

Introduction

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Introductions

- Name: Dr. Fayyaz ul Amir Afsar Minhas
- Teaching Experience
 - 2007 till now
 - AI, ML, BI, MLIB, PCR, CI, CG, CBD,...
- PhD (Computer Science)
 - Fulbright Scholar
 - Colorado State University, Fort Collins, USA
 - Area of research: Machine learning in Bioinformatics
- MS (System Engineering)
 - PIEAS
 - Area of Research: Biomedical signal analysis and machine learning
- BS (Computer & Information Sciences)
 - PIEAS
 - Area of Research: Biometrics and Image Processing
- Biomedical Informatics Research Lab
 - Focus on developing intelligent algorithms for solving problems in Biology and Medicine
- PIEAS Data Science Lab
 - Focus on developing intelligent algorithms for data science
- Your Introduction
 - Name, Background, Hobby or something you do for fun, How does this course fit in with your life beyond this course?



Intelligence

- A very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. [1]
- Measurement of Intelligence: IQ

[1] Mainstream Science on Intelligence reprinted in Gottfredson (1997). Intelligence p. 13

Knight's Plight



Calculative Puzzle

The number of times the digit 0 appears in this puzzle is x. The number of times the digit 1 appears in this puzzle is x. The number of times the digit 2 appears in this puzzle is x. The number of times the digit 3 appears in this puzzle is x. The number of times the digit 4 appears in this puzzle is x. The number of times the digit 5 appears in this puzzle is x. The number of times the digit 6 appears in this puzzle is x. The number of times the digit 7 appears in this puzzle is x. The number of times the digit 8 appears in this puzzle is x.

Calculative Puzzle

The number of times the digit 0 appears in this puzzle is 1. The number of times the digit 1 appears in this puzzle is 11. The number of times the digit 2 appears in this puzzle is 2. The number of times the digit 3 appears in this puzzle is 1. The number of times the digit 4 appears in this puzzle is 1. The number of times the digit 5 appears in this puzzle is 1. The number of times the digit 6 appears in this puzzle is 1. The number of times the digit 7 appears in this puzzle is 1. The number of times the digit 8 appears in this puzzle is 1. The number of times the digit 8 appears in this puzzle is 1.

Paintings by two different painters



Who's painting is this?





Pigeons as Art Experts

- Pigeons were placed in a box and presented pictures of two different artists (Van Gogh and Chagall)
- They were rewarded for pecking when a particular artist was shown to them
- Pigeons were able to discriminate between Van Gogh and Chagall with 95% accuracy (when presented with pictures they had been trained on)
- Discrimination still 85% successful for previously unseen paintings of the artists

http://en.wikipedia.org/wiki/Discrimination_abilities_of_pigeons







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Find the odd one out!





Some More...

- What is the next number in this series:
 1,1,2,3,5,
- Would you cross a road when a fast car is approaching?



Conclusions

- Knight's Plight
 - Planning
- Calculative Puzzle
 - Calculation, Computation, Reasoning
- Finding the odd flower
 - Unsupervised Learning
- Pigeons as Art Experts
 - Supervised Learning
- Series Completion
 - Prediction
- Road Crossing
 - Rational Actions
- Process of Writing this Conclusion
 - Summarizing, Abstraction
- These are the very characteristics of Intelligent beings!!

Searching for a solution is
 central to hintelligence

What is Artificial Intelligence?

- Computers are _____
 - Dumb
- Making a machine (computer) perform the same tasks which you have just done is called

- Artificial Intelligence

- If you learn to do these tasks using existing data, then this is called _____
 - Machine Learning

Artificial Intelligence

- Artificial Intelligence takes the problem of understanding *how we think* a step further
 - It attempts not just to understand it but also to build intelligent entities
- A more proper definition of Artificial Intelligence
 - The art of creating machines that perform functions that require intelligence when performed by people [1]
- Measurement of Artificial Intelligence
 - Turing Test

[1] Rich E., and Knight K., (1991). Artificial Intelligence (2e), McGraw-Hill, NewYork.

Artificial Intelligence

• Turing Test

- Suggested major components of AI: knowledge, reasoning, INTERROGATOR language understanding, learning
- Application of the Turing Test
 - CAPTCHA: Completely Automated Public Turing test to tell Computers and Humans Apart [1]



fellowing

finding

http://en.wikipedia.org/wiki/CAPTCHA
 http://en.wikipedia.org/wiki/List_of_Chatterbots

Some interesting thoughts

- Turing Test: A test for intelligence which shows that machines can be as dumb as humans.
- How about making a machine that will, intentionally, fail the Turing test?



