Artificial and Computational Intelligence

AIMLCZG557

Contributors & Designers of document content : Cluster Course Faculty Team

M1 : Introduction

BITS Pilani

Pilani Campus

Presented by

V Indumathi –Guest Faculty –BITS-W

indumathi.p@wilp.bits-pilani.ac.in

Artificial and Computational Intelligence

Disclaimer and Acknowledgement

- Few content for these slides may have been obtained from prescribed books and various other source on the Internet

- I hereby acknowledge all the contributors for their material and inputs and gratefully acknowledge people others who made their course materials freely available online.

- .I have provided source information wherever necessary

- This is not a full fledged reading materials. Students are requested to refer to the textbook w.r.t detailed content of the presentation deck that is expected to be shared over e-learning portal - taxilla.

- I have added and modified the content to suit the requirements of the class dynamics & live session's lecture delivery flow for presentation

- **Slide Source / Preparation / Review:**

- From BITS Pilani WILP**:** Prof.Raja vadhana, Prof. Indumathi, Prof.Sangeetha

- From BITS Oncampus & External : Mr.Santosh GSK

Agenda

- Course Administration

- Getting Started (with some definitions)

- Course Overview with example

Course Administration - TAXILA
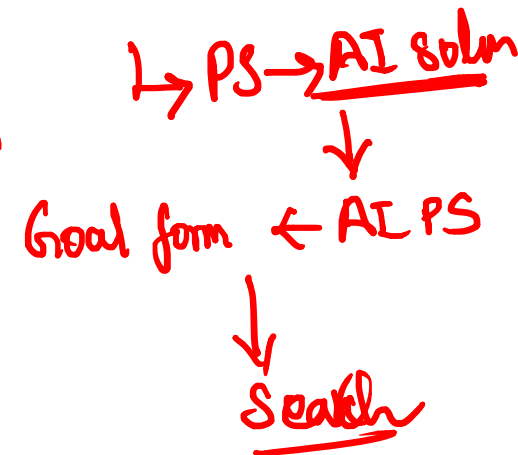
About the course

5 credit course

- Focus on
  - principles of artificial intelligence
  - concepts, algorithms involved in building rational agents
  - topics covered like
    - (informed and uninformed) search & applications
    - (logical & probabilistic) knowledge representation
    - (logical & probabilistic) Reasoning & applications
  - topics not-covered like
    - Formal introduction to machine learning algorithms, neural networks etc., are covered as a ML course is running in parallel, Deep neural networks, which are part of AI as well.
    - Hardware aspects of the Design

M1

M2

local optimization

⤷ PS → AI soln
↓
Goal form ← AI PS
↓
Search

- **Pedagogy**
  - Weekly online live sessions
  - Webinars on lab implementation   *python & prolog*
  - Assignment:
    - 1 Quiz-5%,
    - 2 Assignments- 25%

About the course

EC2
EC2

NO Programming QP
NO MCQ

↳ Descriptive QP (5 Qs)
↳ Scenario based QP

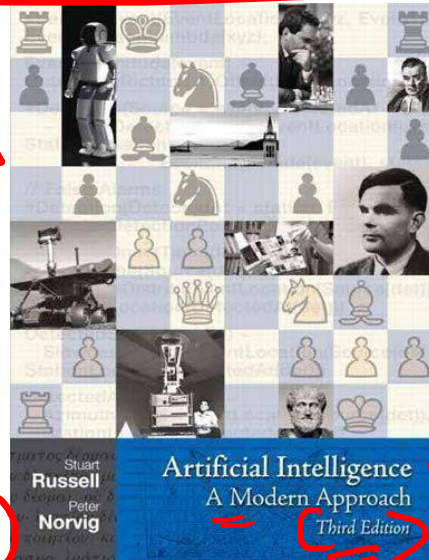R & M

NO Makeup   EC1

Text Book

4 to weeks

W1 → Searching   A1
W2 → Local Search
W3 → Prolog   A2

Artificial Intelligence
A Modern Approach
Stuart **Russell**
Peter Norvig
Third Edition

