UNIT - I
Artificial Intelligence

III / II IT, R 16 - JNTUK

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VVIT

OBJECTIVES

- To have a basic proficiency in a traditional AI language including ability to write simple to moderate programs and to understand code written in that language

- To improve analytical and problem solving skills based on the characteristics of the problem using various heuristic search techniques and to improve designing and playing a game

- To have knowledge on propositional calculus, proportional and predicate logic to understand few systems such as natural deduction, axiomatic system, etc.

Contd..

- To have an understanding of the basic issues of knowledge representation and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI programs.

- To have a basic understanding of some of the more advanced topics of AI such as learning, natural language processing, agents and robotics, expert systems, and planning

- To have basic knowledge on probabilistic analysis and networks as well as fuzzy systems and fuzzy logics.

OUTCOMES:

- Identify problems that are amenable to solution by AI methods
- And which AI methods may be suited to solve a given problem
- Formalize a given problem in the language/ framework of different AI methods
- Implement basic AI algorithms
- Design and carry out an empirical evaluation of different algorithms on problem formalization, and state the conclusions that the evaluation supports

TEXT BOOKS:

- Artificial Intelligence- Saroj Kaushik, CENGAGE Learning,

- Artificial intelligence, A modern Approach , 2nded, Stuart Russel, Peter Norvig, PEA

- Artificial Intelligence- Rich, Kevin Knight, Shiv Shankar B Nair, 3rded, TMH

- Introduction to Artificial Intelligence, Patterson, PHI

REFERENCE BOOKS

- Artificial intelligence, structures and Strategies for Complex problem solving, - George F Lugar, 5thed, PEA

- Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer

- Artificial Intelligence, A new Synthesis, Nils J Nilsson, Elsevier
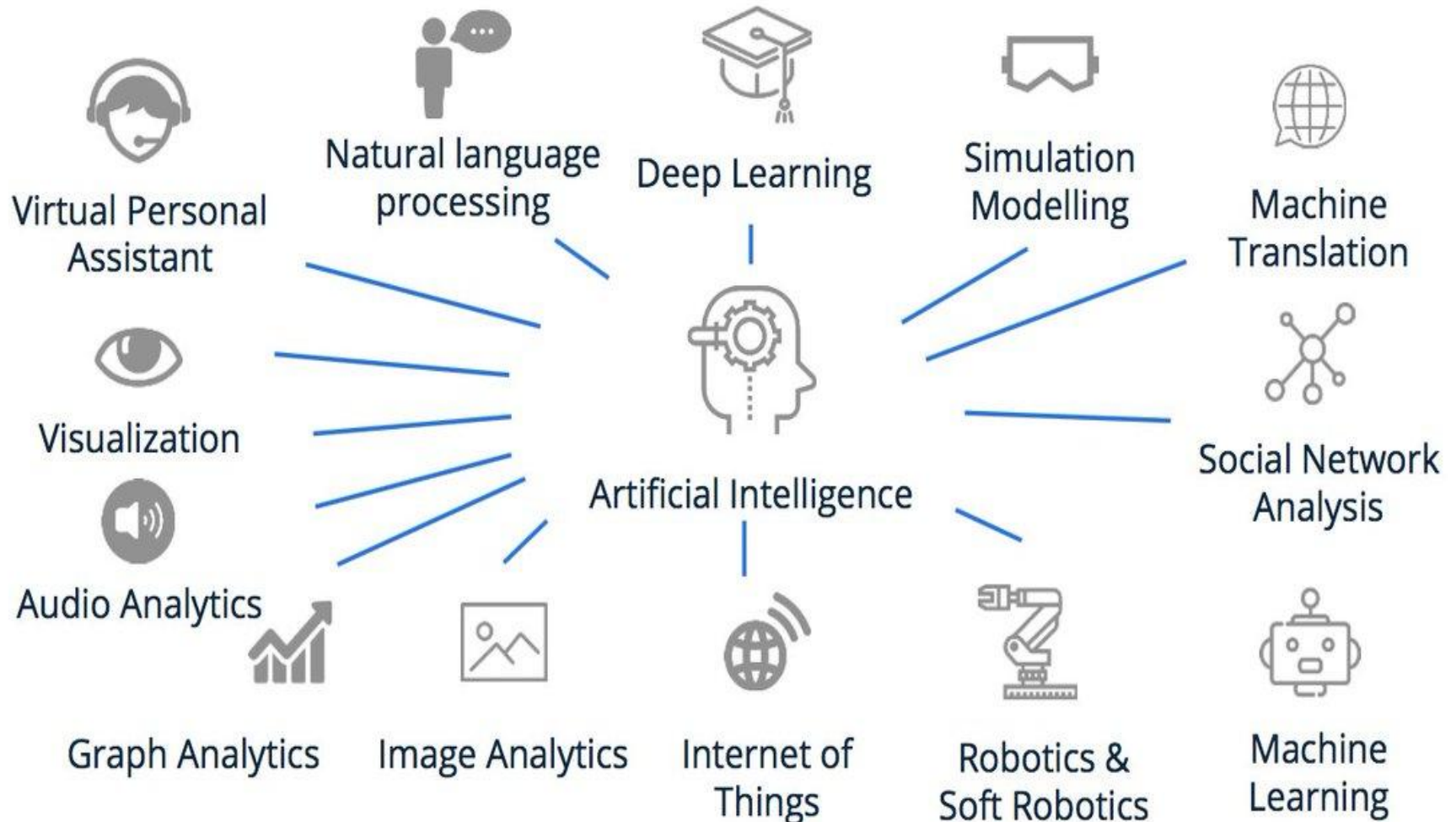
UNIT - I