Is AI Intelligent?

• Planning

- Kasparov Vs. IBM Blue (1997)
- Time Table Schedulers
- Calculation
 - Symbolic Integration in Mathematica
 - Theorem Provers





$$\int e^{2x} \cos 3x \, dx = \frac{1}{3} e^{2x} \sin 3x + \frac{2}{9} e^{2x} \cos 3x - \frac{4}{9} \int e^{2x} \cos 3x \, dx$$
$$+ \frac{4}{9} \int e^{2x} \cos 3x \, dx$$
$$+ \frac{4}{9} \int e^{2x} \cos 3x \, dx$$
$$\frac{13}{9} \int e^{2x} \cos 3x \, dx = \frac{1}{3} e^{2x} \sin 3x + \frac{2}{9} e^{2x} \cos 3x$$
$$\frac{9}{13} \frac{13}{9} \int e^{2x} \cos 3x \, dx = \frac{9}{13} \left(\frac{1}{3} e^{2x} \sin 3x + \frac{2}{9} e^{2x} \cos 3x \right)$$
$$\int e^{2x} \cos 3x \, dx = \frac{3}{13} e^{2x} \sin 3x + \frac{2}{13} e^{2x} \cos 3x + C$$

Is AI Intelligent?...

- Learning without a Teacher
 - ERDAS Imagine –
 Classification of Land
 Use
 - Associative Memories for data storage in Databases

= wetland;

= water:



= marginal habitats; = upland (non-useable habitats).

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Is AI Intelligent?...

- Learning with a teacher
 No Hands Across America!
 - Optical Character Recognition





From Computer Desktop Encyclopedia © 1998 The Computer Language Co. Inc





Is AI Intelligent?...

Prediction

- Sunspot Number Prediction



Cool AI Applications

How Google's 'smart reply' is getting smarter

- VoCo
 - <u>https://youtu.be/RB7upq8nzIU</u>
- LyreBird

– <u>https://lyrebird.ai/demo</u>



GANs Applications: Super-resolution Imaging



Figure 4: Ledig *et al.* (2016) demonstrate excellent single-image superresolution results that show the benefit of using a generative model trained to generate realistic samples from a multimodal distribution. The leftmost image is an original high-resolution image. It is then downsampled to make a low-resolution image, and different methods are used to attempt to recover the high-resolution image. The bicubic method is simply an interpolation method that does not use the statistics of the training set at all. SRResNet is a neural network trained with mean squared error. SRGAN is a GAN-based neural network that improves over SRGAN because it is able to understand that there are multiple correct answers, rather than averaging over many answers to impose a single best output.

Image to Image Translation



Figure 7: Isola *et al.* (2016) created a concept they called image to image translation, encompassing many kinds of transformations of an image: converting a satellite photo into a map, coverting a sketch into a photorealistic image, etc. Because many of these conversion processes have multiple correct outputs for each input, it is necessary to use generative modeling to train the model correctly. In particular, Isola *et al.* (2016) use a GAN. Image to image translation provides many examples of how a creative algorithm designer can find several unanticipated uses for generative models. In the future, presumably many more such creative uses will be found.

Neural Style Transfer

- Using CycleGAN
 - <u>https://github.com/junyanz/CycleGAN</u>



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A Brief History of Al

Dartmouth Conference: The Founding Fathers of AI



John McCarthy



Marvin Minsky

n Minsky Claude Shannon



Herbert Simon Arthur Samuel





And three others... Oliver Selfridge (Pandemonium theory) Nathaniel Rochester (IBM, designed 701) Trenchard More

Ray Solomonoff

(Natural Deduction)





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A Brief History of Al...

- 1993 to onwards
 - IBM Deep Blue
 - NOHAA
 - Checkers Solved
 - ASIMO Robots
 - IBM Watson: Beats Humans in Jeopardy
 - Deep Blue vs. Gary Kasparov
 - Wolfram Alpha: Computational Knowledge Engine
 - KINECT
 - ALPHA GO
 - The Intelligent Agents Paradigm
 - Advances in Machine Learning
 - Deep Learning

Measuring Al

- The broad classes of outcome for an AI test are:
 - optimal: it is not possible to perform better
 - strong super-human: performs better than all humans
 - super-human: performs better than most humans
 - sub-human: performs worse than most humans
- Artificial General Intelligence

Examples



trained human.