H^A

Q2 5
Q1 5 } best

closed book   EC3

Exercises : In Python & its libraries

EC1 **Evaluation** : 25% Assignment + 5% Quiz + 30% Mid Semester + 40% End Semester

Group (5)
(mid)
EC2

open book

A1   A2
I3   I2
Python   Py Prolog → LISP } 1960

M1 & M2

Artificial Intelligence

M1

4th *logical Inferences*

- Term coined by, *John McCarthy* (1955) & *Dartmouth Summer Research Project on Artificial Intelligence* (1956)

Existing

S_1: Socrates is human
S_2: All humans are mortal

$\Downarrow$

new Statement.
"Socrates is mortal"

On September 2, 1955, the project was formally proposed by McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon. The proposal is credited with introducing the term 'artificial intelligence'.

The Proposal states[7]

" We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. "

$a \to b$
$b \to c$

then

$a \to c$

Artificial Intelligence

Uncertainty — **Probability** — 16th

Prob. Axiom : $P(x) + P(\neg x) = 1$

X ✓ $P(x)$
$P(\neg x)$ 0.2

$1 - P(x) = 0.8$

- Term coined by, *John McCarthy* (1955) & *Dartmouth Summer Research Project on Artificial Intelligence* (1956)

On September 2, 1955, the project was formally proposed by McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon. The proposal is credited with introducing the term 'artificial intelligence'.

The Proposal states[7]

" We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. "

Larger Intent, Dream, Overconfidence …

Artificial Intelligence

[handwritten: 1940 & 1980]

- Term coined by, *John McCarthy* (1955) & *Dartmouth Summer Research Project on Artificial Intelligence* (1956)

On September 2, 1955, the project was formally proposed by McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon. The proposal is credited with introducing the term 'artificial intelligence'.

The Proposal states[7]

" We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. "

[handwritten: NLP] *[handwritten: Natural]*

https://en.wikipedia.org/wiki/Dartmouth _workshop_ [01 June, 2019]
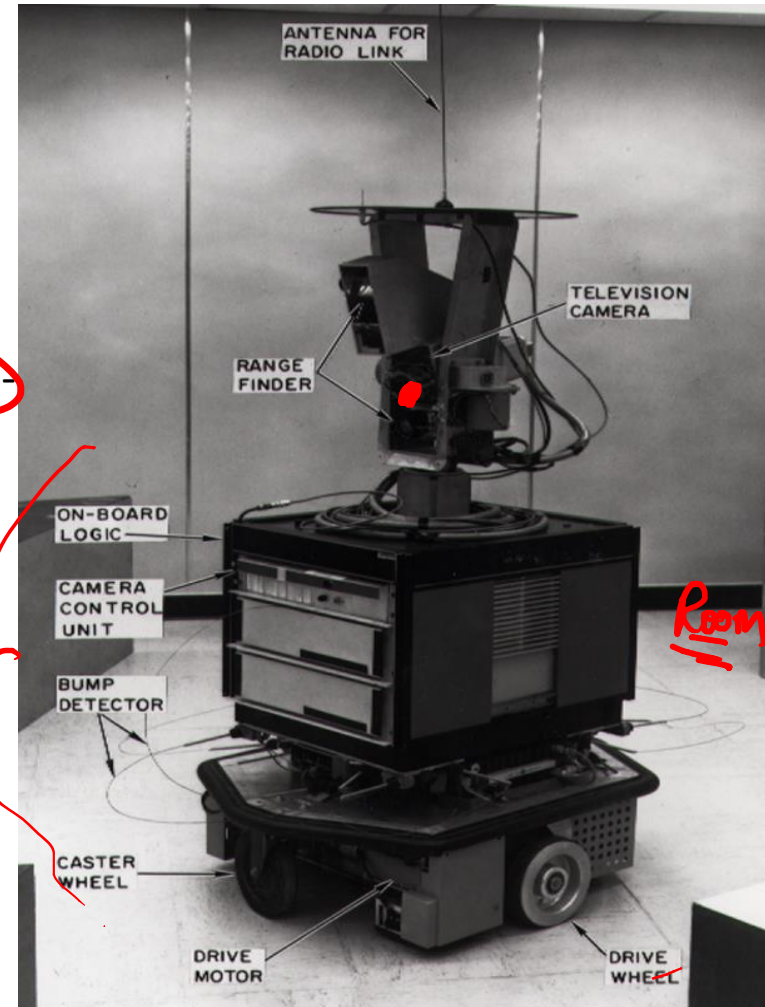
Larger Intent, Dream, Overconfidence ...

