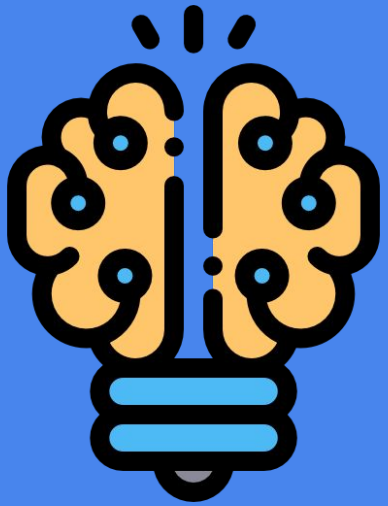
Getting Started with Machine Learning

Session 1: What is Machine Learning?

An Initiative by **Al Bayt Mitwahid** in UAE
Innovation Hub
powered by Google

Session Outline

1. What is Machine Learning (ML)?
2. What is the difference between ML and traditional programming?
3. What challenges can ML be applied to?

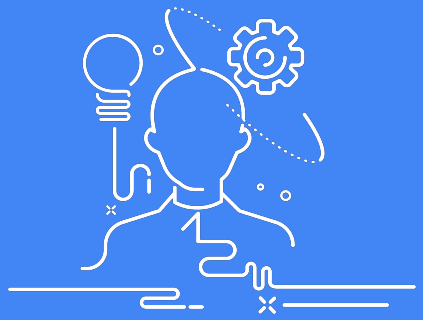


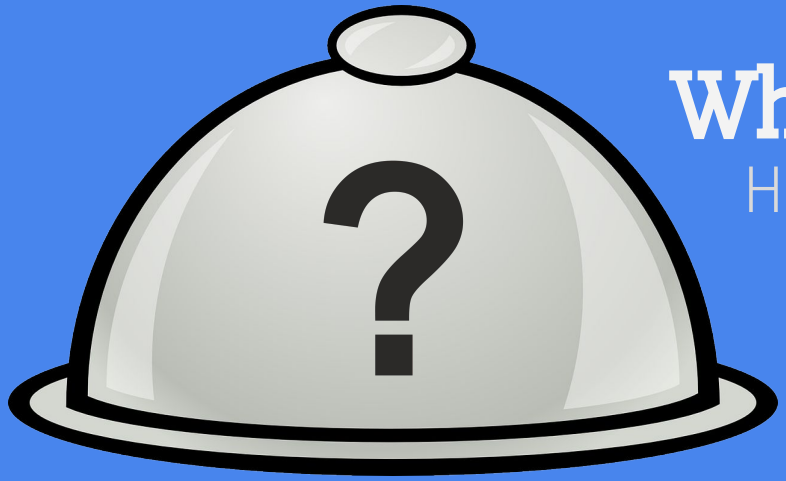
Brainstorm

List the ways you use a computer* each day.

* Laptop, phone, tablet, etc.

Traditional Programming vs. Machine Learning





What food am I thinking of?

How many questions would you need?

What object am I thinking of?

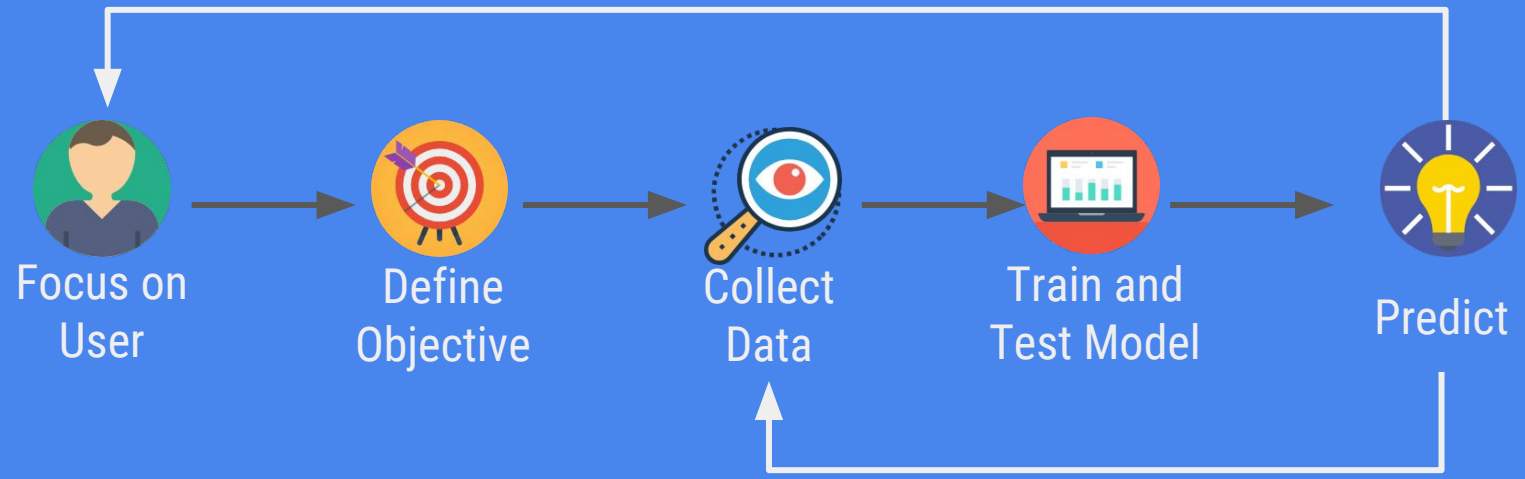
How many questions would you need?

