

Advanced Artificial Intelligence

Introduction

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Instructor Information

Instructor	Dr. Qurat Ul Ain	E-mail	quratul.ain@isb.nu.edu.pk
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Research Interest : Multimedia Forensics, Deepfakes Detection, Adversarial Machine Learning, Deep Learning, Computer Vision			
Personal profile: https://scholar.google.com/citations?hl=en&view_op=list_works&authuser=3&gmla=AH8HC4w0juQIC7KIPC6qhpYw2I_6WTUp4xT_dAQOJ7uP4PSSvc_bwuZ_ill33lq0Do6f1LjbLa0sxtkwYghFWVRxPJe-&user=8FopwFEAAAAJ			
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Class Policies and Guidelines

- Attendance policy: will be marked at the **start of the lecture**



- Use of cell phones
- Discussion with fellows during class (unless needed for some announced task)
- Early leave (will result in absent)
- Frequent movement In-out during class



- **Be interactive, ask questions**
- **Participate in the lecture**
- **Relax and learn** 😊

Announcements and course updates

- Slides and all other material will be available at Google Classroom.
- Assignments will be submitted through the Google Classroom.
- To register the course page at the Google Classroom you will must use your NU email.

Google Classroom Code



ayfrhbcg

What is this Course About ?



Its about **understanding, applying and developing AI systems**



AI Programming



Assumptions: *Prior knowledge of AI Basics*

Marks Distribution (Tentative)

Assessments Type	Weight
Assignments	15%
Quizzes	10%
Project	10%
1 st Sessional	10%
2 nd Sessional	15%
Final Exam	40%

- There will be **Absolute Grading** as per the University policy

Retake Policy & Plagiarism

- **Retake of missed assessment items** (other than **midterm/ final exam**) will not be held (**no retake of assignment/quiz/project**).
- **Late submission (even 1 minute) means no submission**
- For a missed midterm/ final exam, an exam retake/ pretake application along with necessary evidence are required to be submitted to the department secretary. The examination assessment and retake committee decides the exam retake/ pretake cases.

Plagiarism

- Plagiarism in project or midterm/ final exam may result in F grade in the course.
- Plagiarism in an assignment or quiz will result in zero marks (**or F grade**) in that assessment item (all evaluation of that type).

Topics to be covered:

List of Topics	No. of Weeks	Contact Hours	CLO(s)
Introduction, History of AI, Problem Solving	1	3	1
Tree Search, Graph Search, BFS, DFS, IDS, DLS	1	3	1
A* Search, State Spaces, Problems with Search	1	3	1
Advanced Search – Minimax, alpha-beta pruning	1	3	1
Constraint Satisfaction Problems – Backtracking search for CSPs, Problem structure and problem decomposition, Local search for CSPs	1	3	1,2
1st Sessional Exam			

Self-modifying algorithms (GA, PSO, ACO, Differential evolution, Cultural evolution and Co-evolution, Evolution strategies)	2	6	2
FORMS OF LEARNING Unsupervised learning K-means clustering, Hierarchical clustering, Principle Component Analysis, Apriori algorithm	1	3	3
Supervised learning Linear regression, Logistic regression, Support-vector machines, Linear discriminant analysis, KNN, Neural Network.	2	6	3
2 nd Sessional Exam			

Deep Neural Networks Convolutional Neural Network, Word Embeddings, Attention Mechanism, Transformers.	2	6	4
Reinforcement learning Q Learning, Deep Q Learning	1	3	4
Federated Learning (FL) • Federated Learning in health informatics. FL Challenges and opportunities. Future Research directions in FL • Few shot learning • Zero short learning • Meta transfer learning Hands on FedML	1	3	4
Project Presentations	1	3	4
Total	15	45	

A woman's face is shown in profile, looking towards the right. She has a white, mechanical-looking collar around her neck. The background is a solid blue color with a faint, vertical pattern of binary code (0s and 1s). On the right side, there is a large, faint, light blue gear or cogwheel. The title "Today's Agenda" is written in a large, black, sans-serif font at the top left.