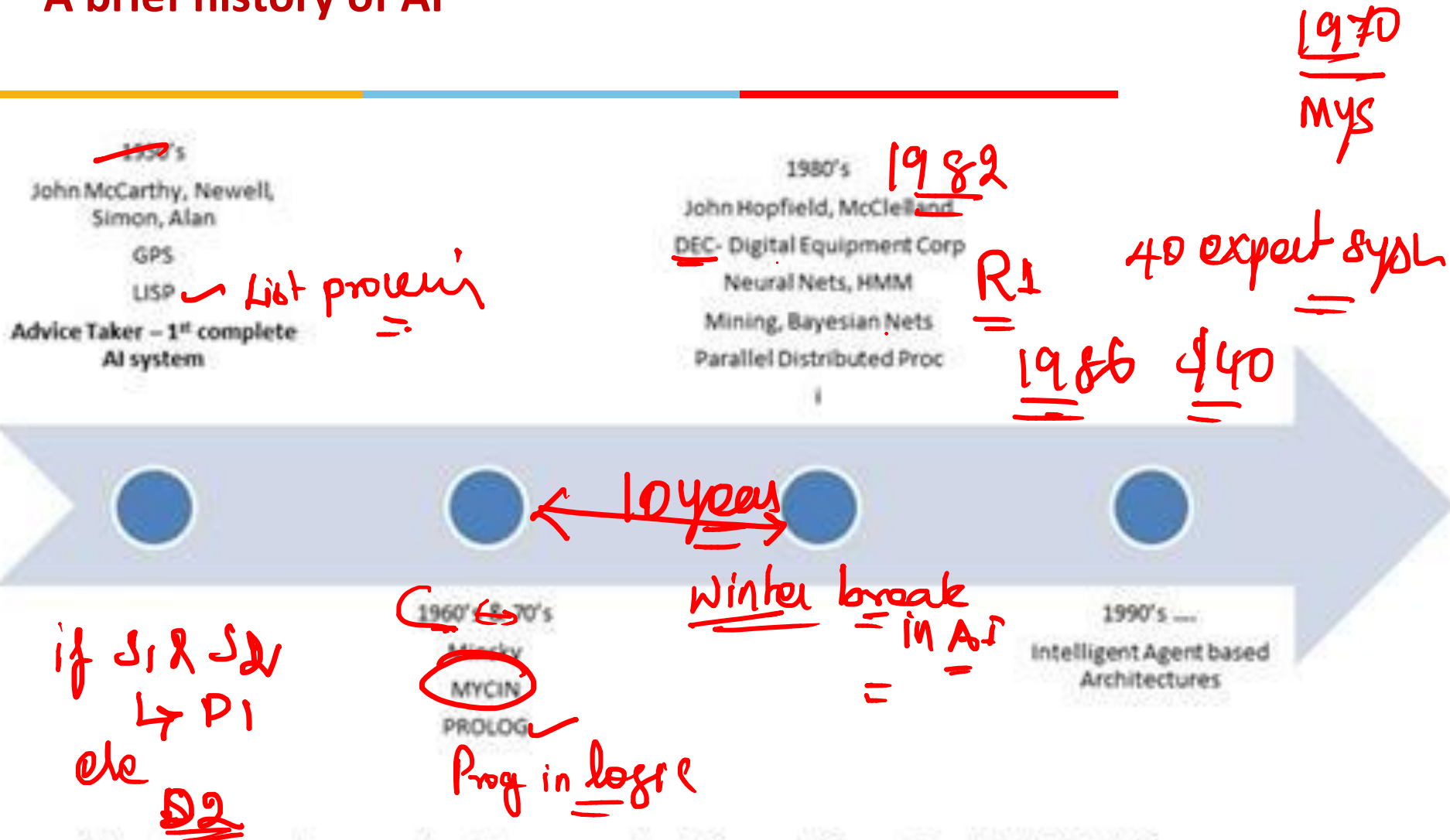Many key projects were initiated after Dartmouth summer project.