Traditional Programming

```
if object.height > 10:
  do x
if object.color is blue:
  do y
if object.numberOfLegs > 2:
  do z
...
```

System only does what it was programmed to do

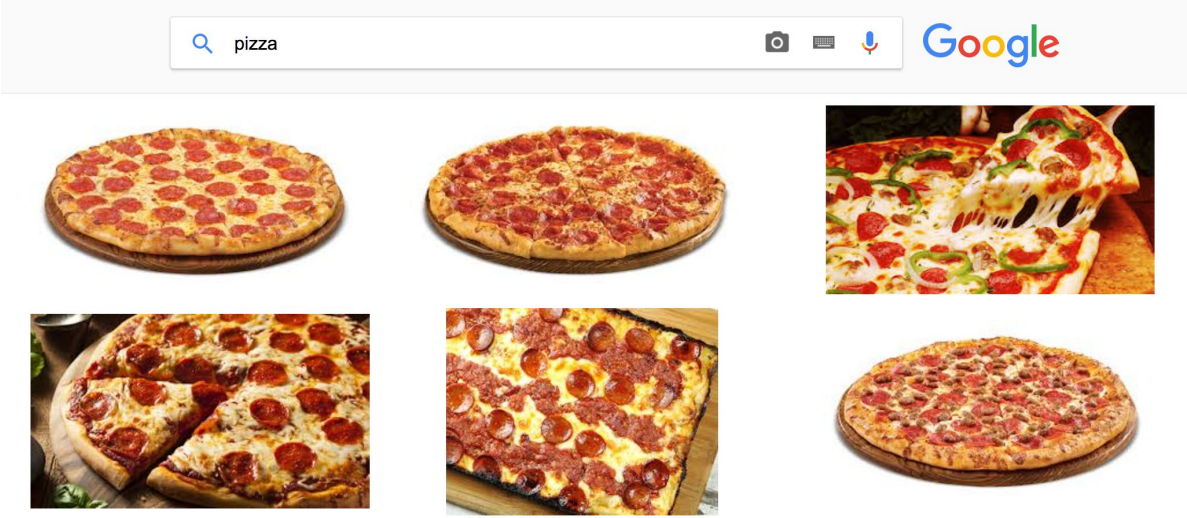
Machine Learning



System learns patterns from data

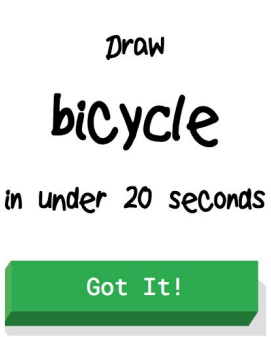
Example: Image Search

Google Image Search



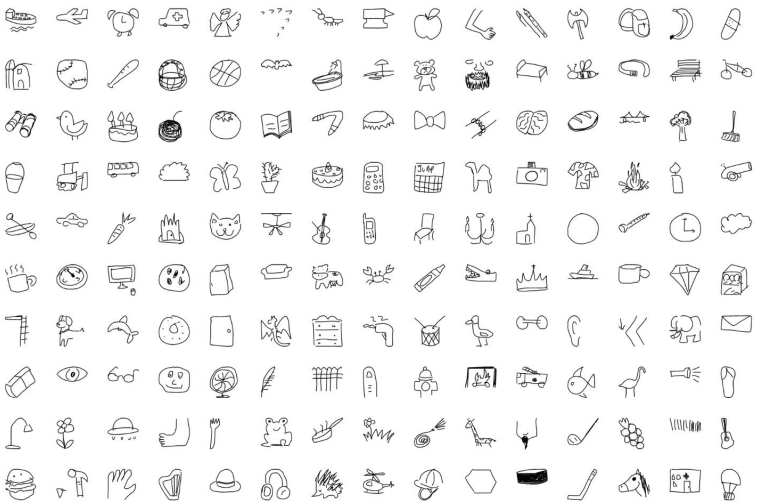
Example: Drawing

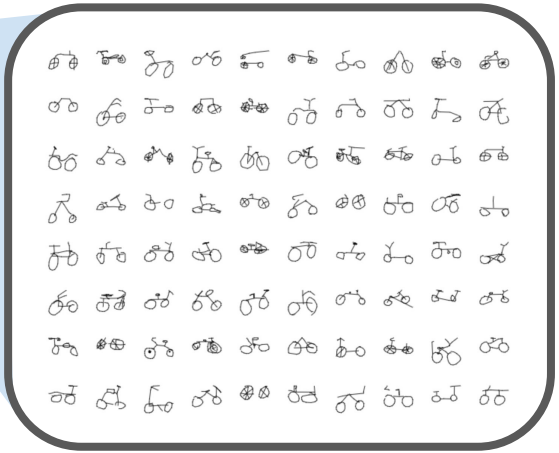
Quick Draw with Google



Example: Drawing (Data)

Quick Draw with Google Data

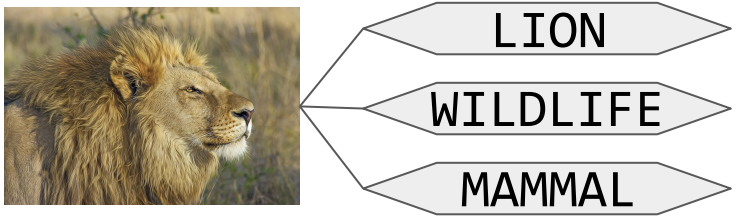




122,500 bicycle drawings

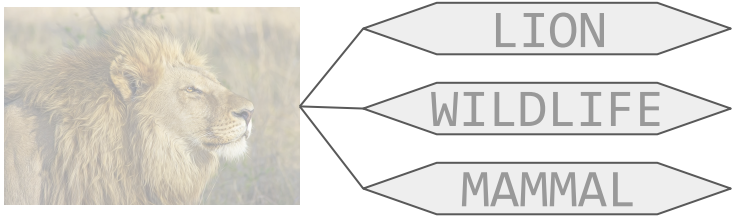
What Can Machine Learning Do?

Classify

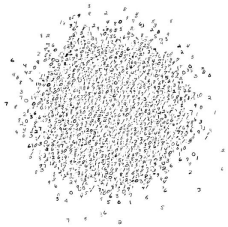


What Can Machine Learning Do?

Classify

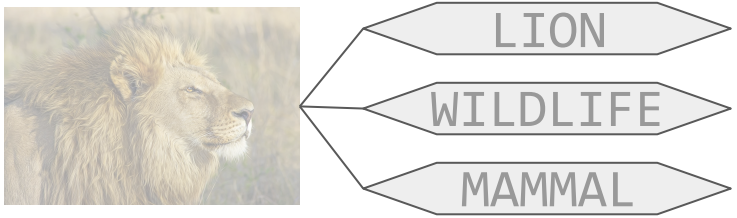


Cluster

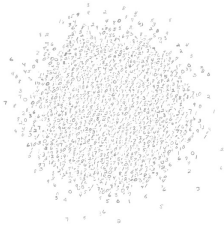


What Can Machine Learning Do?

