Lecture Notes for

Machine Learning in Python

Professor Eric Larson

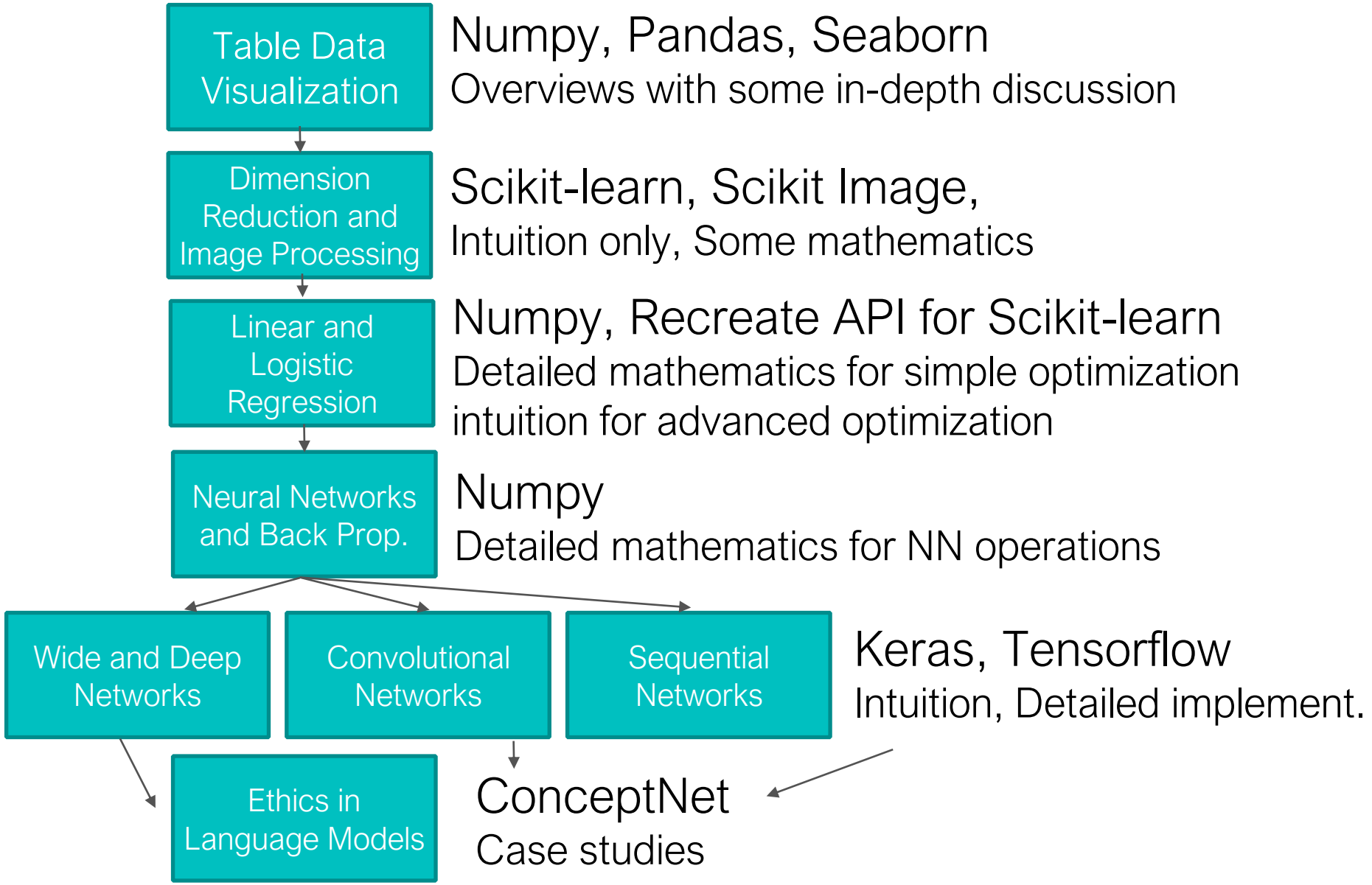
Introduction, Syllabus, Data Types

Class Logistics and Agenda

- Agenda:
  - Course Overview
  - Introduction
  - Syllabus
  - What is Machine Learning?
  - Types of Data

