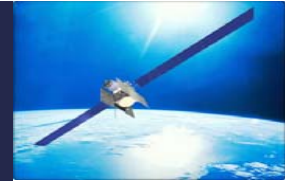


## COMPUTATIONAL INTELLIGENCE: CIS423

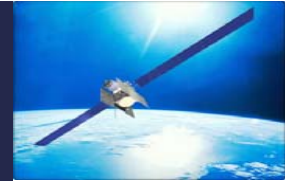
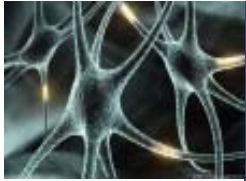
Pakistan Institute of Engineering and Applied Sciences (PIEAS).



Allah says

Ah! ye are those who love them, but they love you not,- though ye believe in the whole of the Book. When they meet you, they say, "We believe": But when they are alone, they bite off the very tips of their fingers at you in their rage. Say: "Perish in you rage; **Allah knoweth well all the secrets of the heart.**"

Al-Qur'an, 003.119 (Aal-E-Imran [The Family of Imran])



# **Lecture-1**

## ***Introduction to Computational Intelligence***

Lecture Slides by Fayyaz, DCIS, PIEAS

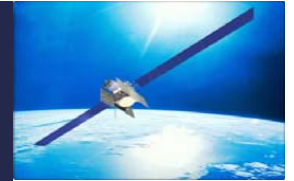
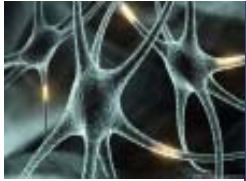
**Fayyaz ul Amir Afsar Minhas**

fayyazafsar@gmail.com

**Department of Computer and Information Sciences**  
**Pakistan Institute of Engineering and Applied Sciences**  
**(PIEAS)**

**P.O. Nilore, Islamabad.**

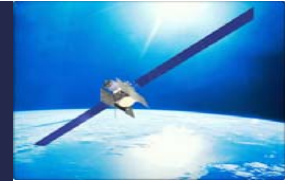
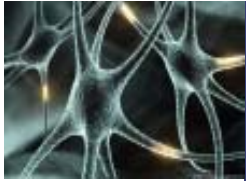
**10<sup>th</sup> September 2007.**



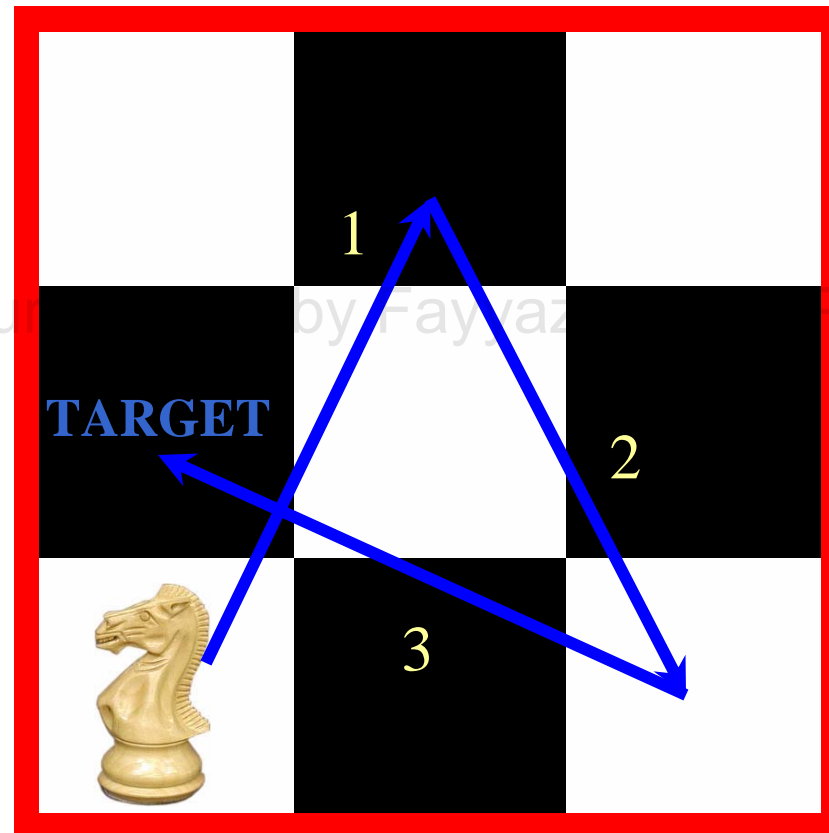
# Intelligence

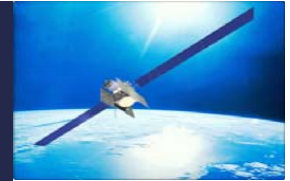
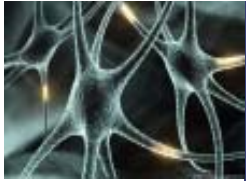
- A very general mental capability that, among other things, involves the ability to **reason**, **plan**, **solve problems**, **think abstractly**, **comprehend complex ideas**, **learn quickly** and **learn from experience**. [1]
- **Measurement of Intelligence: IQ**