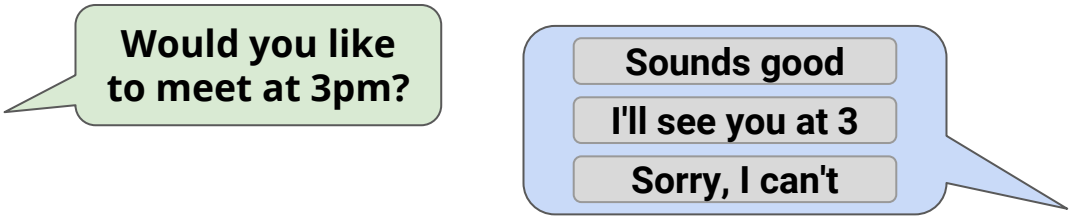
Classify



Cluster



Recommend



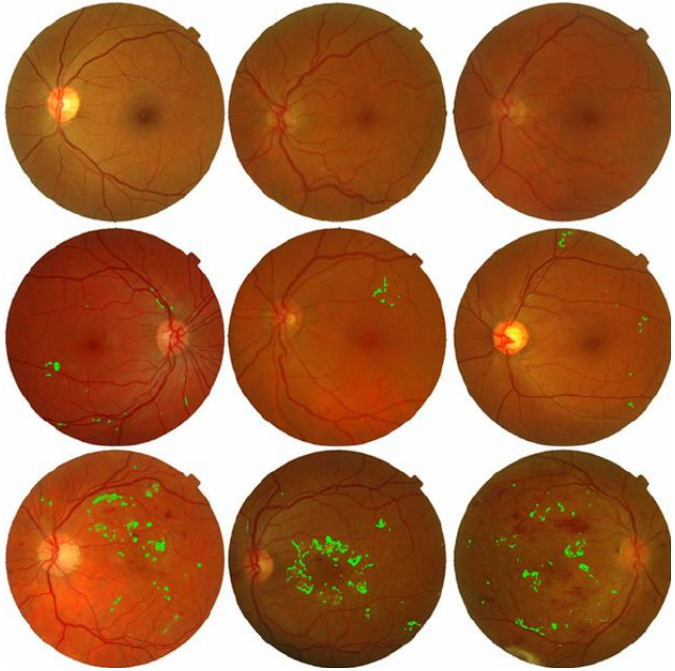
Example: YouTube

1

2

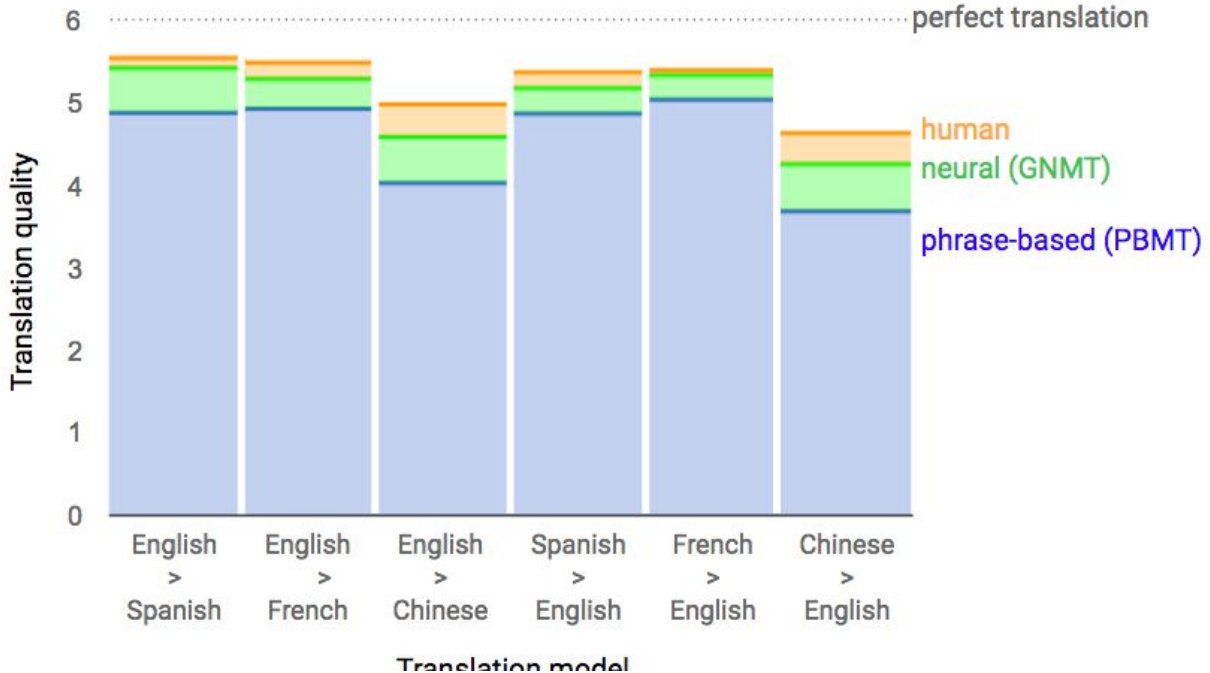
3

Example: Vision Loss from Retina Images

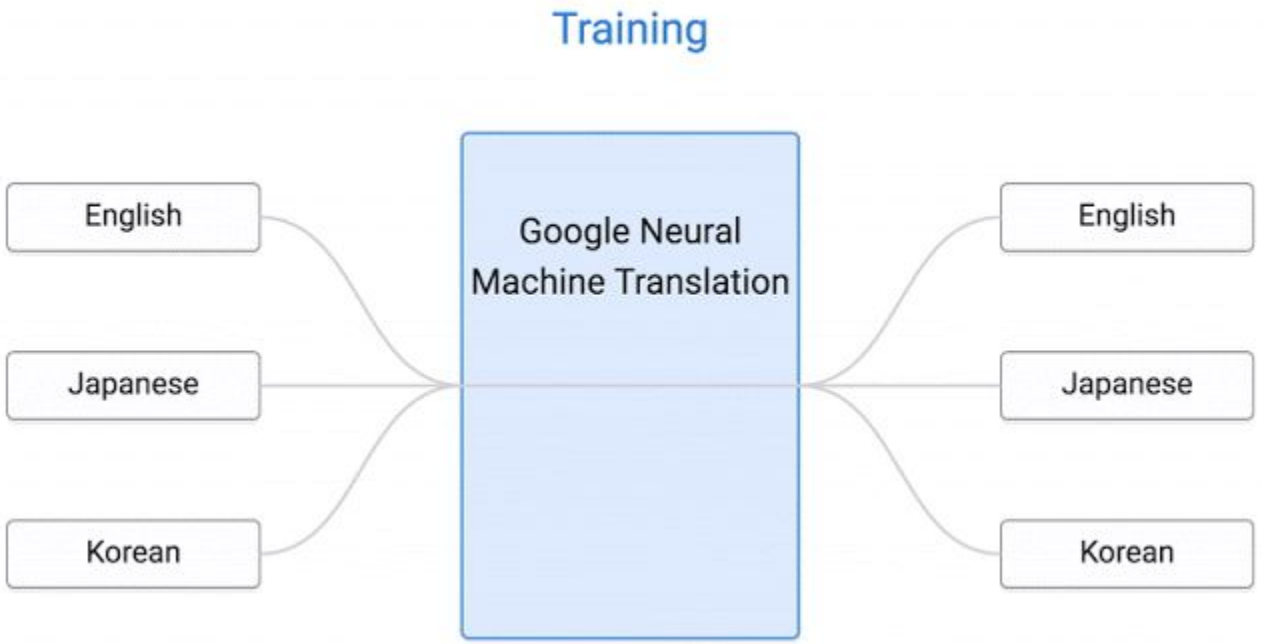


Example: Google Translate (previous version)

Example: Google Translate (deep neural network)

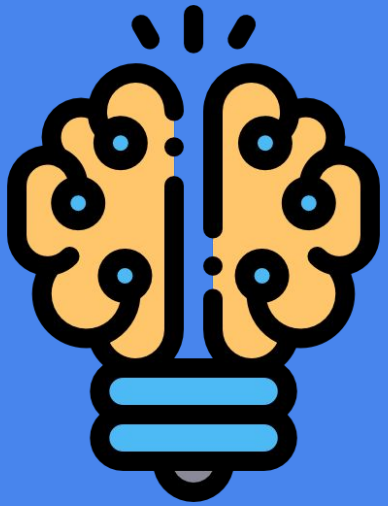


Example: Google Translate (zero-shot translation)



When to use ML?

Alphabetizing a list of song titles	Not ML
Ranking web search results	Both
Predicting housing prices from location data	ML
Processing online payments	Not ML
Recognizing an object in an image	ML
Creating a computer player for an Xs Os game.	Not ML
Creating a computer player for a chess game.	Both



Brainstorm

How could machine learning be applied to the ways you use a computer* each day?