The Future



Figure 1: Aggregate subjective probability of 'high-level machine intelligence' arrival by future years. Each respondent provided three data points for their forecast and these were fit to the Gamma CDF by least squares to produce the grey CDFs. The "Aggregate Forecast" is the mean distribution over all individual CDFs (also called the "mixture" distribution). The confidence interval was generated by bootstrapping (clustering on respondents) and plotting the 95% interval for estimated probabilities at each year. The LOESS curve is a non-parametric regression on all data points.

When Will AI Exceed Human Performance? Evidence from AI Experts

<u>Katja Grace</u>, <u>John Salvatier</u>, <u>Allan Dafoe</u>, <u>Baobao Zhang</u>, <u>Owain Evans</u> (Submitted on 24 May 2017 (<u>v1</u>), last revised 30 May 2017 (this version, v2)) <u>arXiv:1705.08807</u>

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Figure 2: Timeline of Median Estimates (with 50% intervals) for AI Achieving Human Performance. Timelines showing 50% probability intervals for achieving selected AI milestones. Specifically, intervals represent the date range from the 25% to 75% probability of the event occurring, calculated from the mean of individual CDFs as in Fig. 1. Circles denote the 50%-probability year. Each milestone is for AI to achieve or surpass human expert/professional performance (full descriptions in Table S5). Note that these intervals represent the uncertainty of survey respondents, not estimation uncertainty.



The Future

• Deep Learning Is Going to Teach Us All the Lesson of Our Lives: Jobs Are for Machines



https://medium.com/basic-income/deep-learning-is-going-to-teach-us-all-the-lesson-of-our-lives-jobs-are-for-machines-7c6442e37a49

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The Gartner Hype Cycle



Ray Kurzweil's Singularity

- Hypothesis that the invention of artificial superintelligence will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization.
- At the 2012 Singularity Summit, Stuart Armstrong did a study of artificial general intelligence (AGI) predictions by experts and found a wide range of predicted dates, with a median value of 2040.



Google on track for quantum computer breakthrough by end of 2017





https://en.wikipedia.org/wiki/Technological_singularity

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Artificial Intelligence as a Career



Basics and Support

Programming

Algorithms, Data structures

Statistics

Linear Algebra

Calculus, Optimization Techniques

High Performance Computing

Software Engineering, Cloud Systems

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PIEAS Courses

Core

- Artificial Intelligence
- Pattern Classification & Recognition
- Machine Learning
- Computational Intelligence
- Deep Learning
- Information Retrieval & Datamining
- Evolutionary Techniques
- Neural Networks
- Fuzzy Systems
- Info Retrieval & Data Mining
- Data Science

Applications

- Bioinformatics
- Computational Biomolecular Design
- Image Processing
- Computer Vision
- Computers & Network Security
- Robotics
- Medical Image Processing

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What can I do with an AI specialization?

- Academics & Research
- Jobs
 - Bioinformatics
 - Medical Informatics
 - Data Science
 - Vision
 - Security
 - Gaming
- Indirect Effects
 - Algorithms
 - Programming

This Course

- My Assumptions
 - Good programming, data structures & algorithms concepts
 - A passion to learn!
- Objectives
 - Know about the state of the art algorithms and theory in Artificial Intelligence
 - Understand 'agent models' of Artificial Intelligence
 - Be able to apply concepts of Artificial Intelligence in real life development projects
 - 1.5 class hours require 1.5 hours of out-of-class learning
 - One 1.5 hour session will be dedicated to project discussions
- Requirements
 - Attendance (80%)

This Course

Contents

- W1: Basics and Introduction and Python
- Search Techniques
 - W2: Uninformed Search (BFS, DFS, IDS...)
 - W2: Heuristic Search (A*)
 - W3: Local Search (Hill Climbing, Simulated Annealing, GA)
- W5: Game Programming (Min-Max, Alpha-Beta Pruning)
- W6: Reinforcement Learning for Games
- W7-8: Learning from data and Neural Gaming

• Evaluation

- 30% Marks for Final
- 35% Class Project
- 20% Mid
- 15% Assignments and Quizzes
- Bonus

This Course: Logistics

- Course Webpage
 - Piazza
 - <u>https://piazza.com/pieas.edu.pk/summer2017/cis530/home</u>
 - Please register, signup or send me an email so
 - afsar at pieas dot edu dot pk
 - Please use a single email address for all interaction and be sure to check it daily for updates
- Office Hours
 - (Free Tuition Time!)
 - By Email Appointment