- **Introduction to artificial intelligence:**
  - **Introduction - 1**
  - **History - 2**
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  - **Applications - 9**
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  - **Current trends in AI - 16**

Introduction

- Foundation of AI was laid with Boolean theory by a mathematician, Boole & other researchers

- Since the invention of computer in 1943, AI has been of interest to the researchers

- They always aimed to make machines more intelligent than humans

- AI has grown substantially for last six decades starting from simple to intelligent programs

- AI comprises of a numerous subfields ranging from general purpose areas to specific tasks

- General purpose areas: perception, logical reasoning, et.

- Specific tasks: game playing, theorem proving, diagnosing diseases, etc.

- Scientists of other fields use AI to systematize and automate the intellectual tasks

- AI is engaged in two different significant fields:
  - Science of human intelligence
  - Engineering discipline

Possible applications for Artificial Intelligence

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80+ COMPANIES SECURING THE FUTURE WITH AI

ANTI FRAUD & IDENTITY MANAGEMENT

AGARI | feedzai | Ravelin | smyte. | ZYUDLYLABS
邦盛科技 Bangsun Technology | GreatHorn | pulse iD | skymind | CVU
Castle | GYOMO | rippleshot | simility | veridu
CYBERTONICA | id wall | Shift Technology | sift science | UNFRAUD WE PROTECT YOUR BUSINESS
DATAVISOR | PRECOGNITIVE | 数美 nextdata | SOCURE | trooly

MOBILE SECURITY

appthority
Mi3 Security
Sentegrity
Skycure
ZIMPERIUM.

PREDICTIVE INTELLIGENCE

CYLANCE
deepinstinct | Recorded Future
SEC3
indeni | signalsense
INNEFU | ANOMALI
IntelliSpyre | PROTENUS
JASK | patternex
LogRhythm | SentinelOne
SECLYTICS

BEHAVIORAL ANALYTICS / ANOMALY DETECTION
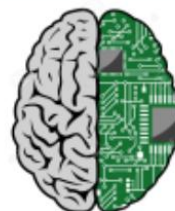
Avata INTELLIGENCE
BehavioSec
DARKTRACE | SPHERICAL DEFENCE
E8 SECURITY | RUBICA | CyberX
| RedLock | sqrrl
perimeterx | INTERSET
exabeam | intensity analytics | TWOSENSE.AI
SECUREDTOUCH | FORTSCALE | StackPath