Shakey robot - First mobile robot to perceive environment & reason about surroundings, actions - Introduced A* algorithm to find paths - Hough Transform for image analysis - Used Lisp for programming - visibility graph used for finding shortest paths in the presence of obstacles...

A brief history of AI

1970
MYS

1950's
John McCarthy, Newell,
Simon, Alan

GPS

LISP — List processing

Advice Taker – 1st complete
AI system

if S_1 & S_2
$\rightarrow$ P1
ele
D2

1960's & 70's
Minsky
MYCIN
PROLOG ✓
Prog in logic

1980's   1982
John Hopfield, McClelland
DEC- Digital Equipment Corp   R1
Neural Nets, HMM
Mining, Bayesian Nets
Parallel Distributed Proc
                          1986 $40

40 expert syst

10 years

Winter break
in AI

1990's ...
Intelligent Agent based
Architectures

How is AI unique or in other words different from Applied Math?
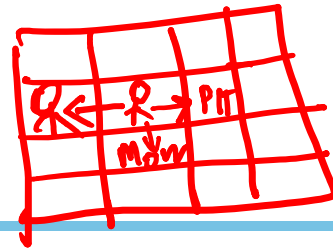
DENDRAL - *Expert System* *if else*

Attempted to encode the domain expertise in molecular biology as an expert system

Led to the creation of expert systems for various other domain, including medical.

A milestone worship in the history of AI   !!!

Perspectives of AI

Definitions

	Thought / Reasoning	Acting
Human Performance	THINKING HUMANLY "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning, … " (Bellman, 1978)	ACTING HUMANLY "The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)
Rational Performance	THINKING RATIONALLY "The study of computations that make it possible to perceive, reason, and act" (Winston, 1992)	ACTING RATIONALLY "Computational intelligence is the study of the design of intelligent agents" (Poole et al., 1998)

Turing Test Approach

- *Turing Test* & *Total Turing test* (operational test to determine an entity is intelligent / not) [50's]

- Skills necessary to pass these tests
    - NLP, Knowledge Representation, Automated Reasoning, ML + Computer Vision & Robotics(for total turing test)
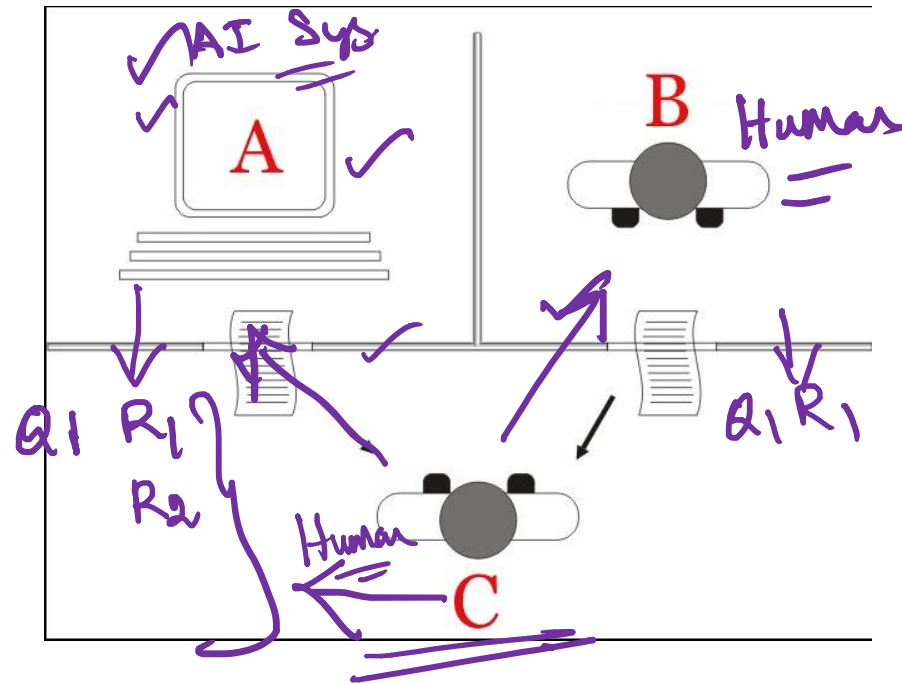
Pictorial Representation of Turing Test from https://en.wikipedia.org/wiki/Turing_test