* Laptop, phone, tablet, etc.

Each has its benefits

Traditional Programming

Explicit instructions from programmer

Improvements come from better algorithms

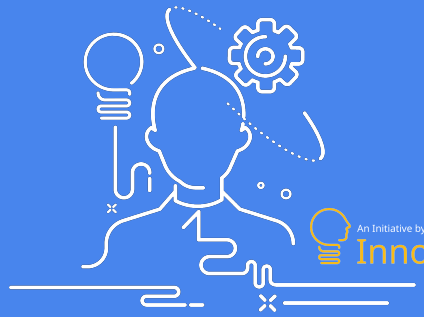
Machine Learning

System learns patterns from data

Improvements may also come from additional data

Getting Started with Machine Learning

Session 2: Using Machine Learning



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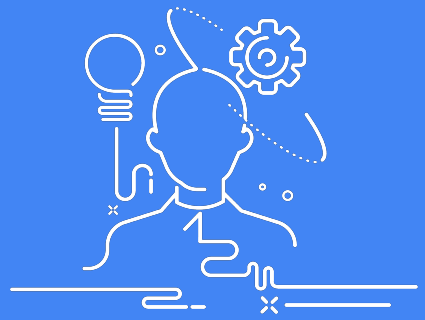
Learning Objectives

By the end of this session, you will be able to:

1. Explain how Google's CloudML platform can be used to create different ML applications.

2. Design and implement a simple app that uses Google's Cloud APIs.

Introduction to Machine Learning APIs



Review: What can ML be used for?

In the last session, we classified Machine Learning applications into 3 different categories.

