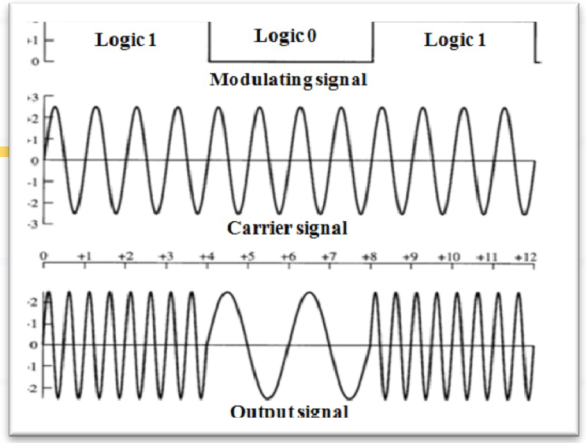
Introduction

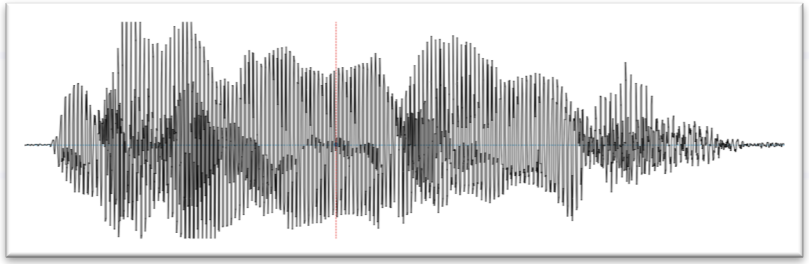
EE698V - Machine Learning for Signal Processing