- My approach to this course:
  - Programming
  - Math
  - **Applications** and **Analytics**

Class Overview, by topic



Class Overview, by assignment

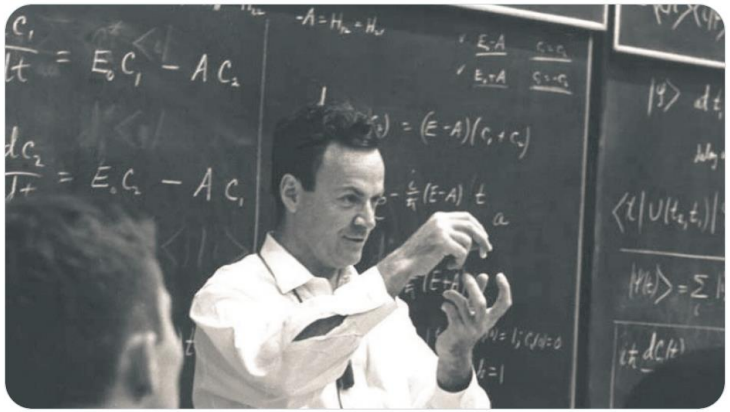
- **Lab One**: Visualize data and extract some features
- **Lab Two**: Analyze Images, Use dimensionality Reduction
- **Lab Three**: Program Logistic Regression in style of Sci-kit Learn
- **Lab Four**: Program NN Back propagation from Scratch, implement Adaptive Gradient Techniques
  - Use given dataset for this lab
- **Lab Five**: Wide and Deep networks
- **Lab Six**: Classify Images with Convolutional Networks
- **Lab Seven**: Classify Text with Sequential Networks

All Assignments posted on Canvas, with Rubric
Everything is a team assignment except quizzes, participation
You CANNOT makeup late quizzes, participation

Introductions & Course Syllabus

Richard Feynman @ProfFeynman · 12h

Don't just teach your students to read.
• Teach them to question what they read, what they study.
• Teach them to doubt.
• Teach them to think.
• Teach them to make mistakes and learn from them.
• Teach them how to understand something.
• Teach them how to teach others.



Richard Feynman @ProfFeynman · 21h

You cannot get educated by this self-propagating system in which people study to pass exams, and teach others to pass exams, but nobody knows anything.

You learn something by doing it yourself, by asking questions, by thinking, and by experimenting. 🧠

Introductions

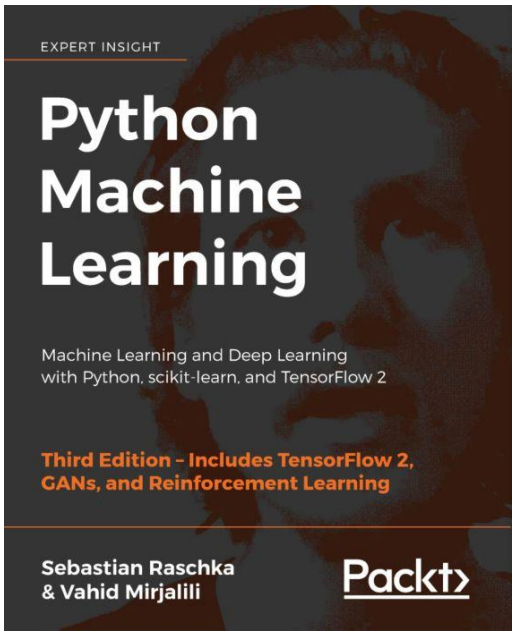
- Me
  - Dr. Labiba 👍
  - Prof. Labiba 👍
  - Labiba 👍

- You
  - Name Department
  - Grad/Undergrad
  - Something true or false

Limited Introduction because of Class Size

FAQ

- Text:
  - **Recommended**: Python Machine Learning, Raschka & Mirjalili, Third Edition
- Use Canvas for posted course material
- Prerequisites:
  - Linear algebra & calculus (multivariate)
  - Basic statistics and probability
  - Basic OO programming, some python
- Version of **python: 3.X**
  - Install through **Anaconda** and pip
  - Use **conda** environments
  - JupyterLab (or **notebook**)
- Most Used Libraries: Numpy, Pandas, Scikit-Learn, Matplotlib, Seaborn, Tensorflow
- Use OIT Data Science Workshops



Canvas Syllabus

- Lab Assignments
- Flipped Assignments
- Grading Rubrics
- Participation
- Course Schedule
- Difference between 5000 and 7000

How will participation be graded?