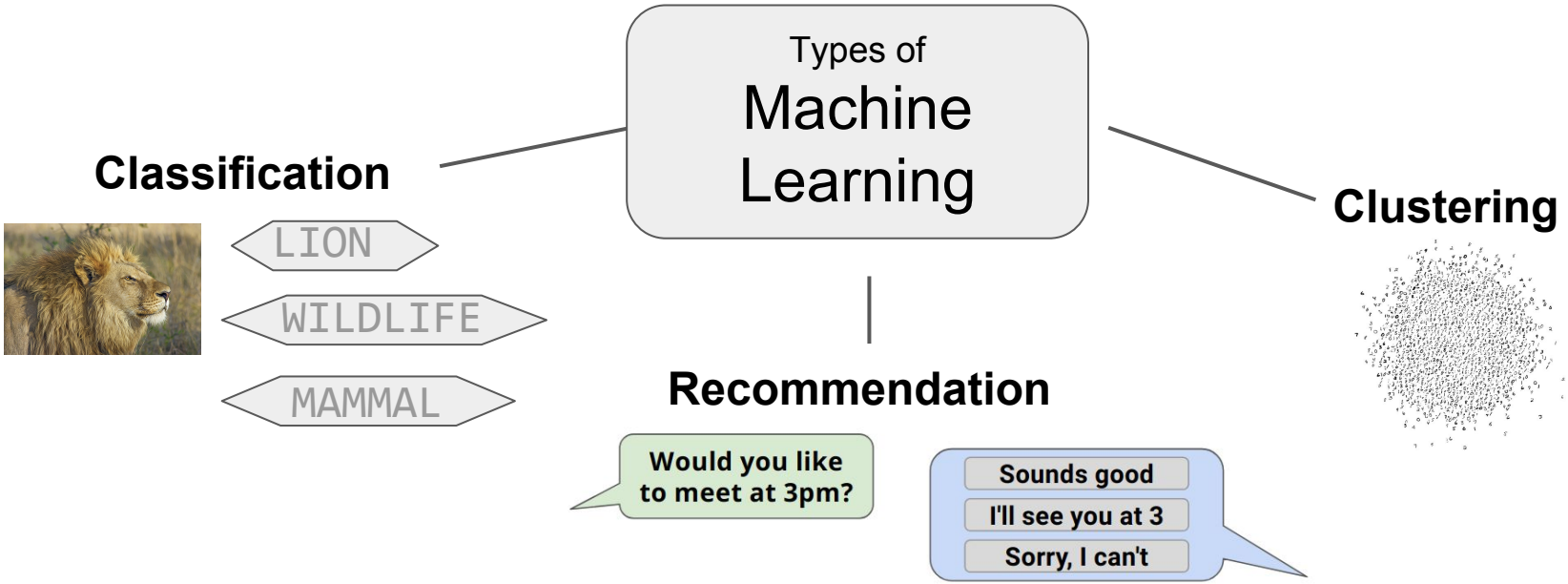
Can you remember what these categories were?

Classification

Clustering

Recommendation

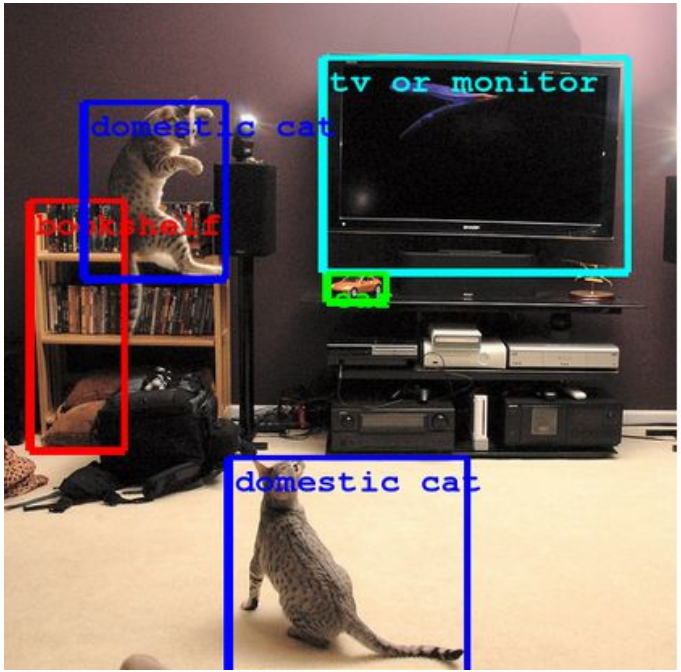
Review: What can ML be used for?

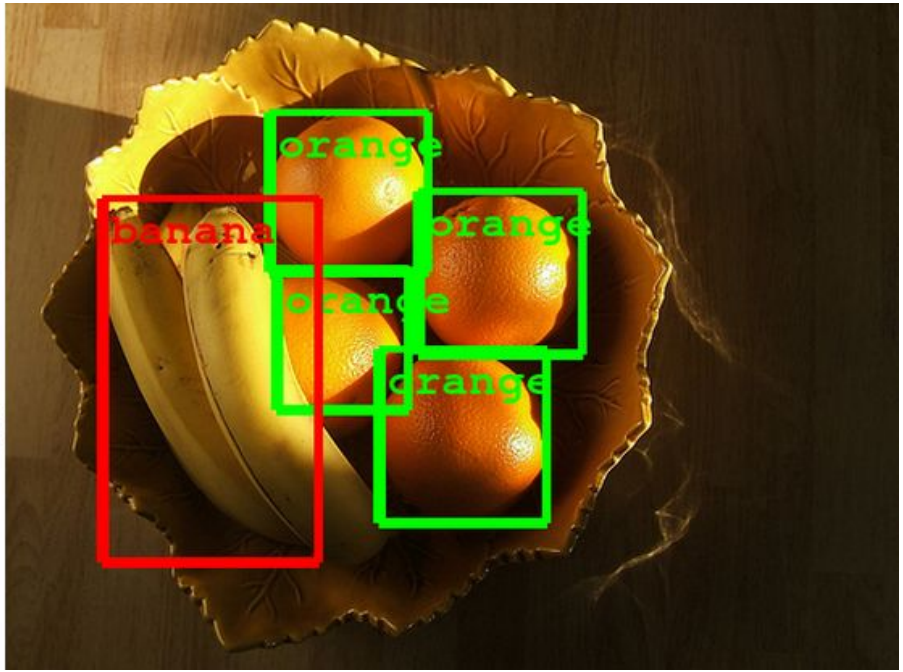


How many examples of Machine Learning can you brainstorm?

Image Recognition

Used to detect individual features / components of an image.

