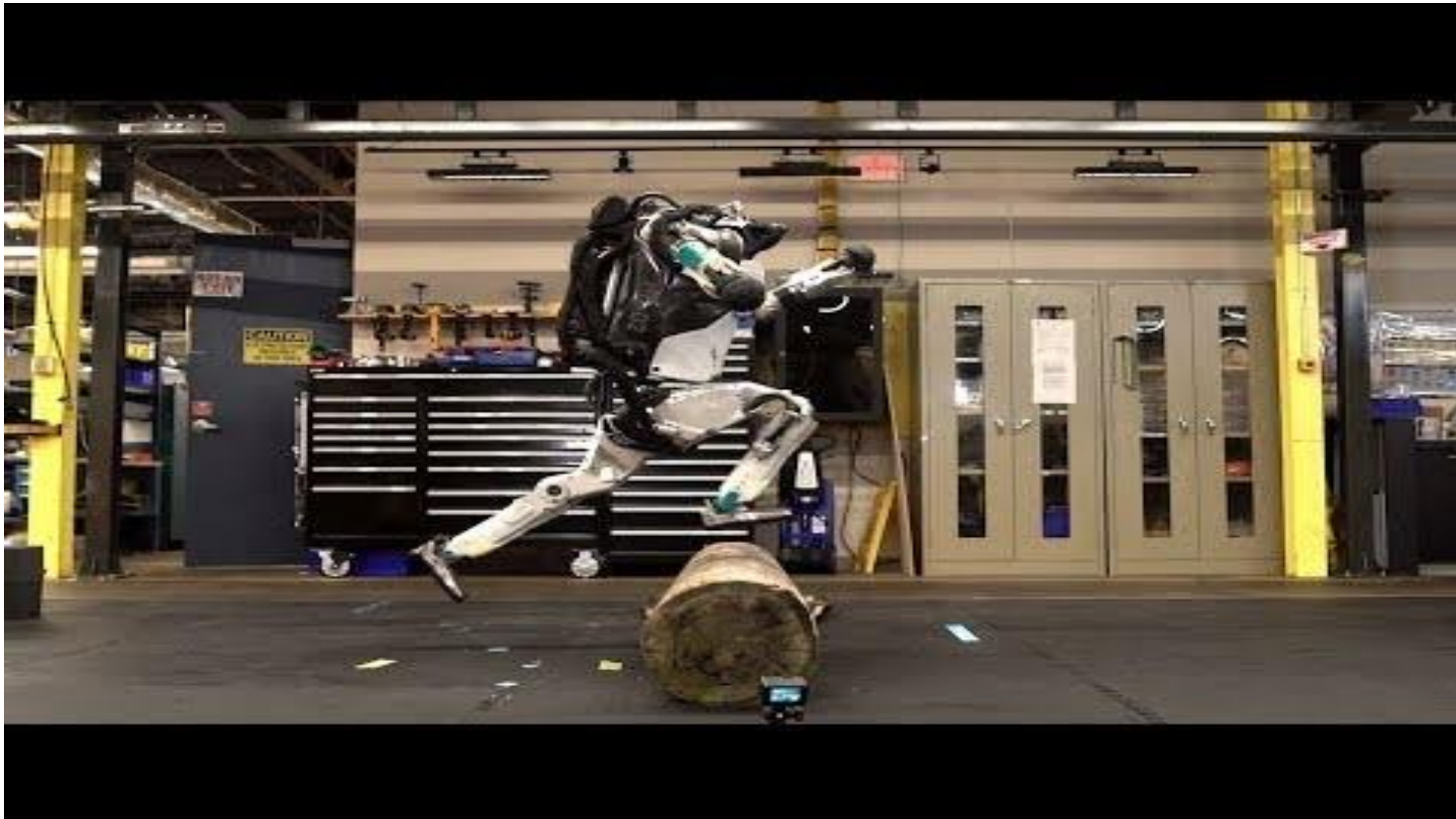
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Douglas Heaven

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# Example: Robotics



<https://www.youtube.com/watch?v=LikxFZZO2sk>

# Example: Deep fakes



<https://www.washington.edu/news/2017/07/11/lip-syncing-obama-new-tools-turn-audio-clips-into-realistic-video/>

Thank you for your attention