- Participation will be graded in the course:
  - **Distance students** will answer these questions via **canvas upload**
  - upload “over” the last submission
    - must upload the questions each week for full credit

- In Class Students:
  - Live question answering (mostly attendance)

Is this plagiarism in this class?

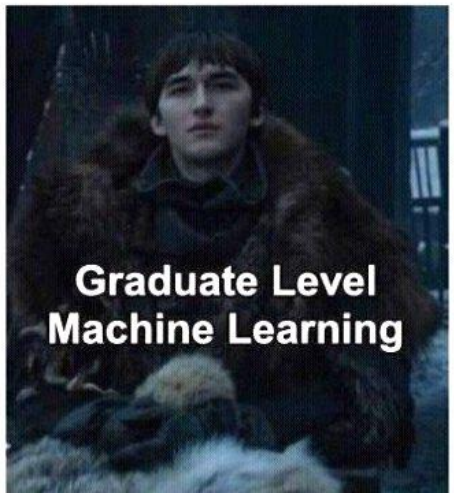
- Copying code/text from another source without citing it
  - A. Yes, plagiarism!
  - B. No, its fine!
- Copying code/text from another source, citing at the end of the assignment in a blanket statement (but not making it clear which part of the assignment was from another source)?
  - A. Yes, plagiarism!
  - B. No, its fine!
- Copying code, citing the source directly next to the code, and commenting on what parts were changed?
  - A. Yes, plagiarism!
  - B. No, its fine!
- Copying text directly and citing the source with the text, but not placing the text in quotes.
  - A. Yes, plagiarism!
  - B. No, its fine!

Is this plagiarism in this class?

- Using ChatGPT or other LLM that generates text/code/responses?
  - A. Yes, plagiarism!
  - B. No, its fine!
  - C. It might be okay, but students should:
    1) acknowledge when using it,
    2) add comments to code used to indicate our knowledge of the subject matter,
    3) check the accuracy and reliability of the output,
    4) do not use text word for word, only as an outline or exemplar of a possible answer

Don't use a LLM at the detriment of your own understanding. Don't use a LLM because your are unsure of your own understanding

Machine Learning Overview



What is Machine Learning?

Machine learning is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. **Machine learning** focuses on the development of computer programs that can change when exposed to new data.

What is machine learning? - Definition from WhatIs.com
whatis.techtarget.com/**definition/machine-learning**

About this result • Feedback

- **Beware of this definition**:
  - full of imprecise, loaded words:
    - intelligence, learning
  - ignores social structures, ethics, deployment, and that all results are interpreted by a human
- **My definition**: a way to optimize model parameters for recognizing complex patterns in data

Machine Learning

Data Mining

ML

- Prediction Methods
  - Use some variables to predict unknown or future values of other variables
- Description Methods
  - Find human-interpretable patterns that describe the data.

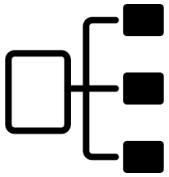
ML

- Classification
- Regression
- Deviation Detection
- Clustering
- Association Rule Discovery
- Sequential Pattern Discovery

section 1, manipulated from Tan et al. Introduction to Data Mining

Problem Types in Machine Learning

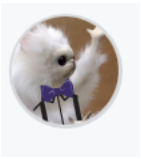
- Inputs
- Outputs



Categories

1.23
-0.4
...

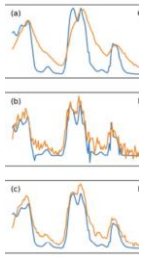
Numeric Data



Images

This is a repository for m
experience in Python an
purpose.