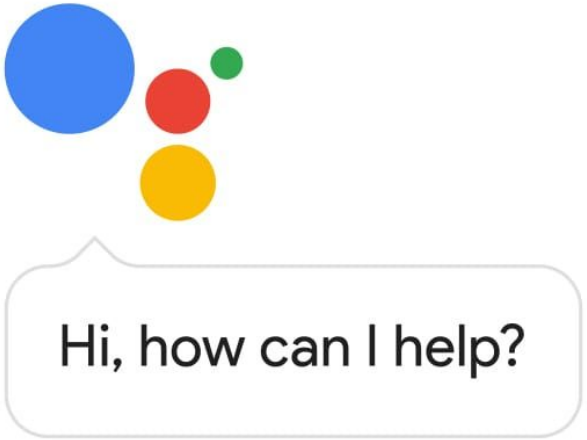




Space Recognition

Translating spoken word to text (Transcribing)

Language detection



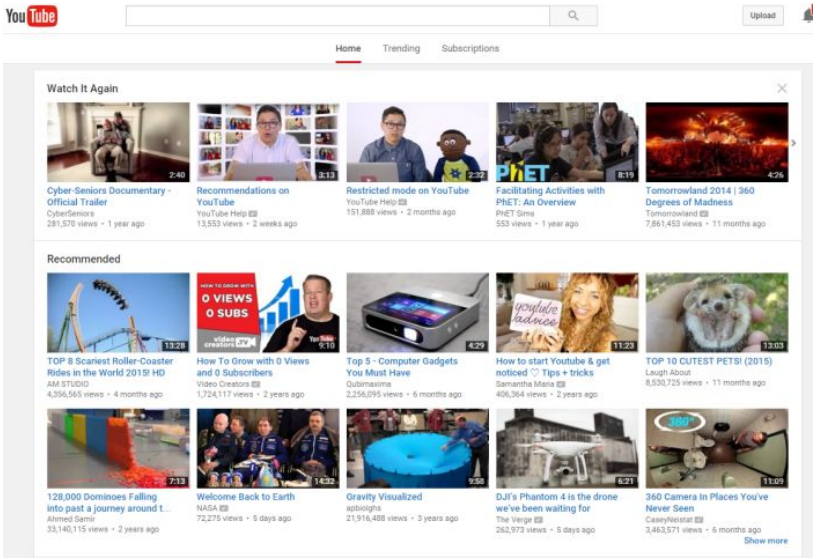
Natural Language Understanding (NLU)

Being able to understand and respond to language.

Personalized Recommendations

YouTube recommendations.

Learning and predicting what a user might like.



What is a **function**, in programming terms?

Functions in Programming

A **function** is a block of code which you can use just by knowing its name.

You don't

Function

You can us
JavaScript
code that
rounding.

```
Math.round(3.18)
```

o control a
the code

```
camera.start_preview()
sleep(5)
camera.capture('/home/pi/Desktop/image.jpg')
camera.stop_preview()
```

How many other functions can you think of?

Functions in Programming

A **function** is a block of code which you can use just by knowing its name.

You don't need to know how it works!

How is ordering a meal like using a function?

Functions in Programming

A **function** is a block of code which you can use just by knowing its name.

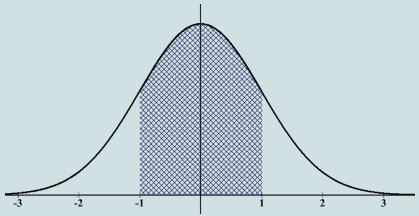
I'll have the "tomato and coconut cassoulet," please

Coming up!

You can get the result you want just by knowing the right name - you don't have to understand how it is created!

Application Programming Interfaces

An Application Programming Interface, or **API**, is a **collection of functions** which are used to access features written by someone else.

An API with functions for encrypting and decrypting data 	An API for doing statistical calculations 
An API for easily reading and writing files 	An API for Machine Learning 

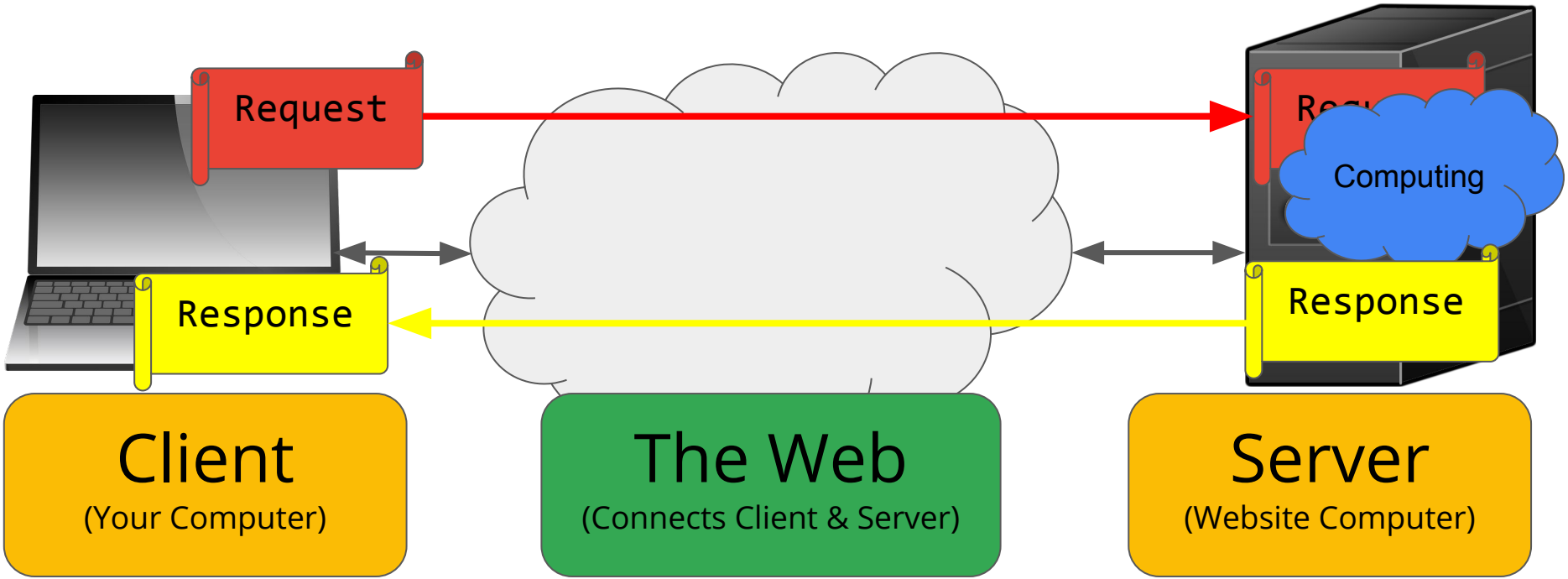
Application Programming Interfaces

An Application Programming Interface, or **API**, is a **collection of functions** which are used to access features written by someone else.