Lecture Slides by Fayvaz, DCIS, PIEAS



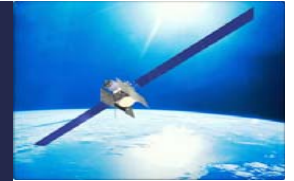
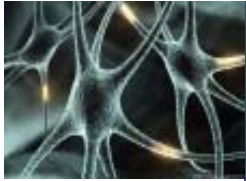
## Knight's Plight





## Calculative Puzzle

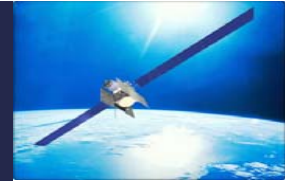
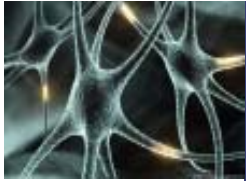
- The number of times the digit 0 appears in this puzzle is x.  
The number of times the digit 1 appears in this puzzle is x.  
The number of times the digit 2 appears in this puzzle is x.  
The number of times the digit 3 appears in this puzzle is x.  
The number of times the digit 4 appears in this 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.  
The number of times the digit 9 appears in this puzzle is x.



## Calculative Puzzle

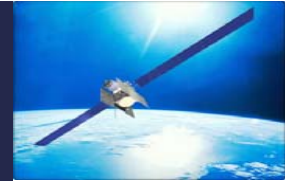
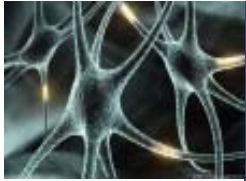
- The number of times the digit 0 appears in this puzzle is 1.  
The number of times the digit 1 appears in this puzzle is 11.  
The number of times the digit 2 appears in this puzzle is 2.  
The number of times the digit 3 appears in this puzzle is 1.  
The number of times the digit 4 appears in this 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 9 appears in this puzzle is 1.





## Spot the Odd One Out

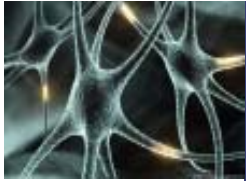




## Pigeons as Art Experts

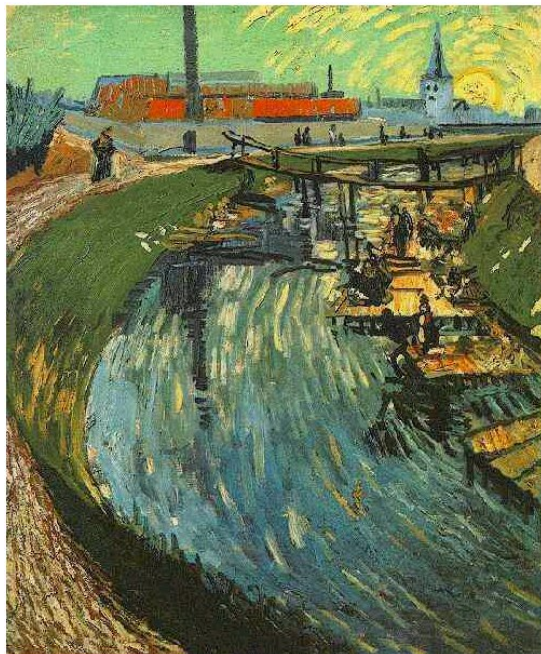
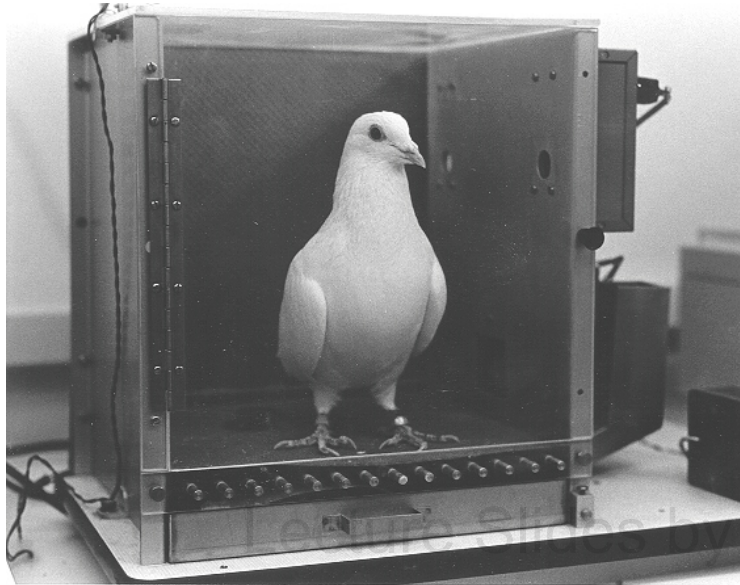
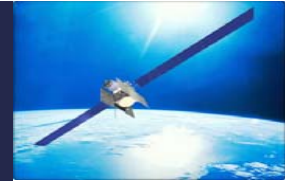
- Pigeons were placed in a box and presented pictures of two different artists (Van Gogh and Chagall)
- They were rewarded for pecking when a particular artist was shown to them
- Pigeons were able to discriminate between Van Gogh and Chagall with **95% accuracy** (when presented with pictures they had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

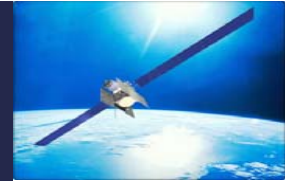
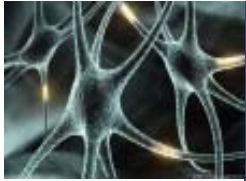




# COMPUTATIONAL INTELLIGENCE: CIS423

Pakistan Institute of Engineering and Applied Sciences (PIEAS).