AUTOMATED SECURITY

DEMISTO
EdgeWave
JAVELIN
LogicHub
TANIUM
ZENEDGE

CYBER-RISK MANAGEMENT

cybersaint
CYENCE
CYtora
Haystax TECHNOLOGY
lexumo
METACERT
wiretap

APP SECURITY

AuthBase
Cryptosense | CYBER 20/20

IOT SECURITY

sparkcognition
Bastille | CUJO

DECEPTION SECURITY

CyberFog | illusive

CBINSIGHTS
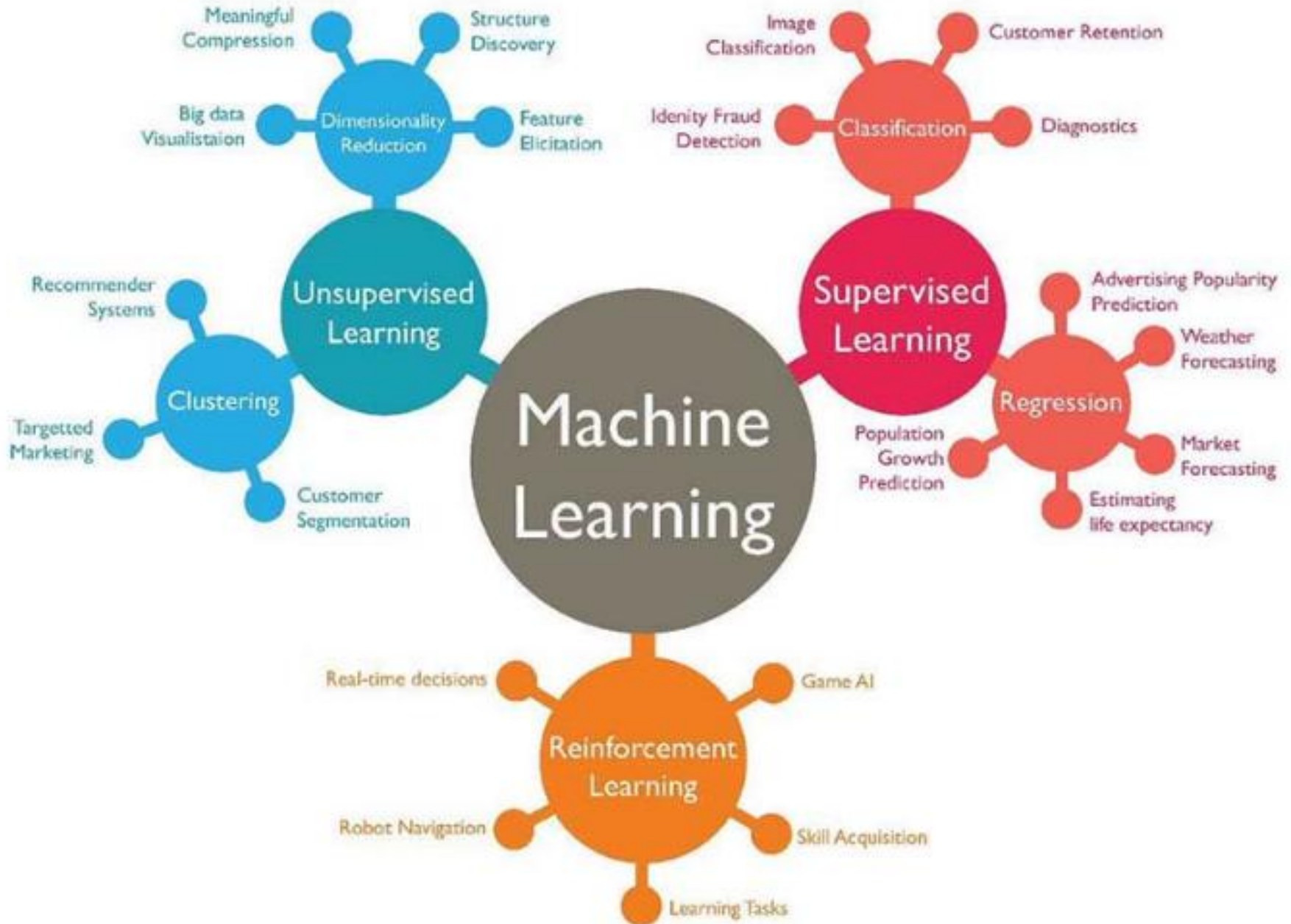
AI applications in financial services

Robo-advice

AML and fraud detection

Machine Learning

Natural Language Processing

AI

Cognitive Computing

Customer recommendations

Chatbots

Algorithmic trading
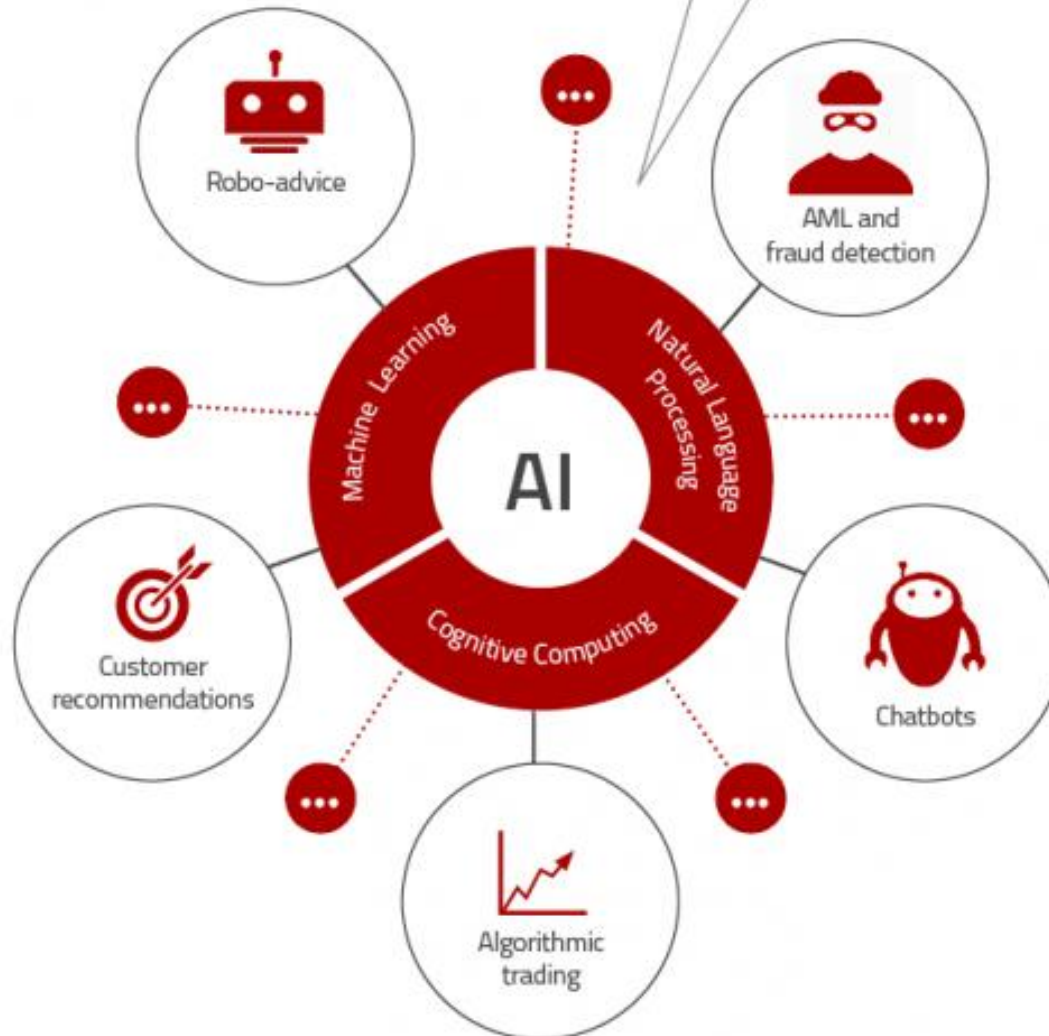
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Cybersecurity Domains