Today's Agenda

01 What is AI ?

02 A brief history

03 Applications of AI

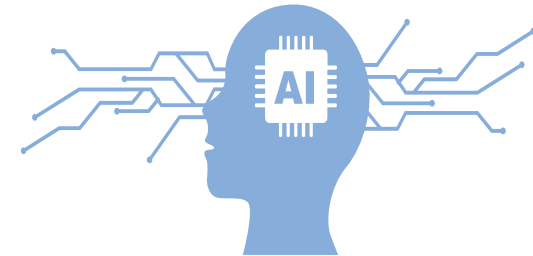
04 The state of the art

What is **AI**?

- Making computers that think ?



- The automation of activities we associate with human thinking, like decision making, learning ... ?



- The art of creating machines that perform functions that require intelligence when performed by people ?

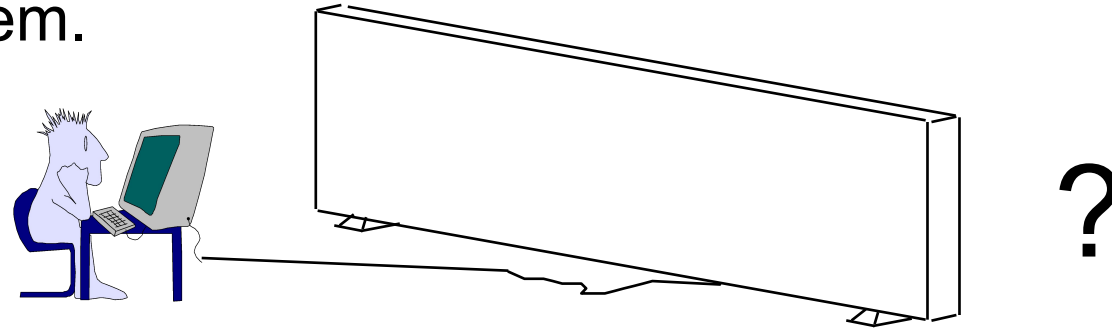


- Artificial
 - Produced by human art or effort, rather than originating naturally.
- Intelligence
 - is the ability to acquire knowledge and use it" [Pigford and Baur]
- **So AI is defined as:**
 - **AI** is the study of ideas that enable computers to be intelligent.
 - **AI** is the part of computer science concerned with design of computer systems that exhibit human intelligence(From the Concise Oxford Dictionary)

- From the above two definitions, we can see that AI has two major roles:
 - Study the intelligent part concerned with humans.
 - Represent those actions using computers.

THOUGHT	Systems that think like humans	Systems that think rationally
BEHAVIOUR	Systems that act like humans	Systems that act rationally
	HUMAN	RATIONAL

- You enter a room which has a computer terminal. You have a fixed period of time to type what you want into the terminal, and study the replies. At the other end of the line is either a human being or a computer system.



- If it is a computer system, and at the end of the period you cannot reliably determine whether it is a system or a human, then the system is deemed to be intelligent.

- The Turing Test approach
 - a human questioner cannot tell if
 - there is a computer or a human answering his question, via teletype (remote communication)
 - The computer must behave intelligently
- Intelligent behavior
 - to achieve human-level performance in all cognitive tasks

TURING TEST EXTRA CREDIT:
CONVINCE THE EXAMINER
THAT HE'S A COMPUTER.

YOU KNOW, YOU MAKE
SOME REALLY GOOD POINTS.
/ I'M ... NOT EVEN SURE
WHO I AM ANYMORE.



- Proposed by Alan Turing (1950)
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years

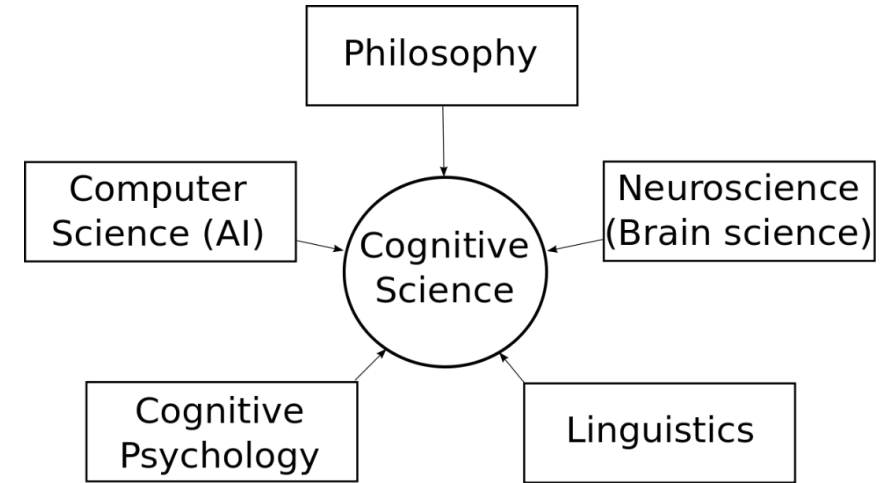
Suggested major components of AI:

- *Natural language processing*
 - for communication with human
- *Knowledge representation*
 - to store information effectively & efficiently
- *Automated reasoning*
 - to retrieve & answer questions using the stored information
- *Machine learning*
 - to adapt to new circumstances

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Cognitive Science

- Humans as observed from ‘inside’
- How do we know how humans think?
 - Introspection vs. psychological experiments
- “[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ...”





- 1960s --cognitive revolution: information-processing psychology replaced prevailing orthodoxy of behaviorism
- Requires scientific theories of internal activities of the brain
- How to validate? Requires
- Predicting and testing behavior of human subjects (topdown)
or
- Direct identification from neurological data (bottom-up)

THOUGHT

**Systems that think
like humans**

**Systems that think
rationally**

BEHAVIOUR

**Systems that act
like humans**

**Systems that act
rationally**

HUMAN

RATIONAL

"laws of thought"

- Humans are not always ‘rational’
- Rational - defined in terms of logic?
- Logic can’t express everything (e.g. uncertainty)
- Logical approach is often not feasible in terms of computation time (needs ‘guidance’)
- “The study of the computations that make it possible to perceive, reason, and act” (Winston)



Thinking rationally: Laws of Thought

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- Normative (or prescriptive) rather than descriptive
- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of logic:
- notation and rules of derivation for thoughts
- Direct line through mathematics and philosophy to modern AI

THOUGHT	Systems that think like humans	Systems that think rationally
BEHAVIOUR	Systems that act like humans	Systems that act rationally
	HUMAN	RATIONAL

- **Rational** behavior: doing the right thing
- **The right thing**: that which is expected to maximize goal achievement, given the available information
- Giving answers to questions is 'acting'.
- I don't care whether a system:
 - Replicates human thought processes
 - Makes the same decisions as humans
 - Uses purely logical reasoning

- Logic ☐
 - Sometimes logic cannot reason a correct conclusion
 - At that time, some specific (in domain) human knowledge or information is used
- Thus, it covers more generally different situations of problems
 - Compensate the incorrectly reasoned conclusion

- Philosophy
 - logic, methods of reasoning
 - mind as physical system
 - foundations of learning, language, rationality
- Mathematics
 - formal representation and proof
 - algorithms, computation, (un)decidability, (in)tractability
 - probability
- Psychology
 - adaptation
 - phenomena of perception and motor control
 - experimental techniques (psychophysics, etc.)

- Economics
 - formal theory of rational decisions
- Linguistics
 - knowledge representation
 - grammar
- Neuroscience
 - physical substrate for mental activity
- Control theory
 - homeostatic systems, stability
 - simple optimal agent designs

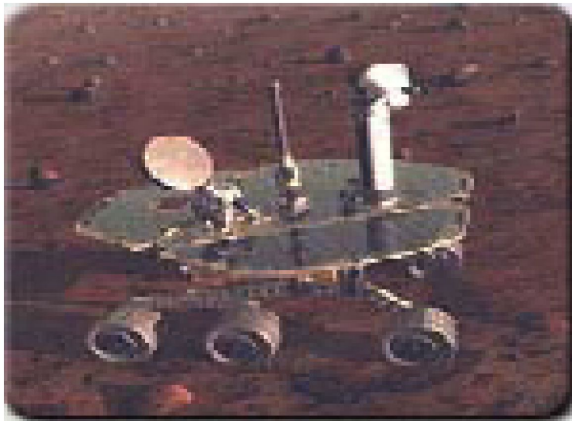
- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's Computing Machinery and Intelligence"
- 1950s Early AI programs, including Samuel's checkers program,
- Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1965 Robinson's complete algorithm for logical reasoning
- 1966--74 AI discovers computational complexity
- Neural network research almost disappears
- 1969--79 Early development of knowledge-based systems
- 1980--88 Expert systems industry booms
- 1988--93 Expert systems industry fall: "AI Winter"
- 1985--95 Neural networks return to popularity
- 1988--- Resurgence of probability; Nouvelle AI: A Life, GAs, soft computing
- 1995--Agents, agents, everywhere : : :
- 2003-- Human-level AI back on the agenda.....