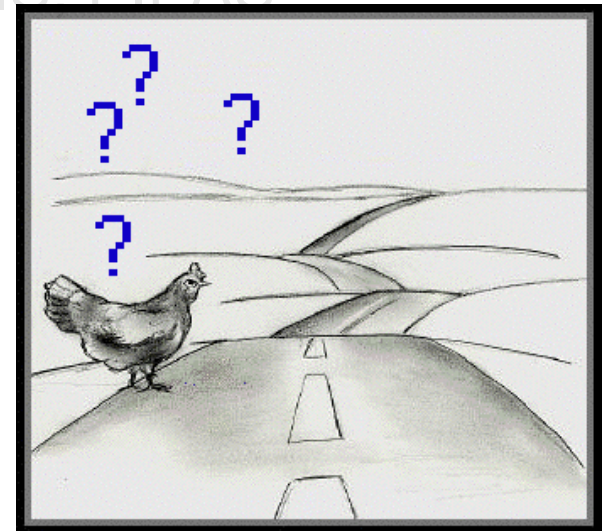


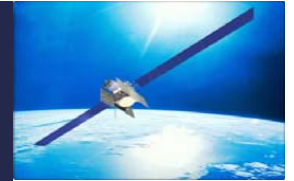
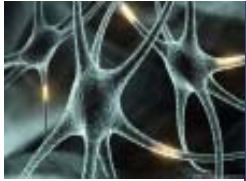


## Some More...

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

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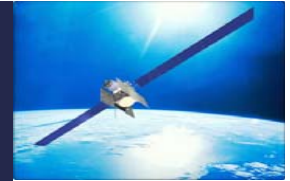
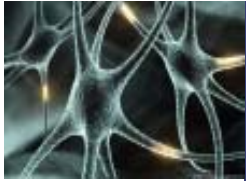




## Conclusions

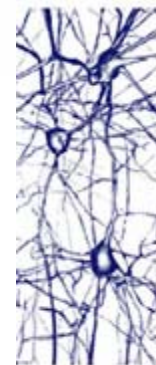
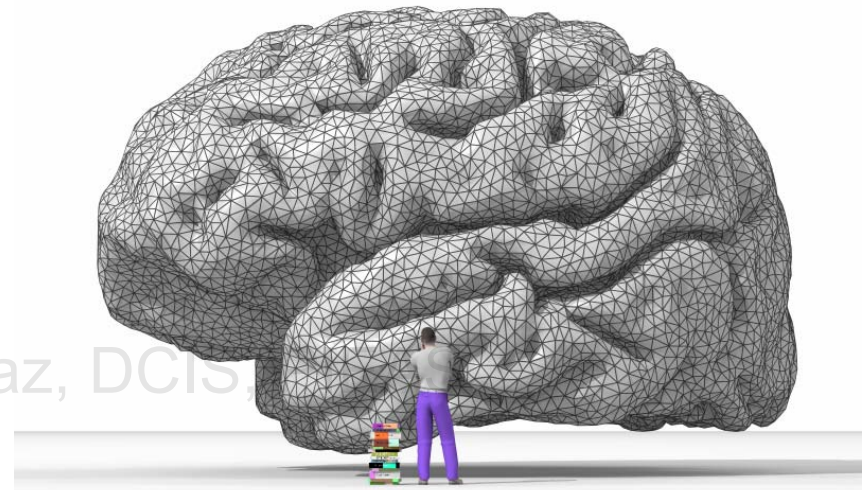
- Knight's Plight
  - **Planning**
- Calculative Puzzle
  - **Calculation, Computation, Reasoning**
- Finding the odd flower
  - **Unsupervised Learning**
- Pigeons as Art Experts
  - **Supervised Learning**
- Series Completion
  - **Prediction**
- Road Crossing
  - **Rational Actions**
- Process of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





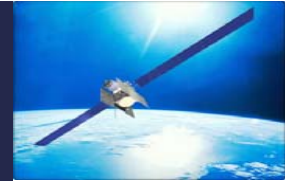
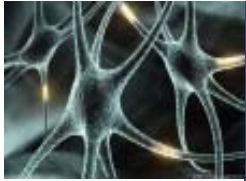
## How do we think? What makes us intelligent?

- **Cognition and Cognitive Modeling**
  - How do we think or how are we intelligent?
- **The Blue Brain Project [1]**
  - A biologically accurate, functional model of the brain using IBM's Blue Gene supercomputer a biologically accurate, functional model of the brain using IBM's Blue Gene supercomputer



**Blue  
Brain  
Project**

[1] <http://bluebrain.epfl.ch/>



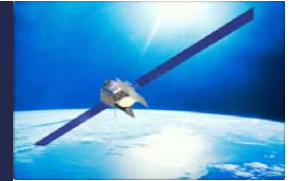
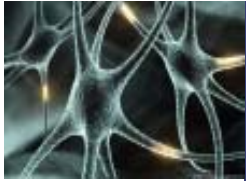
## Artificial and Computational Intelligence

- Artificial and Computational 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 and Computational Intelligence