Security Architecture
- CASB
- Federated Identity
- Data Protection
- Network Design
- Secure Application Development
- Baseline Configuration
- Cloud Security
- Secure System Build
- Access Control
- Cryptography
- Security Engineering
- Identity Management
  - Privileged Access Management
  - Identity & Access Management

Framework and Standard
- COBIT
- ISO/IEC
- SANS/CSC
- NIST

Physical Security

Risk Assessment
- Assets Inventory
- Vulnerability scan
- 4th Party Risk
- Blueteam
  - Social Engineering
- 3rd Party Risk
- Redteam
  - Application
  - Infrastructure
- Penetration test
- Source Code Scan
  - Blackbox
  - Whitebox
- Data-Centric Risk Assessment
  - Data-Flow Map

Career Development
- Certification
- Conferences
- Training
- Peer Groups
- Self Study

Governance
- Industry Specific
- Laws and Regulations
  - Federal
  - State
- Audit
- Risk Informed
- Executive Management Involvement
- Company's Written Supervisory Procedures (WSPs)
  - Reports and Scorecards
  - Compliance & Enforcement
  - KPIs/KRIs
- Policy
- Procedure
- Guideline
- Standard

Security Operation
- DR
- Recovery
- Detection
- Protection
- BCP
- Prevention
- SIEM
- Active Defense
- SOC
- Vulnerability Management
- Data Leakage
- Incident Response
- Breach Notification
- Containment
- Investigation
- Eradication
- Forensics

User Education
- Training (new skills)
- Awareness (reinforcement)

Threat Intelligence
- External
- Internal
- Contextual
- IOCs
- Intel. Sharing

10 AI Applications That Could Change Health Care

APPLICATION	POTENTIAL ANNUAL VALUE BY 2026	KEY DRIVERS FOR ADOPTION
Robot-assisted surgery	$40B	Technological advances in robotic solutions for more types of surgery
Virtual nursing assistants	20	Increasing pressure caused by medical labor shortage
Administrative workflow	18	Easier integration with existing technology infrastructure
Fraud detection	17	Need to address increasingly complex service and payment fraud attempts
Dosage error reduction	16	Prevalence of medical errors, which leads to tangible penalties
Connected machines	14	Proliferation of connected machines/devices
Clinical trial participation	13	Patent cliff; plethora of data; outcomes-driven approach
Preliminary diagnosis	5	Interoperability/data architecture to enhance accuracy
Automated image diagnosis	3	Storage capacity; greater trust in AI technology
Cybersecurity	2	Increase in breaches; pressure to protect health data

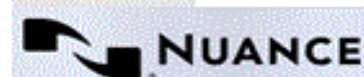# Selected Firms with AI Banking Applications

Identification
FACE++

HR
unitive
textio

Help Desk
DigitalGenius
IBM Watson
interactions
simply better understanding
Sobot.com
next IT
NUANCE

Marketing
Localytics
ai AUTOMATED INSIGHTS
NarrativeScience
Wise.io

CRM
salesforceIQ
fuse|machines
clari
Next+ 欧姆融
EVERSTRING
appboy

Knowledge Mgt.
cloze
context relevant
FinGenius
KENSHO
alphasense

AML
Digital Reasoning

Risk Management
WOLFRAM
COMPUTATION MEETS KNOWLEDGE
AYASDI

BI
DATARPM
METRIC INSIGHTS
H₂O

Google Prediction API
IBM Watson
cloudInfra

Microsoft Azure
bigml
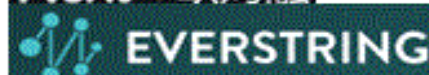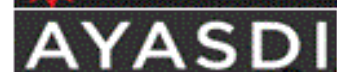
5 USE CASES OF AI + ROBOTICS IN AGRICULTURE