Turing Test Approach

Some Definitions of AI:

"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)

"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)

Thinking Humanly

Cognitive Modelling Approach

- How do we capture human thinking to implement?
    - Introspection
    - Psychological Experiments
    - Brain Imaging

- System : *"General Problem Solver"* (*Newell and Simon, 1961*)
    - Designed to work as a universal problem solver
    - Problems represented by horn clauses
    - First AI Machine which has KB + Inference separation
    - Authors focus on this is on comparing the trace of its reasoning steps to traces of human subjects solving the same problems

- Growth of Cognitive science and AI supports each other

Transcript of a chat

EUGINE - a thirteen-year-old Ukrainian boy, chats

JUDGE: Hello.
EUGENE: Hello, I'm really glad to have the chance to chat with you! My guinea pig Bill sends his regards too!
JUDGE: Is Bill a male or a female?
EUGENE: Ask Bill personally, please.
JUDGE: Well I'd rather talk to you. What is your name?
EUGENE: Call me Eugene. I am glad to talk to you!
JUDGE: My name is Jane and I am female. How about you? What's your gender?
EUGENE: I'm a male. A "guy' I'd say.
JUDGE: Pleased to meet you Eugene. What's the weather like where you are?
EUGENE: Let's get on with our conversation!
JUDGE: Don't you like talking about the weather?
EUGENE: All these talks about weather is a waste of time.
JUDGE: What would you like to discuss?
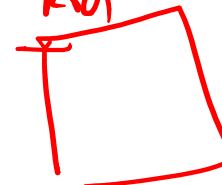EUGENE: I don't know. Better tell me more about yourself!

Passing the Turing Test

- 2014 - Royal Society (London) - Sixteenth Anniversary of Alan Turing -

- Chabot - Eugene Goostman - Pretended to be a thirteen-year-old Ukrainian boy

  - Passed the turing test for the first time

  - 10/30 Judges believed the response is from human

- *Turing predicted in 50 years time, computers can be programmed to play imitation game in which an average interrogator fails to identify the machine 70% time in a 5 mins questioning*

Thinking Humanly

Cognitive Modelling Approach

Some Definitions of AI:

"The exciting new effort to make computers think . . . machines with minds, in the full and literal sense." (Haugeland, 1985)

"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)

Thinking Rationally

"Laws of Thought" Approach

- Invention of Formal Logic, Greek Philosopher **Aristotle**, Third century BC.

- Introduced syllogisms, providing argument structures

In all boring classes, students sleep

It is a boring class

Students sleep in this class [Are you ?]

- Field of Logics gave rise to codifying rational thinking

    - When elements are '*things*', we reason about things

Hurdles to the idea : (1) Not everything can be logically coded (2) no provably correct

action at a moment (3) Exhaustive computational resources

Acting Rationally

The Rational Agent Approach

- An agent is an entity that perceives and acts

  This course is about designing rational agents

- Abstractly, an agent is a function from percept histories to actions:

  [f: P* → A]

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

- Computational limitations make perfect rationality unachievable

- Design best program for given machine resources

Acting Rationally

- Rational behaviour: doing the *right thing*

- The *right thing:* that which is expected to maximize goal achievement, given the available information

- Rational behaviour is not just about correct inference / thinking, skills needed to pass turing test etc.

  (adv) : More General - Correct inference is just a thing

  (adv) : More amenable for scientific developments, as the rational

behaviour is better defined than human thinking and behaviour

Definitions

Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think … *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …" (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI …is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Required Reading: AIMA - Chapter # 1

AIMA is the first prescribed text book

Thank You for your active participation

Note : Some of the slides are adopted from AIMA TB materials

Next Class Plan

- Agent Design
- Environment
- Agent Architecture
- Problem Solving Agent Formulation