- Application of the Turing Test
  - **CAPTCHA: Completely Automated Public Turing test to tell Computers and Humans Apart [1]**

following

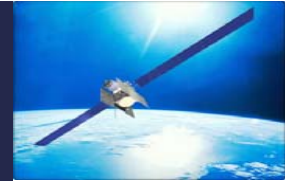
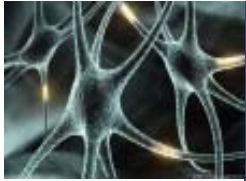
finding

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[1] <http://en.wikipedia.org/wiki/CAPTCHA>

[2] [http://en.wikipedia.org/wiki/List\\_of\\_Chatterbots](http://en.wikipedia.org/wiki/List_of_Chatterbots)



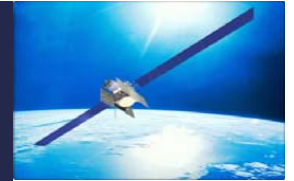
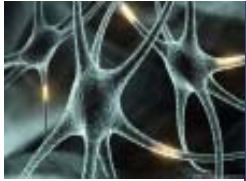
## Is ACI Intelligent?

- **Planning**
  - Kasparov Vs. IBM Blue
  - Time Table Schedulers
- **Calculation**
  - Symbolic Integration in Mathematica
  - Theorem Provers

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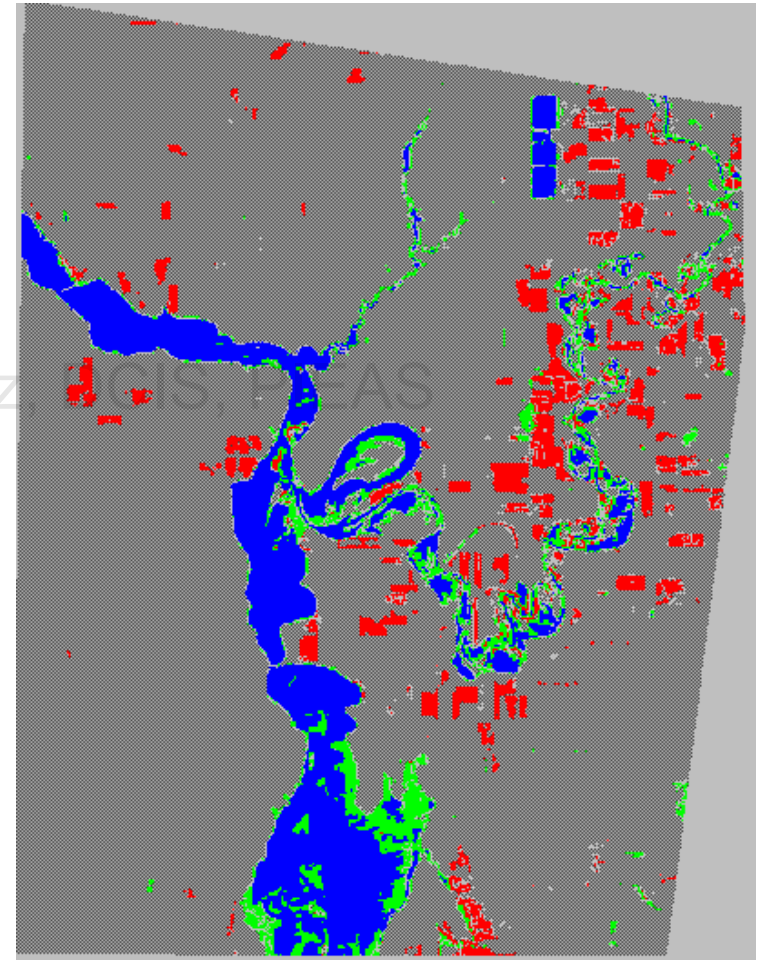


$$\begin{aligned} \int e^{2x} \cos 3x \, dx &= \frac{1}{3} e^{2x} \sin 3x + \frac{2}{9} e^{2x} \cos 3x - \frac{4}{9} \int e^{2x} \cos 3x \, dx \\ &+ \frac{4}{9} \int e^{2x} \cos 3x \, dx \qquad \qquad \qquad + \frac{4}{9} \int e^{2x} \cos 3x \, dx \\ \frac{13}{9} \int e^{2x} \cos 3x \, dx &= \frac{1}{3}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

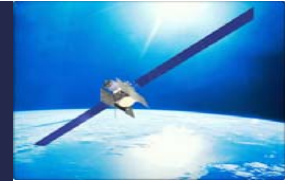
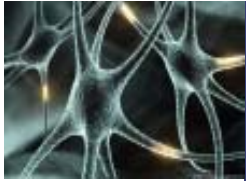


## Is ACI Intelligent?...

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



■ = water, ■ = wetland, ■ = marginal habitats, ■ = upland (non-useable habitats).

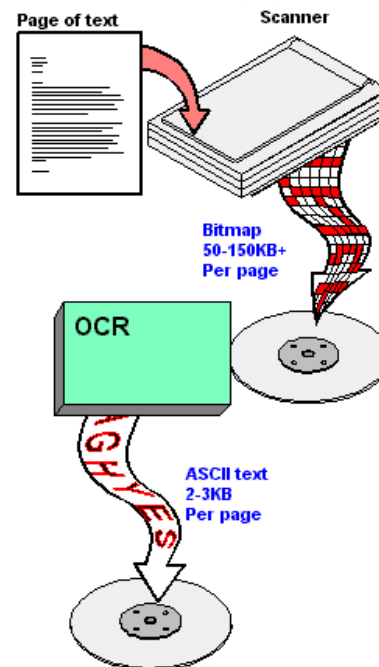


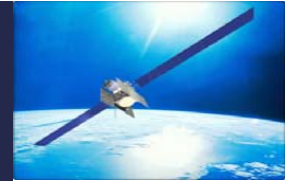
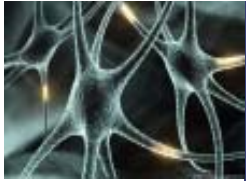
## Is ACI Intelligent?...