ANALYZING SATELLITE IMAGES

Descartes Labs
farmshots growing with you
Orbital Insight
OmniEarth

IN-FIELD MONITORING

HoneyComb
SkySquirrel technologies
DJI
GeoVisual analytics
AGRIEYE
SKYCISION
AIRWOOD
SENSURION AEROSPACE
RAPTOR MAPS
HUVR DATA
GAMAYA
PRECISIONHAWK
RESSON
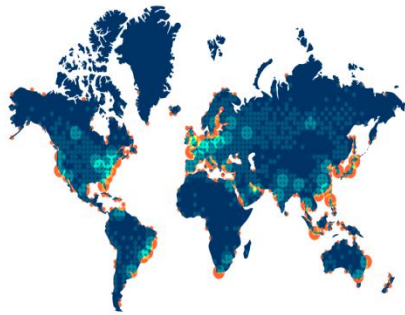
ASSESSING CROP/SOIL HEALTH

TRACE GENOMICS
indigo
peat
BENSON HILL BIOSYSTEMS

PREDICTIVE ANALYTICS

ec2ce easytosee
aWhere The Power of Agricultural Intelligence
OPTIMAL applied reinforcement learning

AGRICULTURAL ROBOTS

CLEARPATH ROBOTICS™
FarmBot
HARVEST CROO ROBOTICS
BLUE RIVER TECHNOLOGY
abundant ROBOTICS

CBINSIGHTS

History

✓ In 400 B.C, **philosophers** said that, mind operates on knowledge encoded in some internal language

✓ **Psychologists** strengthened the idea that, living creatures are **information processing machines**

✓ **Mathematicians** provided tools to manipulate certain or uncertain logical statements of certainty as well as probabilistic statements

- John McCarthy organized a conference on machine intelligence in 1956, since then the field is known as AI

- In 1957, a program named GPS (**General Problem Solver**) was developed and tested on problems requiring common sense

- John McCarthy announced his new development i.e., **LISP** (LISt Processing language) in 1958

- MarvinMinsky of MIT demonstrated that computer programs could solve **spatial and logic problems**

- 1960, another program named as **STUDENT** was developed to solve algebraic problems

- L.Zadeh has developed **Fuzzy set and logic** to make decisions under uncertain conditions.

- Terry Winograd at MIT, AI Laboratory developed **SHRDLU**, is a program which carries a simple dialogue with a user in English. This is written in **MACLISP.**

- Minsky also developed **Frame Theory** around 1970 used for storing structured programs to be used by AI programs.

- R.Kowalski developed **PROLOG** language around 1970. (Expert Systems are also developed in the same year)

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Top 10 milestones in the history of AI.

01 — 1950
The 1st advancement in the field made by Alan Turing through the Turing Test. It said if a machine could carry on a conversation that could not be differentiated from that of a human, then the machine had begun "thinking".

02 — 1956
AI emerged as a field in Computer Science. The term was coined in the Dartmouth Conference.

03 — 1974-80
AI Winters: A very bleak period in the history of AI. Several reports criticized AI. As a result, government spending & interest in the field reduced.

04 — 1980-87
The field revived. The British government started funding AI again to compete with the efforts made by the Japanese. One of the 1st popular AI films- "The Terminator" was released. The film showed a war between machines & humans.

05 — 1987-93
The 2nd AI winter period.

06 — 1997
The field picked up again as IBM's Deep Blue computer beat the reigning world champion- Garry Kasparov.

07 — 2001
Steven Spielberg releases "A.I. Artificial Intelligence"- a tech noir/drama on a robotic boy who dreams to be human.

08 — 2011
IBM's Watson wins "Jeopardy", an American TV quiz show, beating the former champions Brad Rutter and Ken Jennings. In October, Apple introduced Siri, an intelligent personal assistant on its iPhone 4s.

09 — 2012
Google launched its version of Siri- Google Now.

10 — 2014
Amazon Echo was introduced.

Intelligent systems

- AI is combination of Computer Science, Physiology and Philosophy
- AI is a broad area consisting from Machine Vision to Expert Systems
- John Mc Carthy defines intelligence as the computational part of the ability to achieve goals in the world
- Different people think of AI differently and there is no unique definition
- In brief, AI is the study of making machines do things intelligently

- Hence, AI programs must have capability and characteristics of intelligence such as
  - learning,
  - reasoning,
  - inferencing,
  - perceiving and
  - comprehending information
- AI requires an understanding of related terms such as intelligence, knowledge, reasoning, cognition, learning, and few other

- AI programs are not perfect and even make mistakes like humans
- AI programs also can be treated as non-numeric (common sense) ways of solving problems
- AI programs need not be perfect by give reasonably good solutions
- There are two views of AI goals
  - Duplicating what brain does (cognitive science)
  - Duplicating what brain should do (logical thinking)