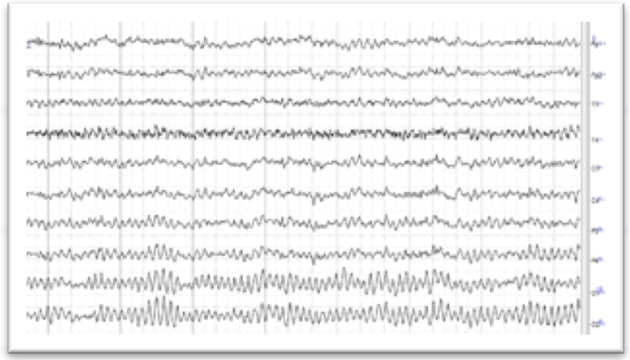
Vipul Arora

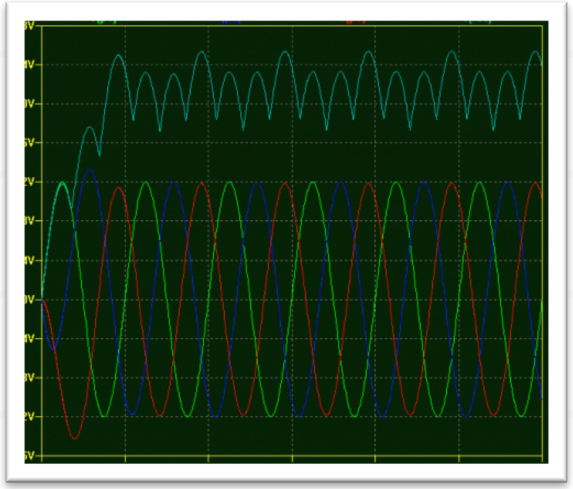
Signal Processing



- What are signals?
- A function or measurement that conveys information







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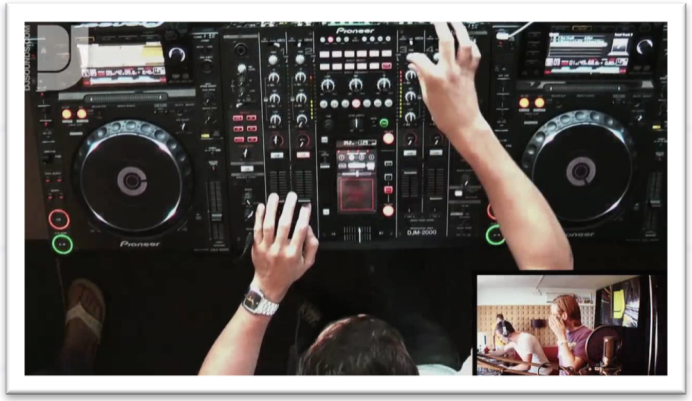
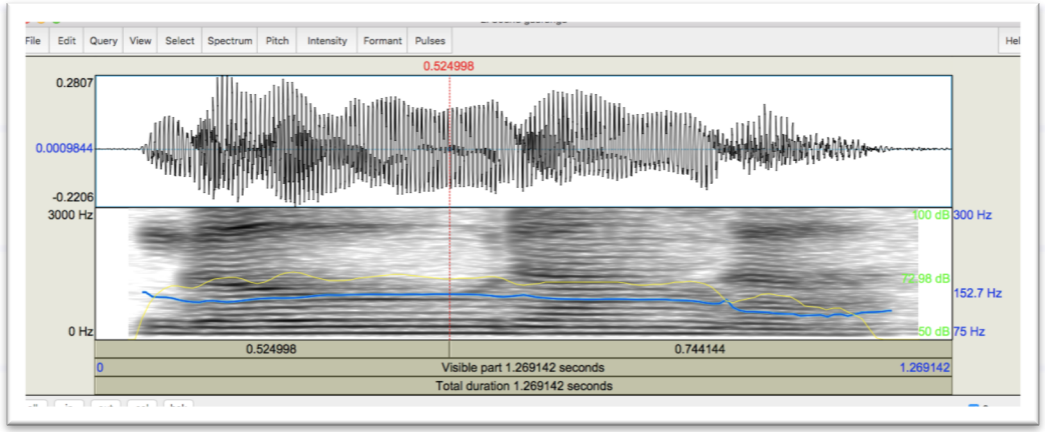
Signal Processing

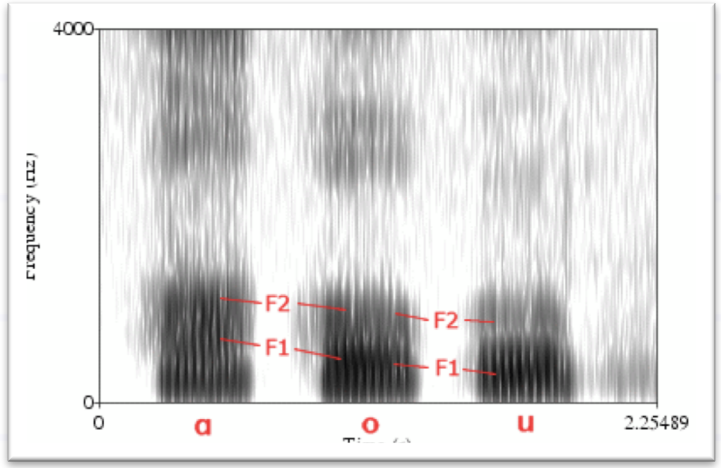
- What is signal processing?

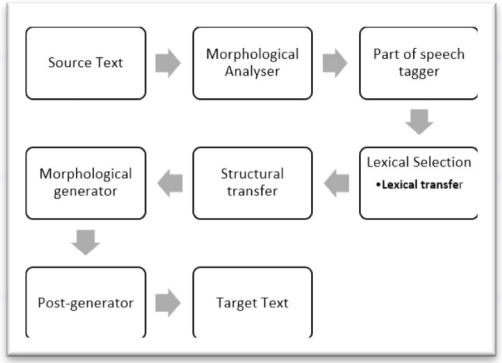




Signal Processing

- Speech recognition with linguistic rules
  - Ken Stevens' "Acoustic Phonetics"
- Image segmentation/recognition algorithms
- Machine translation of text