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



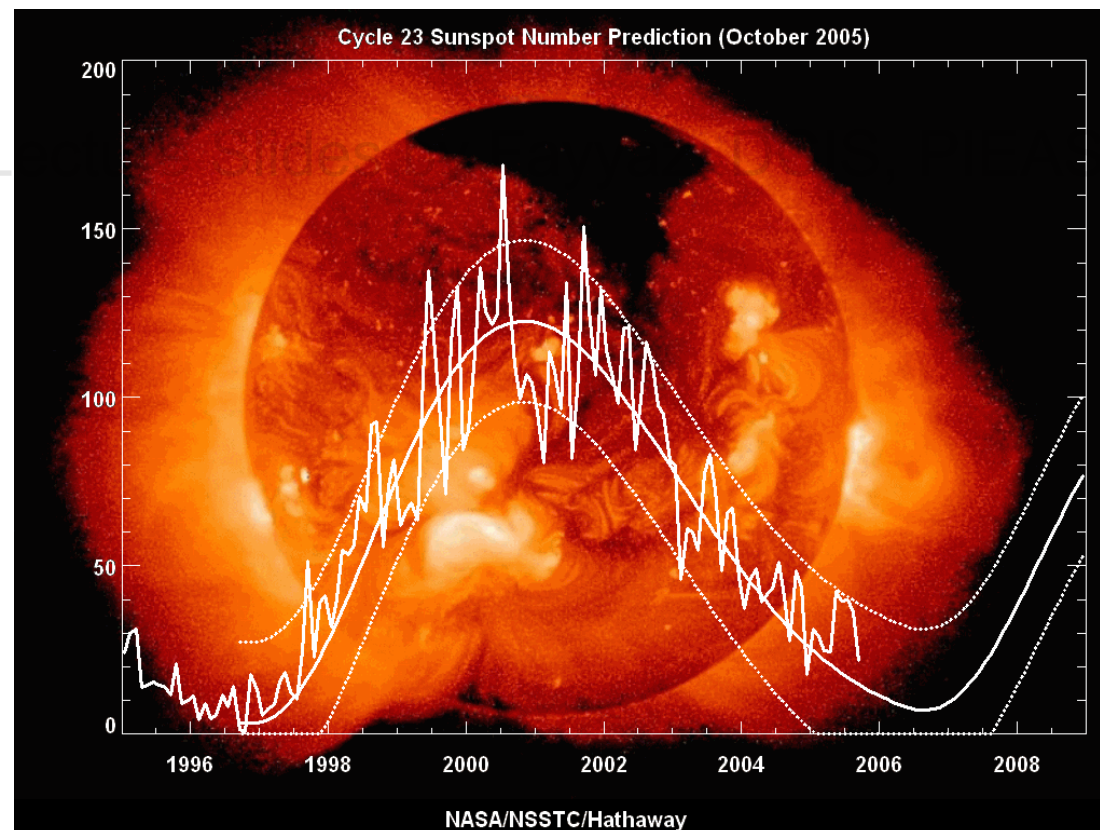
Lecture Slides by Payaz, DCIS, PIEAS



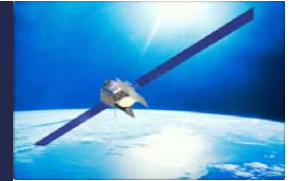
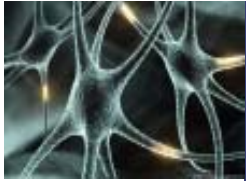


## Is ACI Intelligent?...

- **Prediction**
  - **Sunspot Number Prediction**

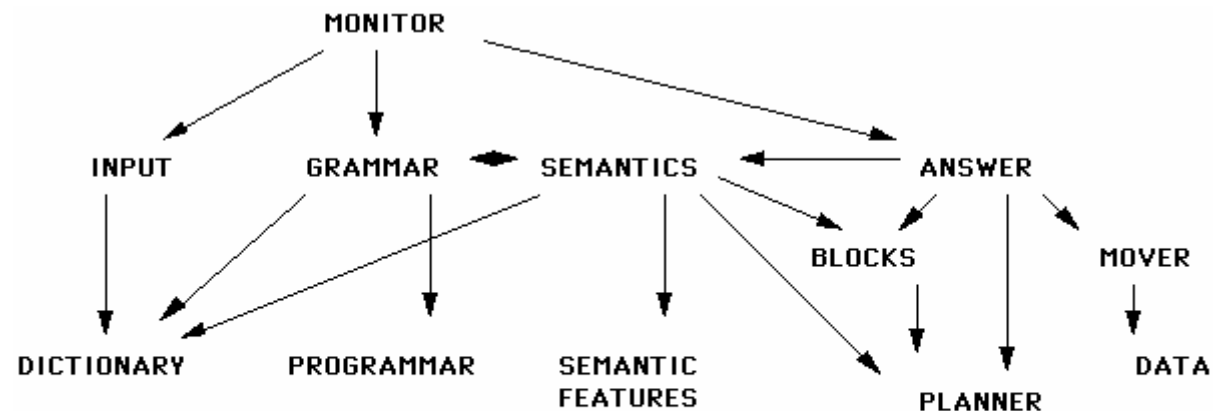
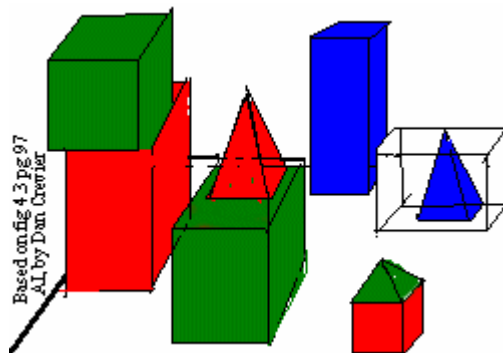