Eliza

- The very first intelligent system by Joseph Weizenbaum developed in 1964 - 1966

- A program that conversed with user in English

- Able to converse about any subject, since it stored the subjects information in data banks

- It was able to pick up speech patterns from user's questions and provide responses

- The main characteristics of Eliza are briefly mentioned as:

- Simulation of intelligence
  - Eliza programs are not intelligent since they cont understand the meaning
  - They understand the keywords and phrases
- Quality of response
  - It is limited by the sophistication of the ways in which they can process the input
  - Ex. The no.of templates available is a limitation

- Coherence
  - Earlier versions had no structure on the conversation
  - Every statement was based on entirely on the current input and no context info was maintained
  - More complex versions can do better
  - Any intelligence strongly depends on coherence
- Semantics
  - Have no semantic representation of content
  - It does not have intelligence of understanding
  - It imitates the human conversation style

Categorization of Intelligent Systems

- In order to design Intelligent Systems, they are categorized in to four

  - **Systems that think like humans**

  - **Systems that act like humans**

  - **Systems that think rationally**

  - **Systems that act rationally**

- **Systems that think like humans**
  - Requires cognitive modelling approaches
  - Should know the functioning of brain and its mechanism for processing information
  - It is an area of cognitive science
  - The stimuli are converted into mental representation
  - Cognitive processes manipulate it to build new representation to generate actions
  - Neural Network is a computing model for processing information similar to brain

- **Systems that act like humans**
  - Requires the overall behaviour of the system should be human like
- **Systems that think rationally**
  - Relies on logic to measure correctness
  - Logical formulae and theories are used for synthesizing outcomes
  - E.g. John is a human, and all humans are mortal, hence the conclusion is John is mortal
  - Should not that all intelligent behaviours are not by logical deliberation
- **Systems that act rationally**
  - By rational behaviour we mean doing the right thing
  - Though the method is illogical, the observed behaviour must be rational

- To summarize, it can be defined that intelligence is the property of mind which encompasses capabilities like:
  - Reason and draw meaningful conclusions
  - Plan sequences of actions to complete a goal
  - Solve problems
  - Think abstractly
  - Comprehend ideas and help computers to communicate in NL
  - Store knowledge provided before or during interrogation
  - Learn new ideas from environment and new circumstances
  - Offer advice based on rules and situations
  - Learn new concepts and tasks that require high levels of intelligence

Components of AI Program

- AI Program should have:
  - Knowledge base and navigational capacity which contains control strategy and
  - Inference mechanism
- Knowledge base:
  - AI programs should be learning in nature and update its knowledge accordingly
  - it consists of facts and rules and characteristics like voluminous, incomplete, imprecise, dynamic and keep changing

- Control strategy:
  - It determines which rule to be applied
  - For this heuristics, or related thumb rules are used
- Inference mechanism:
  - It requires search through knowledge base
  - Derives new knowledge using existing knowledge with the help of inference rules

Foundations of AI

- Commonly used AI techniques are rule-based, fuzzy logic, neural networks, decision theory, statistics, probability theory, genetic algorithms, etc.

- Since AI is interdisciplinary in general, foundations of AI are
  - Mathematics
  - Neuroscience
  - Control theory
  - Linguistics

Applications

- Business: financial strategies, advising
- Engineering: check design, offer suggestions to create new products, expert systems
- Manufacturing: assembly, inspection, maintenance
- Medicine: monitoring, diagnosing, prescribing
- Education: teaching
- Fraud detection
- Object identification
- Space shuttle scheduling
- Information retrieval

Tic-tac-toe game playing

- The objective is to write a program which never loses

- Three approaches are presented to play the game which increases
  - Complexity
  - Use of generalization
  - Clarity of their knowledge
  - Extensibility of their approach

Approach 1

- 3x3 board is represented as nine element vector

- Each element in a vector can contain any of the following three digits
  - 0- represents blank position
  - 1 – indicates X player move
  - 2 – indicates O player move

- The program makes use of a move table that consist of vector or 3^9 (19683) elements

Table 1.1 Move Table

Index	Current Board Position	New Board Position
0	000000000	000010000
1	000000001	020000001
2	000000002	000100002
3	000000010	002000010
⋮		

- Initially the board is empty and represented by nine zeros

- The best new board position is 000010000

- All possible board positions are stored in **'Current Board Position'** column with its corresponding next best possible board position in **'New Board Position'** column

- Once the table is designed, the program has to simply do the table look up

- The algorithm is as follows

1. View the vector as a ternary number

2. Get an index by converting this vector to its corresponding decimal number

3. Get the vector from new board position stored at the index. The vector thus selected represents the way the board will look after the move that should be made