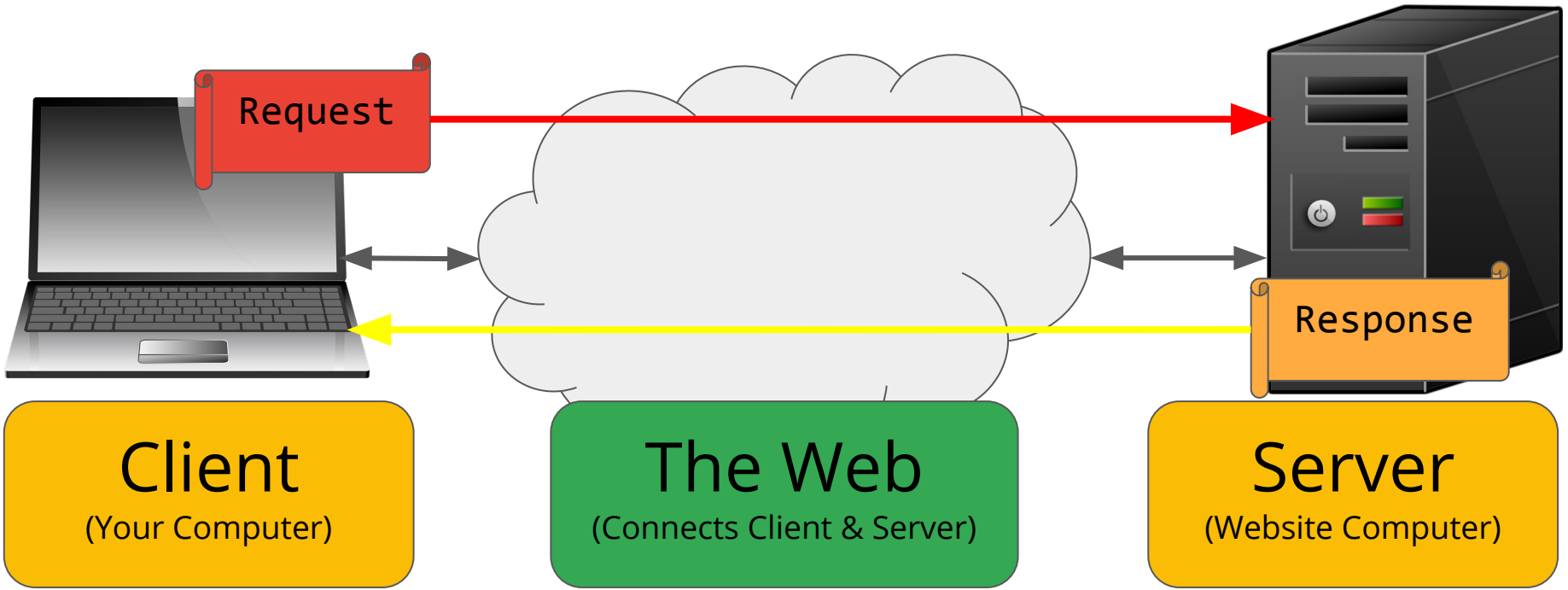
How is a restaurant menu like an API?

What is Web API?

What is Web API?

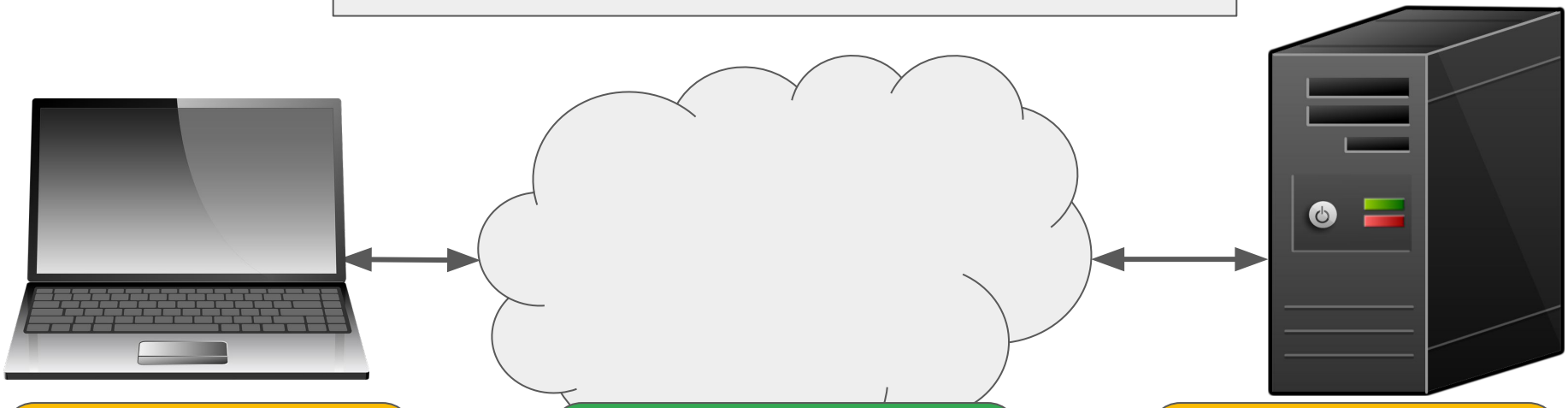


What is Web API?