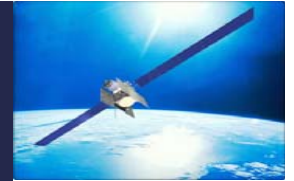
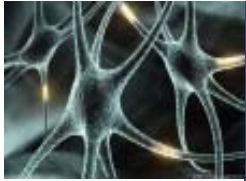


## Moving Towards Computational Intelligence...

- **Classical AI (GOFAI: Good Old Fashioned AI)**
  - Concerned primarily with **symbolic problems**:
    - Search Algorithms: e.g., A\* Algorithm, Min-Max
    - Knowledge Representation and Reasoning on Knowledge
    - Tarzan and Jane...
    - Typical Example: SHRDLU



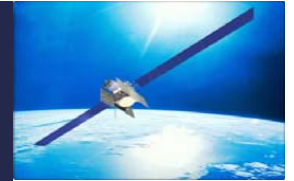
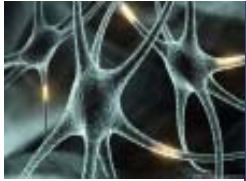
ORGANISATION OF SHRDLU



## Moving Towards Computational Intelligence...

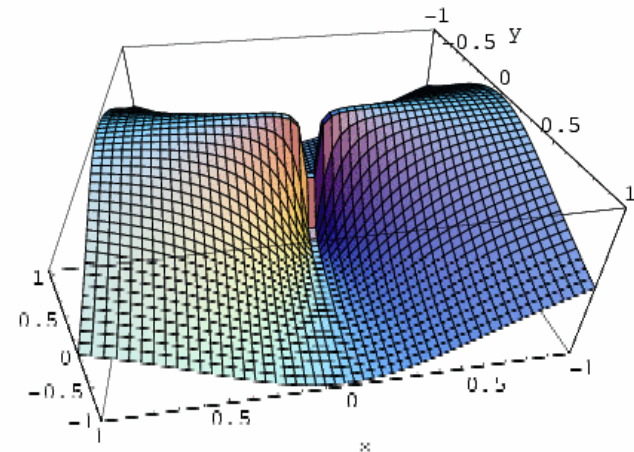
- **Computational intelligence** research aims to use **learning, adaptive, or evolutionary algorithms** to create programs that are, in some sense, **intelligent**.

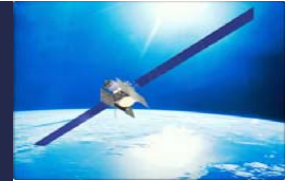
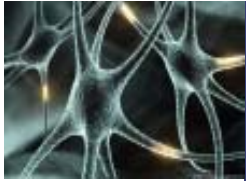
Lecture Slides by Fayyaz, DCIS, PIEAS



## Motivation for CI

- **Fuzzy, Imprecise or Imperfect data**
  - **Example:** Imagine Designing a Car Driving System and its rules being taken from an illiterate driver!!!
  - *Expert opinions are often fuzzy*
- **No available mathematical relation**
  - **Example:** Finding the maxima of a discontinuous unknown function!!
  - *Search spaces in practical can often be discontinuous*

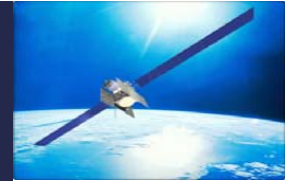
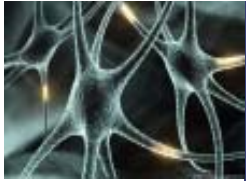




## Motivation for CI

- **Only Domain Experts are Available**
  - **Example:** Medical Diagnosis - No precise rules available
  - *Trigger for data mining*
- **Robustness and Adaptability**
  - *Required in practical scenarios*
  - **Example:** Pose invariant and Lighting Invariant face detection



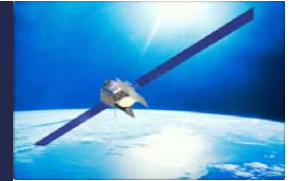
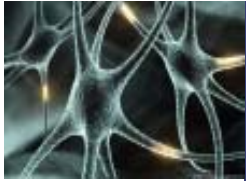


## Inspirations for CI

- The previous desired characteristics are exhibited and applied by intelligent living beings
- So a good algorithm can be achieved by considering how the minds of intelligent beings evolve and work