Applications of AI

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- Autonomous Planning & Scheduling:
 - Autonomous rovers.

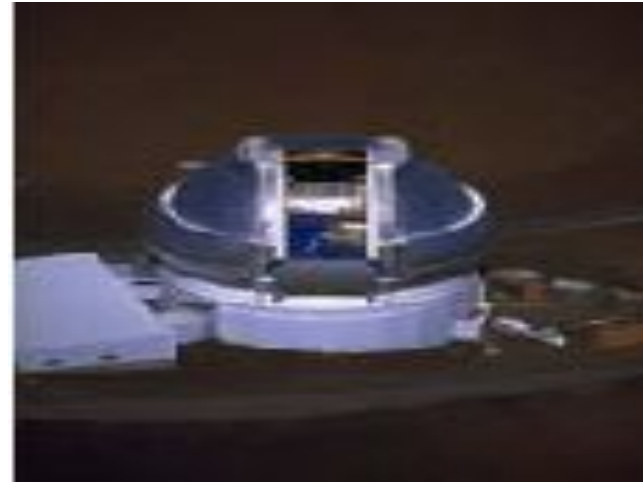




AI Applications

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- Autonomous Planning & Scheduling:
 - Telescope scheduling

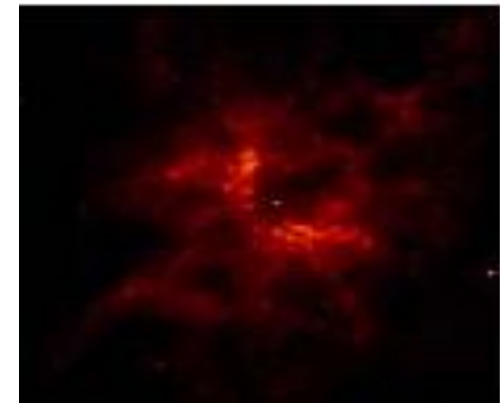
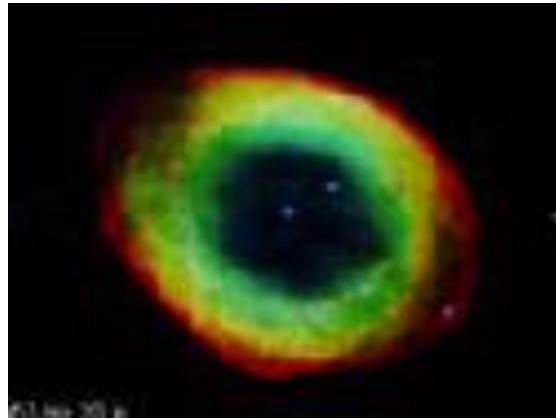




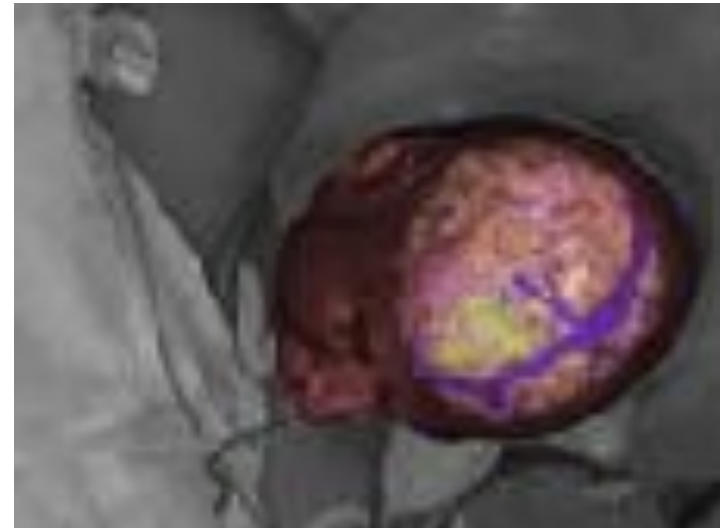
AI Applications

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- Autonomous Planning & Scheduling:
 - Analysis of data



