CS60020: Foundations of Algorithm Design and Machine Learning

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COURSE ORGANISATION

Resources

Teaching Assistants:

- Kiran Purohit
- Mainul Islam

- Website: http://cse.iitkgp.ac.in/~sourangshu/coursefiles/cs60020_22S.html

- Assignment submission / Test: CSE Moodle https://moodlecse.iitkgp.ac.in/moodle/login/index.php

Resources

Text Books:

- Introduction to Algorithms (Third Edition) Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein

- Pattern recognition and machine learning. Christopher M. Bishop springer, 2006.

- Latest Papers / Tutorials

Pre-requisites

- Basic Programming and Data Structures.
  - For C Programming: Book by Kernigham and Richie.
  - For Data Structures: Section 10.1 of book by Cormen et al.
- Mathematics: functions, matrix algebra, optimization.
  - Basic graduate level books
- Discrete Maths: Graphs, Trees, etc.
  - Introduction to Graph Theory by Douglas West
- Logical thinking and Hard work !!

Evaluation

- Grades:
  - Assignments: 40
  - Tests: 60

SYLLABUS AND LECTURE SCHEDULE

Algorithms

- An algorithm is an unambiguous specification of a sequence of steps to solve a problem.
- Important Aspects:
  - Application
  - Analysis
  - Design

- Example: Euclid's algorithm for finding the greatest common divisor.

Algorithms

- Example: Euclid's algorithm for finding the greatest common divisor.

```
EUCLID(a, b)
1  if b == 0
2        return a
3  else return EUCLID(b, a mod b)
```

$$\begin{aligned}
\text{EUCLID}(30, 21) &= \text{EUCLID}(21, 9) \\
&= \text{EUCLID}(9, 3) \\
&= \text{EUCLID}(3, 0) \\
&= 3 .
\end{aligned}$$

Algorithm Design

Week	**Algo topic**
28/3 - 31/3	Searching, BST
04/4 - 07/04	Balanced BST
11/4 - 14/4	Discussion / Test
18/4 - 21/4	Sorting, Insertion, Bubble, Selection sort
25/4 - 28/4	D&C - Mergesort
02/5 - 05/5	Quicksort
09/5 - 12/5	Heapsort, Priority queue
16/5 - 19/5	Midterm

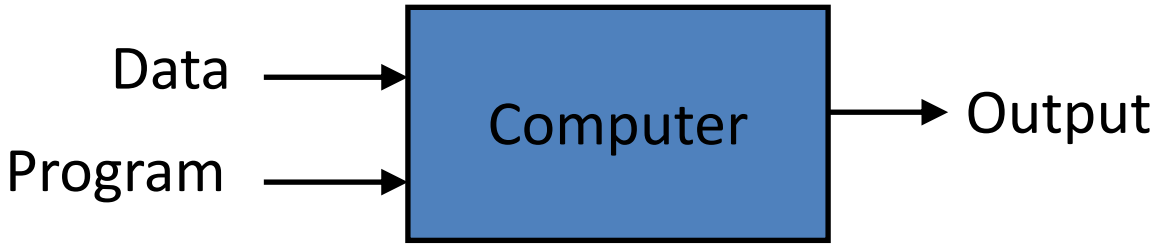
Algorithm Design

Week	**Algo topic**
23/5 - 26/5	Hashing
30/5 - 02/6	Graphs, MST
06/6 - 09/6	Dijkstra, Bellman-ford, Floyd -Warshal
13/6 - 16/6	Discussion
20/6 - 23/6	Endterm

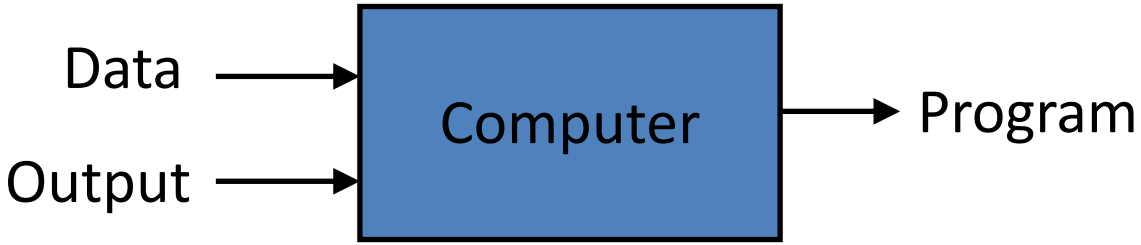
Machine Learning

- Machine learning is a field of computer science that gives computers the ability to learn [from data] without being explicitly programmed.
- Example: Bayesian classifier for automatically filtering email spams.
- Aspects:
  - Application
    Modeling
  - Inference and learning

Traditional Programming



Machine Learning



Magic?

No, more like gardening

- **Seeds** = Algorithms
- **Nutrients** = Data
- **Gardener** = You
- **Plants** = Programs

Sample Applications

- Web search
- Computational biology
- Finance
- E-commerce
- Space exploration
- Robotics
- Information extraction
- Social networks
- Debugging
- [Your favorite area]

Machine Learning

Week	**ML Topic**
28/3 - 31/3	Regression, Classification
04/4 - 07/04	Discussion / Test
11/4 - 14/4	Linear models, Overfitting, Regularization
18/4 - 21/4	Non-parametric, K-NN
25/4 - 28/4	Bagging / Boosting, Random Forests
02/5 - 05/5	Neural Network, SGD
09/5 - 12/5	RNN, CNN
16/5 - 19/5	Midterm

Machine Learning

Week	**ML Topic**
23/5 - 26/5	Discussion
30/5 - 02/6	SVM, Kernels
06/6 - 09/6	Basic Reinforcement Learning
13/6 - 16/6	Advanced topics
20/6 - 23/6	Endterm