4. So set board position equal to that vector

Disadvantages

- Requires lot of space to store move table

- Lot of work is required to create move table

- Move table creation is highly error prone

- Cannot be extended to 3D since 3^{27} board positions are required

- This program is not intelligent at all since it does not meet any of AI requirements

Approach 2

- The board B[1..9] is represented by a nine element vector

- Here
  - 2 – represents blank position
  - 3 – indicates X player move
  - 5 – indicates O player move

- There are totally 9 moves in game

- They are represented by an integer 1 for first move and 9 for last move

- We use the following 3 sub procedures

Human strategy

- If human is winning in the next move, then he plays in the desired square

- If he is not winning in next move, then he checks if the opponent is winning

- If so, then he blocks that square

- Go(n) – use this function computer can make a move in square n

- Make_2 – this function helps the computer to make valid 2 moves

- PossWin(p) – if player p can win in the next move, then it returns the index (from 1 to 9) of the square that constitutes a winning move, otherwise it returns a 0

- The function PossWin operates by checking, one at a time, for each of rows/ columns/ diagonals

- If PossWin(p) = 0, then p cannot win
- Find whether opponent can win
- If so, then block it, this can be achieved as
    - If (3*3*2 = 18), then X player can win as there is one blank square
    - If (5*5*2 = 50), then O player wins
- Let us represent computer as C & human as H
- First player is X and second player is O
- The following table consists of rules to be applied by computer for all nine moves

Table 1.2 Rules for Nine Moves

(C plays X, H plays O)	(H plays X, C plays O)
1 move : Go (5) / Go(1)	**2 move :** If B[5] is blank, then Go(5) else Go(1)
3 move : If B[9] is blank, then Go(9) else *{make 2}* Go(3)	**4 move:** *{By now human (playing X) has played 2 moves}:* If PossWin(X) then *{block X}* Go(PossWin(X)) else *{make 2}* Go(Make_2)
5 move : *{By now both have played 2 moves}:* If PossWin(X) then *{X wins}* Go(PossWin(X)) else if PossWin(O) *{block O}* then Go(PossWin(O)) else if B[7] is blank then Go(7) else Go(3)	**6 move :** {By now computer has played 2 moves}: If PossWin(O) then *{O wins}* Go(PossWin(O)) else if PossWin(X) *{block X}* then Go(PossWin(X)) else Go(Make_2)
7 & 9 moves : *{By now human (playing O) has played 3 chances}:* If PossWin(X) then *{X wins}* Go(PossWin(X)) else *{block O}* if PossWin(O) then Go(PossWin(O)) else Go(Anywhere)	**8 move :** {By now computer has played 3 chances}: If PossWin(O) then *{O wins}* Go(PossWin(O)) else *{block O}* if PossWin(X) then Go(PossWin(X)) else Go(Anywhere)

Disadvantages

- Though it can be treated as AI approach since it applies heuristics, it has following disadvantages:

  – Not as efficient as first one w.r.t time

  – Several conditions are checked before each move

  – Still cannot generalize to 3D

Approach 3

- The board is chosen as a magic square of order 3

- The magic square of order n consists of n^2 distinct numbers from 1 to n^2

- The numbers of columns, rows and diagonals some to the same constant

How to create magic squre 3x3

- Begin by placing 1 in the middle of first row
- Subsequently place next numbers diagonally up and to left
- Go down if the work is over

- **The only thing to be remembered is the matrix is wrapped-around**

Table 1.3 Magic Square of Order 3

8	1	6
3	5	7
4	9	2

- In this approach, a list of blocks played by each player is maintained

- Each pair of blocks a player owns is considered

- Difference D between 15 and the sum of the blocks is calculated

- If D<0 or D>9, then those two blocks are not collinear and so can be ignored

- Else if the block representing difference in blank, i.e. not in the list, then player can move in that block

Table 1.4   Status of Both Lists after Seventh Move

Player X (Human)

| 8 | 1 | 4 | 2 | | |

Player O (Computer)

| | | | ↓ | | |

| 5 | 6 | 3 | | | |

IMG_0773.JPG

1. Suppose H plays in block 8
2. C plays in block 5
3. H plays in block 1
4. C checks if H can win or not
   - Compute sum of blocks played by H
     - S=8+1=9
     - Compute D=15-9=6
   - The sixth block is a winning block for H and not there on either list. So, C blocks 6
5. H plays in block 4
6. C checks if C can win
   - Compute sum of blocks played by C
     - S=5+6=11
     - Compute D=15-11=4; discard this block as it already is in list
   - Now C checks whether H can win
     - Compute sum of pair of square from list of H which have not used earlier
       - S=8+4=12
       - Compute D=15-12=3
     - Block 3 is free, so C plays in block 3.
7. If H plays in block 2 or 9, then computer wins. Lets assume h plays 2
8. C checks if it can win
   - Compute sum of blocks played by C which has not used earlier
     - S=5+3=8
     - Compute D=15-8=7
   - Block 7 is free, so C plays in block 7 and wins the game
9. If H plays in block 7 then there is a draw