- **Medicine:**
 - Image guided surgery
 - Disease Prediction

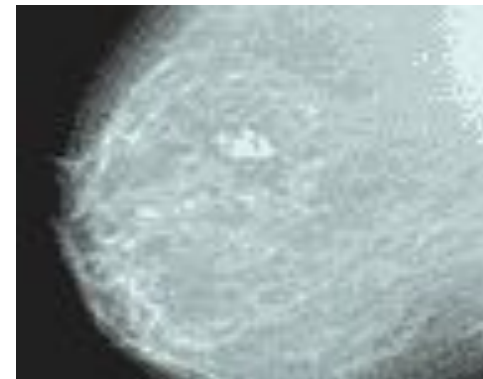
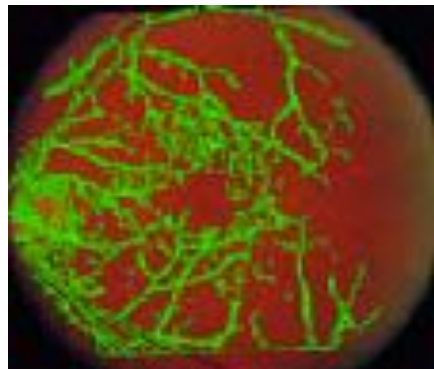




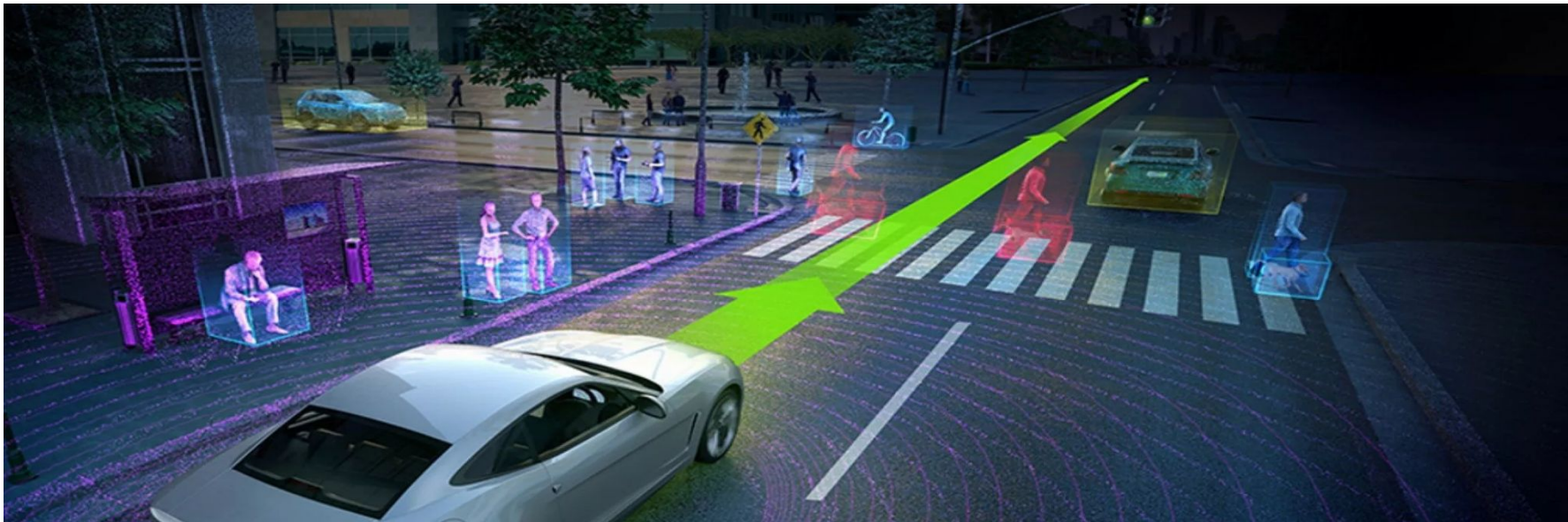
AI Applications

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- **Medicine:**
 - Image analysis and enhancement