This Course: Logistics

- Books
 - \\172.30.10.2\FacultyShare\Fayyaz ul Amir Afsar
 Dr\CIS530
- Python Help
 - Faculty Share
 - \\172.30.10.2\FacultyShare\Fayyaz ul Amir Afsar Dr
 - \\172.30.10.2\FacultyShare\Fayyaz ul Amir Afsar Dr\PYTHON
- Online Help
 - Scikit: <u>http://scikit-learn.org/stable/tutorial/basic/tutorial.html</u>
 - Scipy: <u>http://www.scipy-lectures.org/</u>

Tasks for Lecture-1

- Warm-up Assignment
 - Write an (efficient!) Python program that, given a stick of integer length N, breaks it up into smaller sticks of integer but all un-equal lengths. How many unique ways are there to break up the stick?
 - Write a Python program that, given a square with side length N breaks it into squares of integer but all unequal lengths (challenge!)
- Other Questions (on Piazza)
 - What are the limitations of Turing Test?
 - What are some cool applications of AI?
 - What are some novel applications of AI? (BONUS)
- Study
 - Artificial Intelligence@ Wikipedia
 - <u>http://en.wikipedia.org/wiki/Artificial_intelligence</u>
 - <u>http://en.wikipedia.org/wiki/History_of_artificial_intelligence</u>
 - <u>http://en.wikipedia.org/wiki/Timeline_of_artificial_intelligence</u>
 - <u>http://en.wikipedia.org/wiki/Portal:Artificial_intelligence</u>
 - Chapter-1 in AIMA

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Previous Class Projects

- Objective of projects
 - Explore
 - Hands-on Learning
 - Make something useful
 - Have fun!
- Context Aware Image Resizing
- Correlation Filters
- Rejection Learning
- Eternity-II Puzzle
- Othello
- Sudoku
- Chess
- Autonomous Car Driving (extendable)
- Lying AI (extendable)
- Hand Shape Recognition





Some project ideas

- Cell phone detection for rescue robots and other applications (1)
- Intelligent Assistive Technologies: QR codes (2)
- Hemo-Meter (*2, Needs 1 additional person)
- Elderly Care and Support App (1)
- Biopsy Assistant (2)
- Smart Checklist App (1)
- Sound Source Localization (1)
- Style Transfer using Deep Learning (1)
- Neural Game Playing (2)
- Deep Learning based Telephonic Speaker Recognition (1)
- Automatic Poetry Generation (2)
- Machine Learning
 - Frozen Nets (1)
 - Data Hungry AI (1)
 - Heterogenous Learning (1)
- Biomedical Informatics
 - Prediction of properties of molecules (1)
 - Understanding the dark genome (1)
 - Countering antibacterial proteins with AI (1)
 - Searching for anti-CRISPR proteins (1)



How to choose a project?

 How does this course fir in with your life goals beyond this course?



Al Projects in my lab

• Focus

- Intelligent Algorithms for
 - Biology
 - Medicine

- Predicting Liver Disorders
 - Given: Liver ultrasound Images
 - Output: Diagnose surface & textural irregularities



- Detecting cells
 - Input: Histopathology
 Images
 - Output: Identifying
 location and types of
 cells



- Predicting ECG Abnormalities
 - Input: ECG
 Recording



10

6

PCA Component - 1

8

12

2

PCA Com

2

6

PCA Component - 1

12

10

- Interactions of Cotton Leaf Curl Virus
 - -21% growth in cotton
 - Identifying the interactions of CLCuV



http://www.intechopen.com/books/world-cotton-germplasm-resources/cotton-germplasm-of-pakistan

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- Predicting Protein Binding Sites
 - Input: Protein Sequences or 3D structures
 - Output: Identifying interfaces



Calmodulin

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Low predicted binding propensity

PDB: 1YRT

Identifying Molecular Causes of Disease



- Predicting Prion Proteins
 - Input: Protein Sequences
 - Output: Whether this protein can form prions



- Predicting Chemical Compounds in Mass-Spectrometry Data
 - RAMClust





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- Development of opensource machine learning tools and packages
 - PyLemmings: Python
 Based Large Margin
 Multiple Instance
 Learning System
 - CAFÉ-Map: Context
 Aware Feature Mapping





Other Projects

Hurricane Intensity
 Prediction



BMI Lab Projects: Biometrics



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End of Lecture

We want to make a machine that will be proud of us.

- Danny Hillis

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