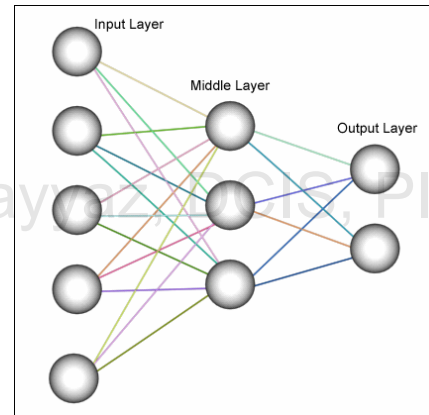
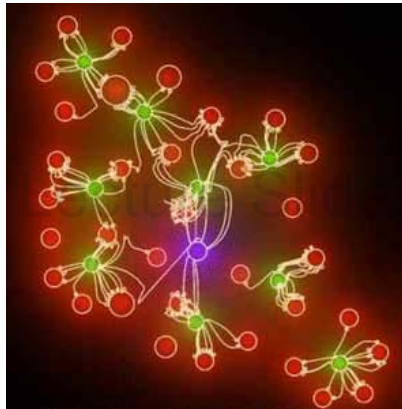
Lecture Slides by Fayyaz, DCIS, PIEAS



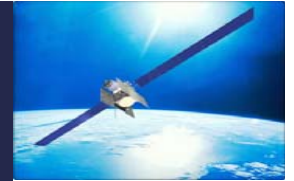
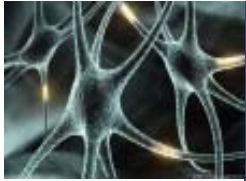


# Biological Inspirations

- **Artificial Neural Networks**
  - Mimic the learning process of the biological neuron

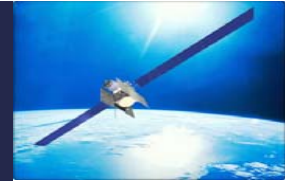
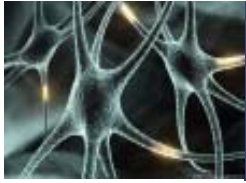


- **Applications**
  - Disease Classification
  - EEG Based Classification
  - Load Forecasting
  - Face Recognition
  - No Hands Across America!



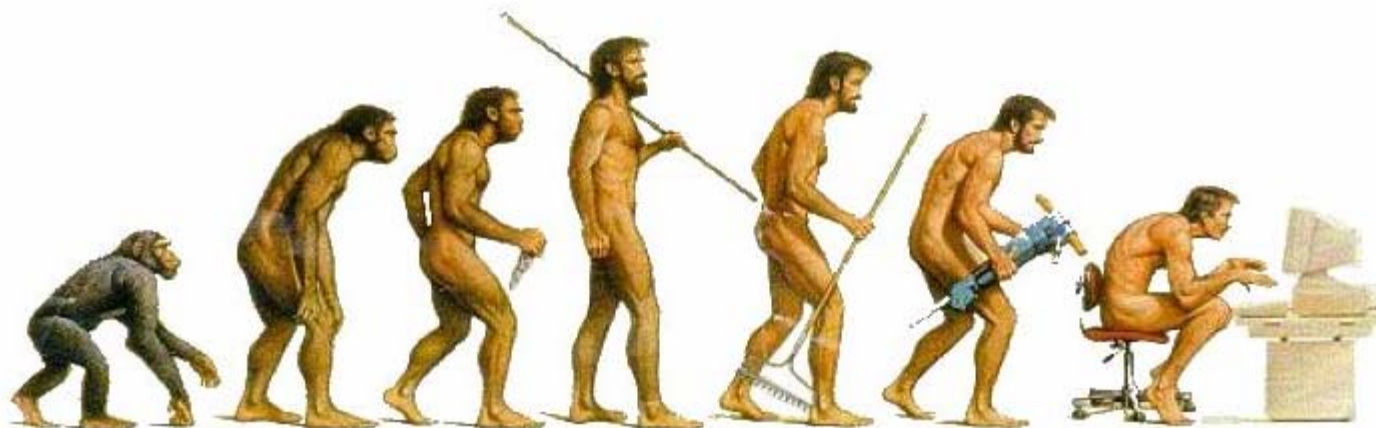
## Psychological Inspirations

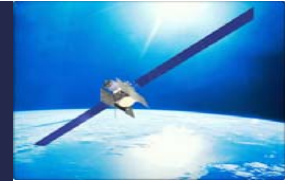
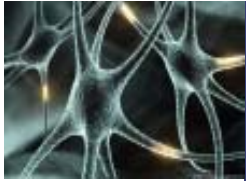
- Our daily life descriptions of things is fuzzy
  - Taller, smaller, heavier etc.
  - So researchers have developed **fuzzy systems** that provide effective solutions to complex problems by mimicking this capability
- Applications
  - EEG Based Classification
  - Disease Diagnosis
  - Control Applications