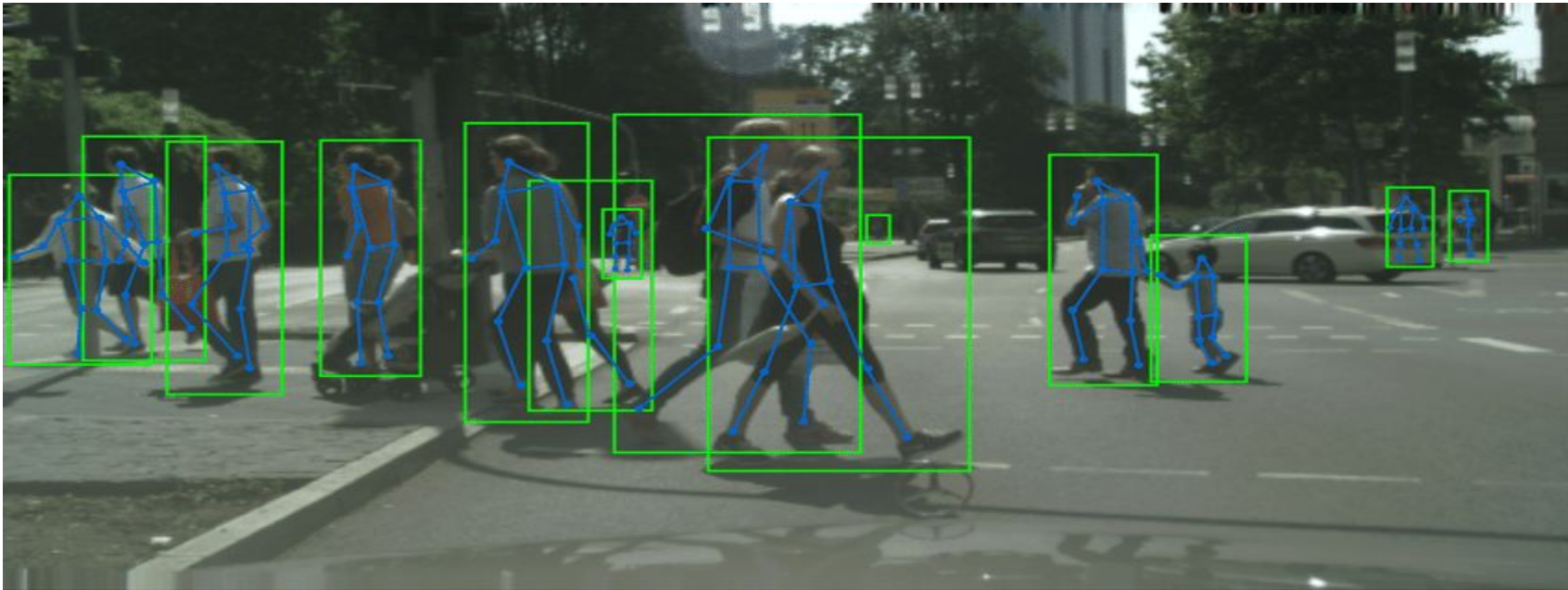


- **Transportation:**
 - Autonomous vehicle control:





- **Transportation:**
 - Pedestrian detection



- Games:



- **Other application areas:**
- **Bioinformatics:**
 - Gene expression data analysis
 - Prediction of protein structure
- **Text classification, document sorting:**
 - Web pages, e-mails
 - Articles in the news
- **Video, image classification**
- **Music composition, picture drawing**
- **Natural Language Processing**

Which of the following can be done at present?

- Play a decent game of table tennis
- Drive safely along a curving mountain road
- Buy a week's worth of groceries on the web
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Design and execute a research program in molecular biology
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time
- Converse successfully with another person for an hour
- Perform a complex surgical operation