Free Text



Times Series

classification

regression

image generation

text generation

auto encoding

Categories

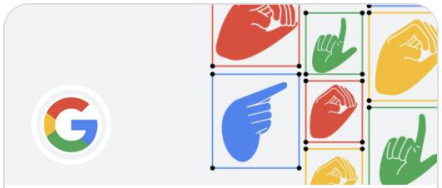
Numeric Data

Images

Free Text

Time Series

Problem Types in Machine Learning



Google - American Sign Language Fingerspelling...

Train fast and accurate American Sign...

Research · Code Competition

1269 Teams

$200,000 3 days to go

CommonLit - Evaluate Student Summaries

Automatically assess summaries writt...

Featured · Code Competition

925 Teams

$60,000 2 months to go

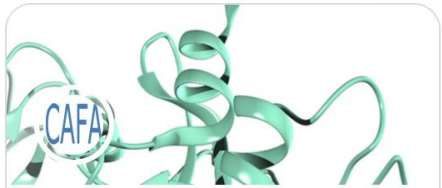
Bengali.AI Speech Recognition

Recognize Bengali speech from out-of...

Research · Code Competition

317 Teams

$53,000 2 months to go



CAFA 5 Protein Function Prediction

Predict the biological function of a pro...

Research · Code Competition

1655 Teams

$50,000 10 hours to go

Kaggle - LLM Science Exam

Use LLMs to answer difficult science ...

Featured · Code Competition

1471 Teams

$50,000 2 months to go

RSNA 2023 Abdominal Trauma Detection

Detect and classify traumatic abdomi...

Featured · Code Competition

333 Teams

$50,000 2 months to go

Predict CO2 Emissions in Rwanda

Playground Series - Season 3, Episod...

Playground

1401 Teams

Swag 10 hours to go

Titanic - Machine Learning from Disaster

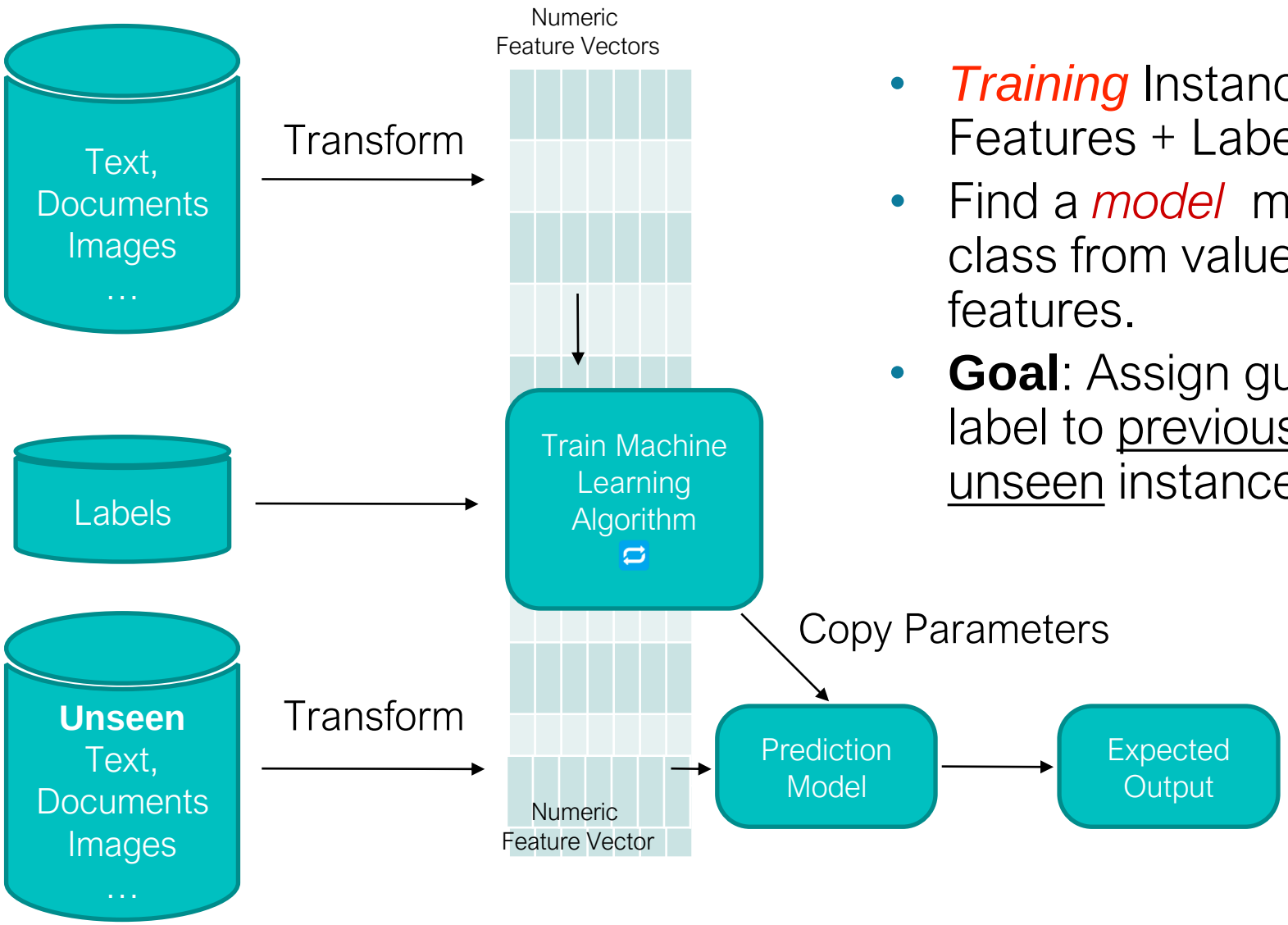
Start here! Predict survival on the Tita...