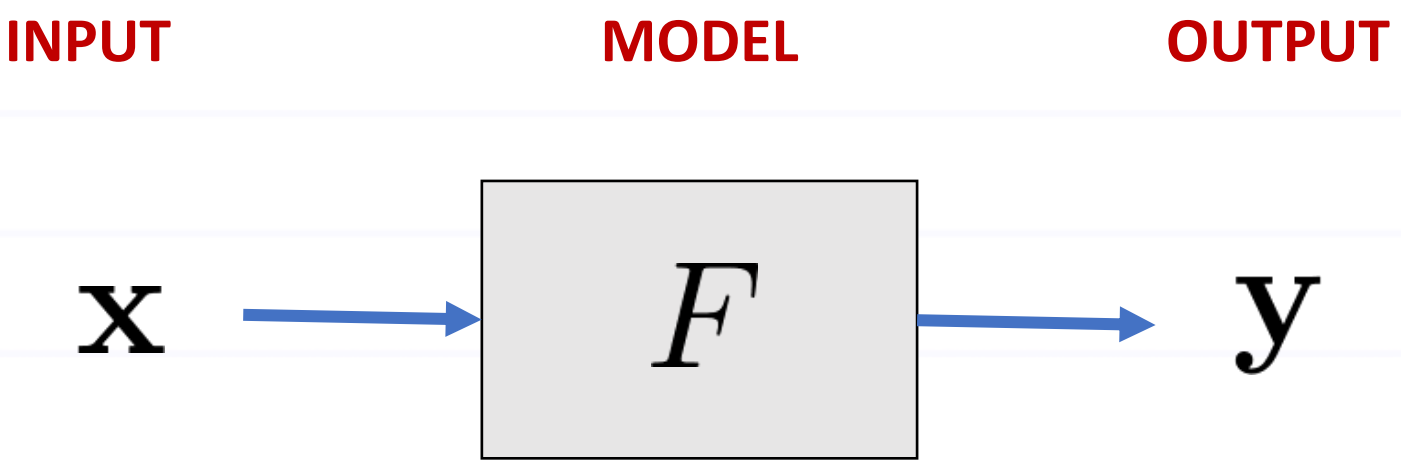




Machine Learning

- What is Machine Learning?
- Algorithms to make a computer do specific tasks
  - without hand-made explicit rules
  - but by learning from data

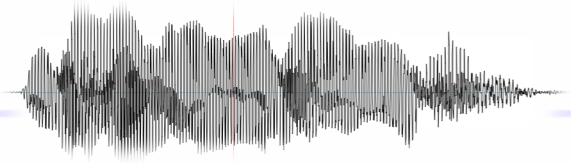
Machine Learning



A little girl sitting on a bed with a teddy bear.

A group of people sitting on a boat in the water.

Xu, K., Kiros, J. L. B. R., Courville, K. C. A., Salakhutdinov, R., Zemel, R. S., & Bengio, Y. (2015). Show, Attend and Tell: Neural Image Caption Generation with Visual Attention. In ICML. https://doi.org/10.1109/72.279181



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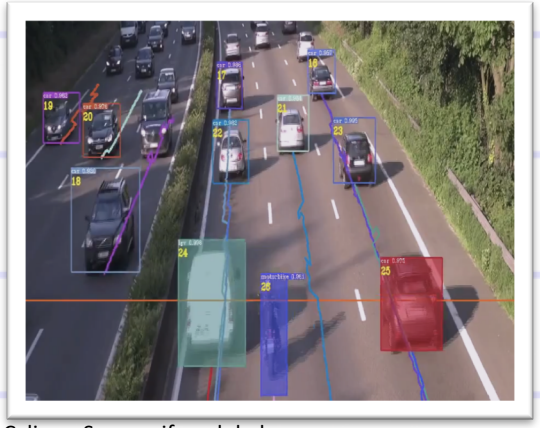
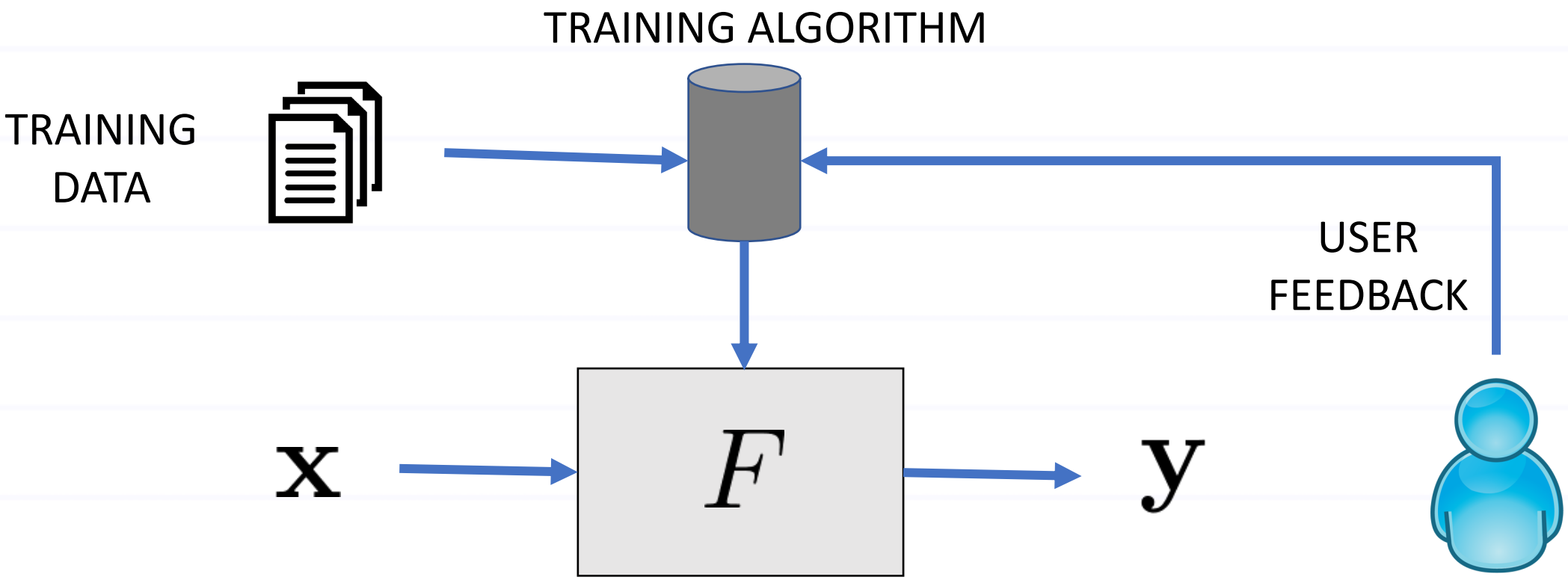
EEG Controlled Wheelchair