Execution of program

Advantages & Disadvantages

- Program requires much time than other two approaches as it must search all possible moves

- But the advantage is that the approach could be extended to handle 3D tic-tac-toe

- It could also be extended to handle games more complicated than tic-tac-toe

3 Dimensional Tic-Tac-Toe

- This is similar to the traditional Tic-Tac-Toe
- But played on a cube of order 3
- Cube is created by stacking 3 grids
- Now the 3 in a row can be on any of the three levels, or between levels
- To win, a player must place three of his symbols on three squares that line up vertical, horizontal or diagonal on a single grid or over all other grids

8	24	10	15	1	26	19	17	6
12	7	23	25	14	3	5	21	16
22	11	9	2	27	13	18	4	20
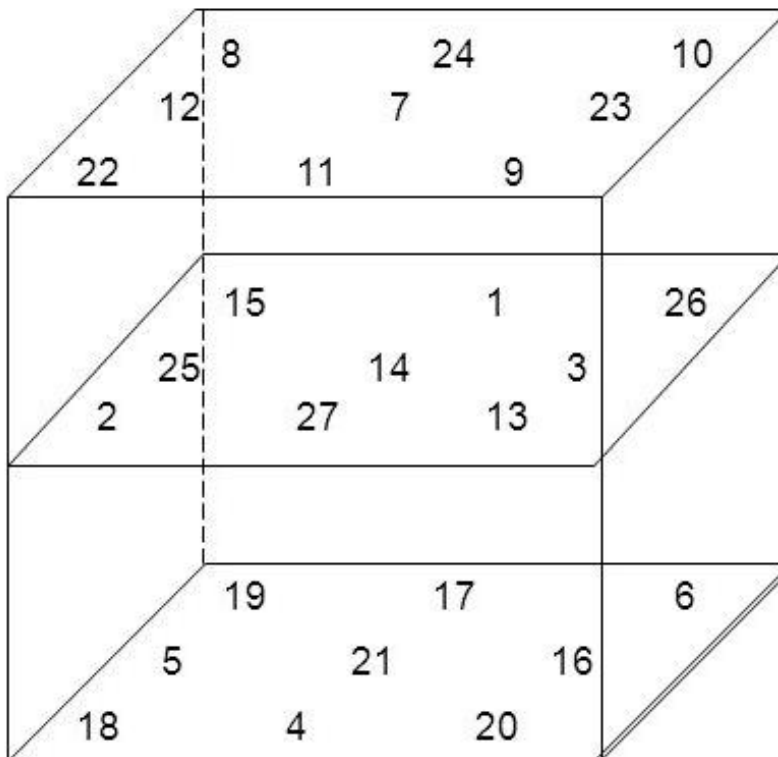
- Magic Cube has 6 outer and 3 inner and 2 diagonal surfaces

- Outer 6 surfaces are not magic squares as diagonals are not added to 42.

- Inner 5 surfaces are magic square.

- In this game, one may use the magic cube as shown in fig.

- Numbers from 1 to 27 are arranged in a 3x3x3 pattern

- Sum of the numbers on each row, column, diagonal is 42, called magic constant of cube

- The magic cube of order n has a magic constant equal to $n[(n^3+1)/2]$

Development of AI languages

- AI languages stress on knowledge representation schemes, pattern matching, flexible search, and programs on data

- E.g. LISP, Pop-2, ML, Prolog, etc.

- LISP is a functional language based on calculus

- Prolog is a logic lang. based on 1st order predicate logic

- Pop-2 is a stack based language providing greater flexibility and has similarity with LISP

- Pop 11 is embedded in an AI programming environments which focuses on domain level

- AI programming can exploit any language from BASIC through C to Smalltalk

Current trends in AI

- Current trends in AI are basically towards the development of technologies which have origin with biological or behavioral phenomena related to human or animals such as evolutionary computation

- Evolutionary computation uses iterative progress, such as growth or development

- It is inspired by biological mechanism or evolution

- Evolutionary paths of AI and simulation started to converge in cognitive psychology
- Simulation has been developed to study and understand complex time varying behaviours exhibited by real physical systems
- ANN has been developed based on functioning of human brain to predict features based on previous details
- Evolutionary techniques mostly involve meta-heuristic optimization algorithms such as evolutionary algorithms and swarm intelligence

- Genetic algorithms based on Darwin theory of evolution were developed mainly by emulating the nature and behaviour of biological chromosome

- Swarm intelligence is based on the collective behaviour of decentralized, self-organized systems

- Ants, bees and termites etc. solve complex problems by mutual cooperation

- This emergent behaviour of self-organization by a group of social insects is known as swarm intelligence

- In computational sense, the set of mobile agents which are liable to communicate directly or indirectly with each other and which collectively carry out a distributed problem solving is known as swarm intelligence

- Expert systems continues to remain an attractive field for its practical utility in all walks of real life

- Emergence of agent technology as a subfield of AI, is a significant paradigm shift for s/w development