Getting Started

14897 Teams

Knowledge Ongoing

Classification and Regression, Supervised



- *Training* Instances: Features + Labels
- Find a *model* mapping class from values of features.
- **Goal**: Assign guessed label to previously unseen instances

Some Popular Datasets

ImageNet

1M+

224 x 224 Color Image

⬇

1000 Classes
(prominent object)

MNIST

60k

24 x 24 Grey Image

⬇

10 Classes (digits)

Adult

# feature	original feature
1	age
2	workclass
3	final weight
4	education
5	ed_num
6	marital_status
7	occupation
8	relationship
9	race
10	sex
11	capital_gain
12	capital_loss
13	hours × week
14	country

5k

Census Demographics

⬇

Binary (salary > 50k?)

CoCo

200k Images

Large, Multi-sized Images

⬇

Location, Size, 80 Objects

Boston Housing

```
1. CRIM
2. ZN

3. INDUS
4. CHAS

5. NOX
6. RM
7. AGE
8. DIS
9. RAD
10. TAX
11. PTRATIO
12. B

13. LSTAT
14. MEDV
```

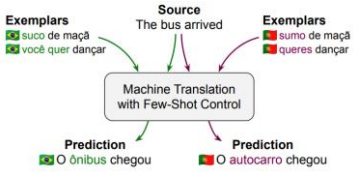
House/Neighborhood Descriptions

⬇

House Price
$$

500 Examples

Translation



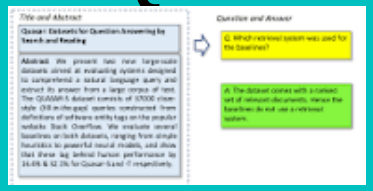
Language A

⬇

Language B

Many datasets

SQuAD



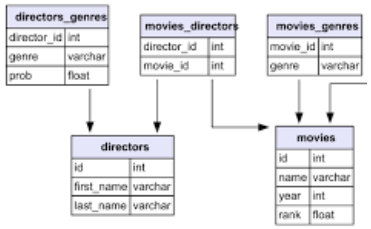
Question

⬇

Answer

100k+

Imdb



Movie/Actors/Director/+

⬇

Critic/Audience rating

50k reviews

Self Test

- **A. Classification**
  B. Regression
  C. Not Machine Learning
- **D. Machine Learning Generation**

- Dividing up customers by potential profitability?

- Extracting frequency of sound?