## Biological Inspirations

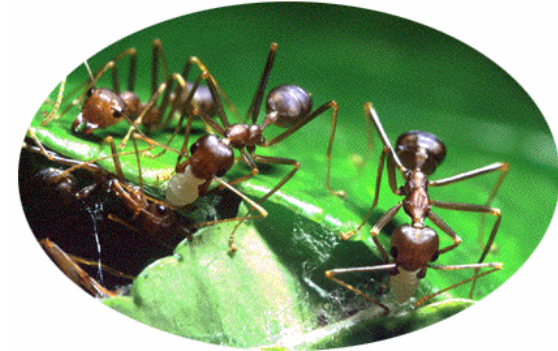
- **Theory of Evolution**
  - Has Resulted in the Development of **Genetic Algorithms** and **Genetic Programming**
  - **Multi-objective Genetic Algorithms**
- **Applications:** Slides by Fayyaz, DCIS, PIEAS
  - **Robotic Path Planning**
  - **Automatic Program Building**



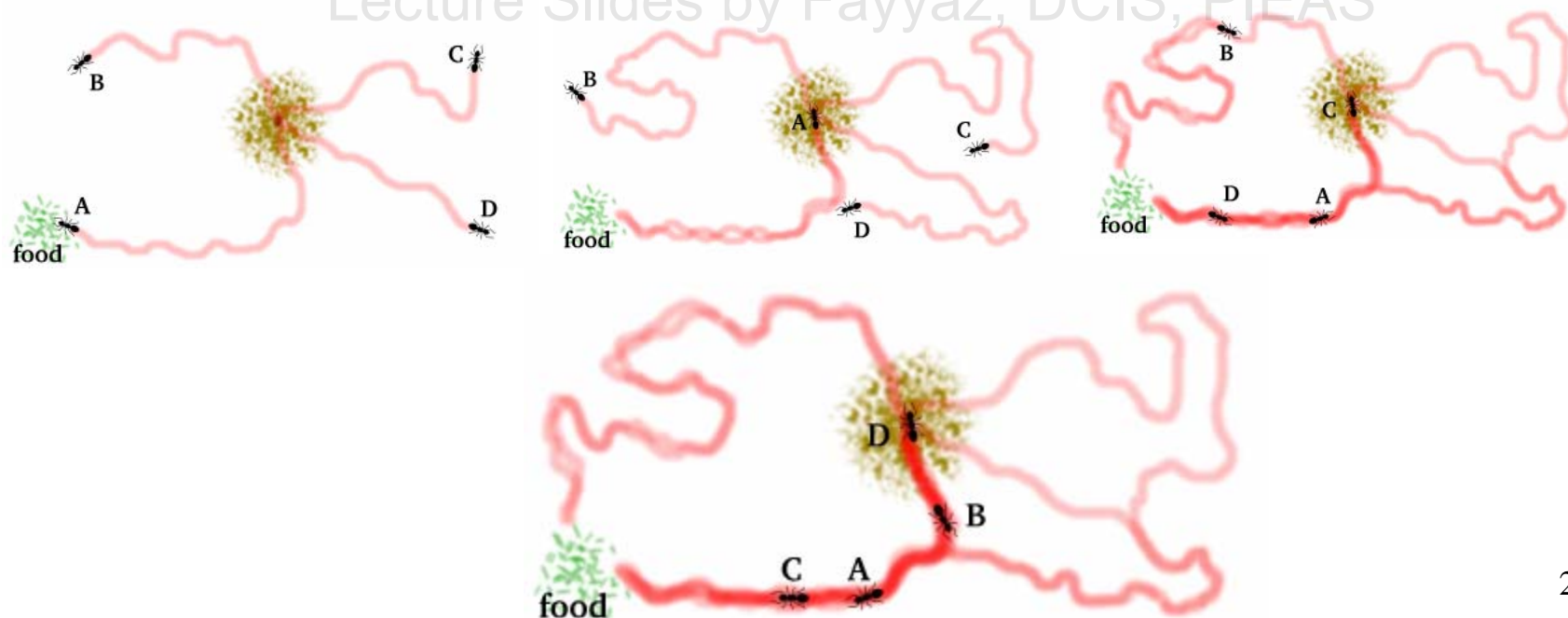


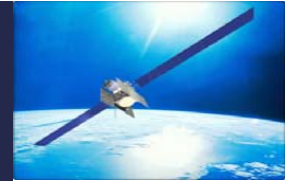
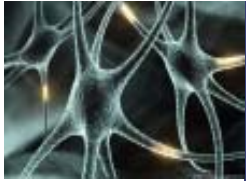
## Behavioral Inspirations

- **Swarm Intelligence**
  - Ant Colony Optimization
  - Particle Swarm Optimization



Lecture Slides by Fayyaz, DCIS, PIEAS





## Course Objectives

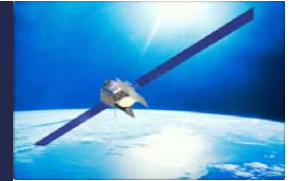
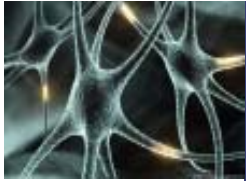
- **Focus Upon**

- Artificial Neural Networks
- Genetic Algorithms
- Genetic Programming
- Fuzzy Logic
- Neuro-Fuzzy Systems

- **Evaluation**

- Assignments
- Quizzes
- Tests
- Sessional





## End of Lecture-1

Lecture Slides by Fayyaz, DCIS, PIEAS

**"Great spirits have always found violent opposition from mediocrities. The latter cannot understand it when a man does not thoughtlessly submit to hereditary prejudices but honestly and courageously uses his intelligence."**

**(Albert Einstein)**