Calipsa. Source: ifsecglobal.com

Video Surveillance

Machine Learning



Machine Learning

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- Algorithms to make a computer do specific tasks
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    - Yes, feature engineering helps when small data
    - A lot of hand-tuning of learning algorithms needed
    - Data and computation costs
    - Black box? Many more problems for research …

Machine Learning for Signal Processing

- Signal processing is opaque to the tasks humans are interested in
- Machine learning is opaque to the structure in the signal

This course aims at bringing the two together…

Signal Processing	Machine Learning
Studies a wide variety of phenomena	A model is specific to a particular problem
Relies on lesser data	Needs huge amounts of data
Provides explanation, so easy to debug and correct	Mostly opaque to explanation, difficult to debug
Less accurate for tasks in the wild	High accuracy for tasks in the wild
Needs a lot of manual effort by experts	Needs less manual effort by experts
Large number of manually tunable parameters	Small number of manually tunable parameters

What we shall be studying

- Mathematical representation of data
- How to classify into categories
- How to predict continuous values
- How to classify time-series into sequence of categories
- How to extract low dimensional representations
- How to separate mixtures into their constituents
- Most importantly, how to evaluate a method

What we shall be studying

- Mathematical representation of data
  - Audio, Visual, text, time series
- Linear Models for Classification and Regression
- Probabilistic Models
- Neural Networks
- Hidden Markov Models
- Finite State Transducers
- PCA, NMF and embeddings

Some more interesting stuff

- Industry practices
- Data visualization
- Semi-supervised learning
- Transfer learning
- Zero/few shot learning
- Data augmentation
- Data collection and annotation
- Learning from imbalanced data
- Dealing with invariances

Course focuses more on

- **practical depth** than the theoretical width
- mastering simple ubiquitous **basics** than complicated niche jargon
- developing **intuitive understanding** than memorizing techniques

Reference books

- "Pattern Recognition and Machine Learning", C.M. Bishop, 2nd Edition, Springer, 2011.
  - https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf
- "Deep Learning", I. Goodfellow, Y, Bengio, A. Courville, MIT Press, 2016.
  - https://www.deeplearningbook.org/
- "Automatic Speech Recognition: A Deep Learning Approach", D. Yu and L. Deng, Springer, 2016.

LMS

- Microsoft Teams
  - Get a subscription of MS Office-365 from CC
  - This is paused until CC resumes its support
- We can use piazza instead
  - https://piazza.com/iitk.ac.in/firstsemester2019/ee698v/home

Platforms for Implementation

- Programming languages
  - Python (mostly)
  - Bash scripts
- Python Jupyter, either of these:
  - Install on your machine
  - Microsoft Azure Notebooks - https://notebooks.azure.com/
  - Google Colab - https://colab.research.google.com/

Grading

- Assignments/papers: 40%
- Quizzes: 10%
- Mid-sem: 20%
- End-sem: 30%

ZERO tolerance towards plagiarism, cheating,

or any other dishonest means

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Course Registration

- The course is over subscribed
- If you are planning to drop, please do it asap to allow other students to register

Last but not the least

- Feedbacks and suggestions are most welcome
- Bonus questions for the those who like to be challenged