Flight Booking API

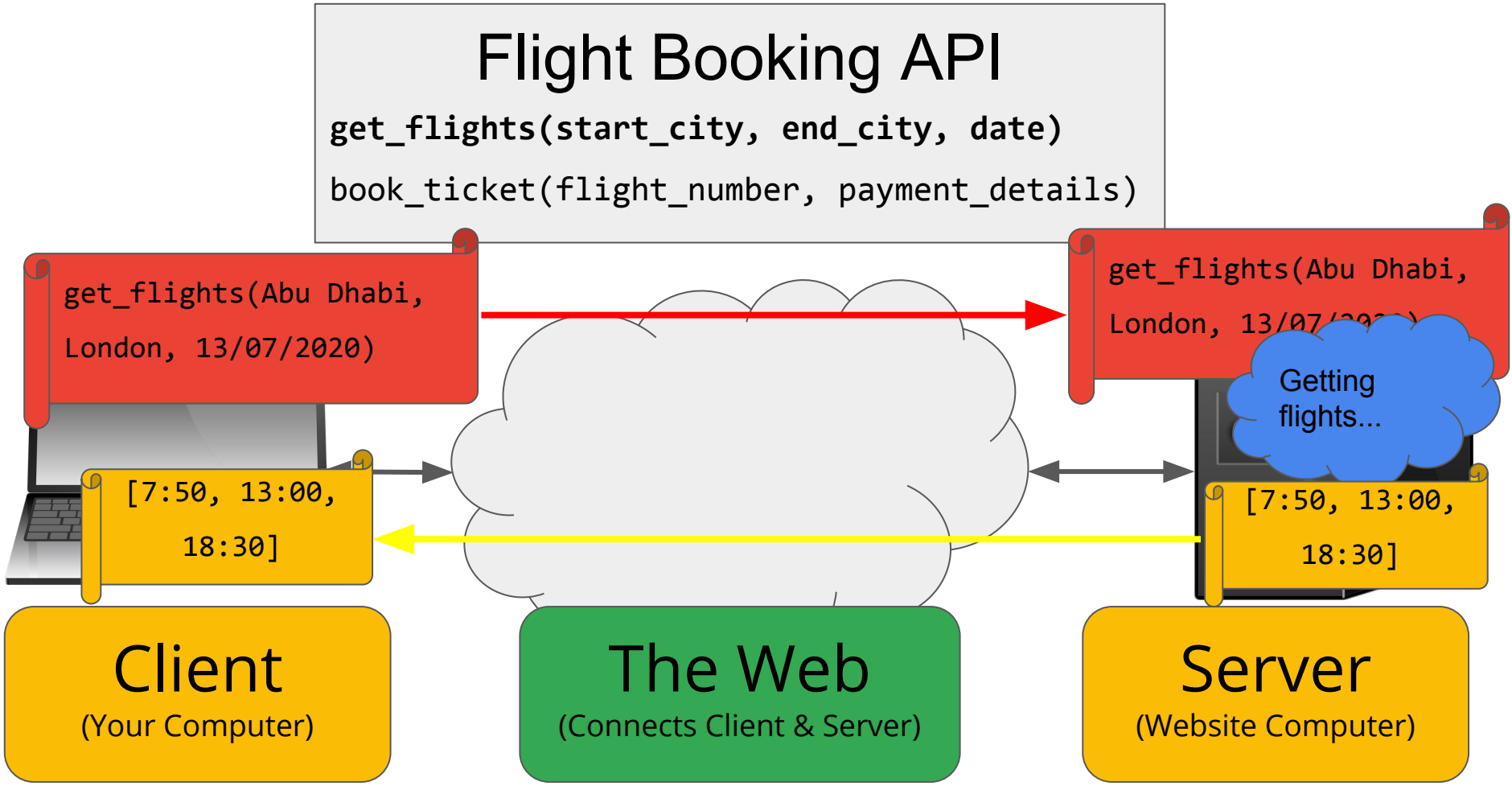
```
get_flights(start_city, end_city, date)
book_ticket(flight_number, payment_details)
```



Client
(Your Computer)

The Web
(Connects Client & Server)

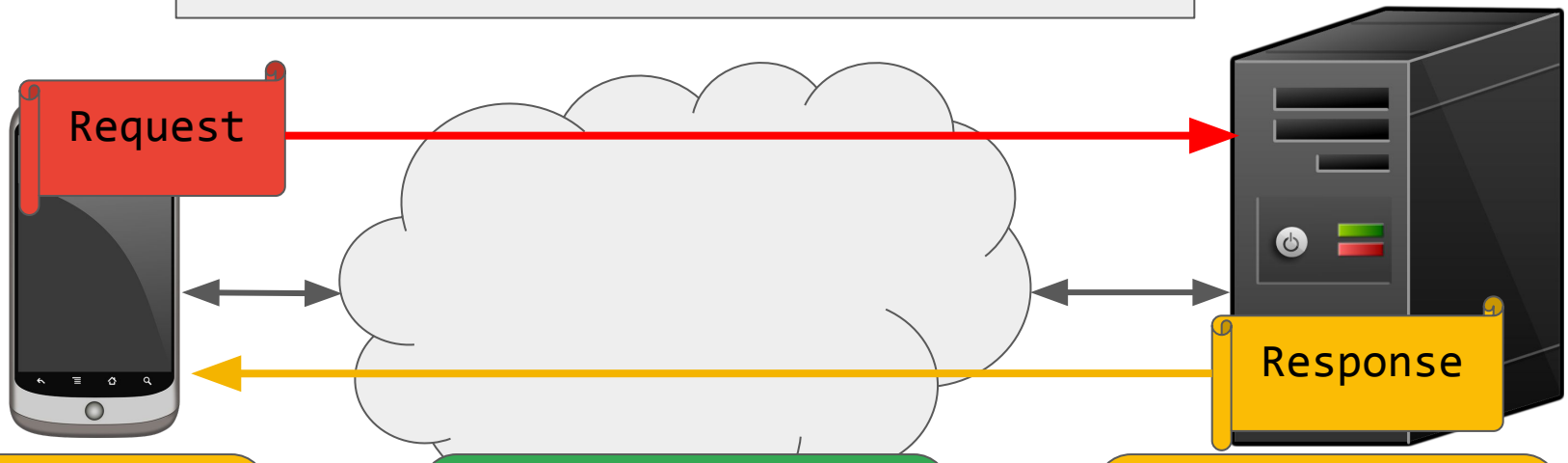
Server
(Website Computer)


Flight Booking API
get_flights(start_city, end_city, date)
book_ticket(flight_number, payment_details)
get_flights(Abu Dhabi, London, 13/07/2020)
get_flights(Abu Dhabi,
Getting flights...
[7:50, 13:00, 18:30]
[7:50, 13:00, 18:30]
Client
(Your Computer)
The Web
(Connects Client & Server)
Server
(Website Computer)

Jump to Quiz

Flight Booking API

```
get_flights(start_city, end_city, date)
book_ticket(flight_number, payment_details)
```



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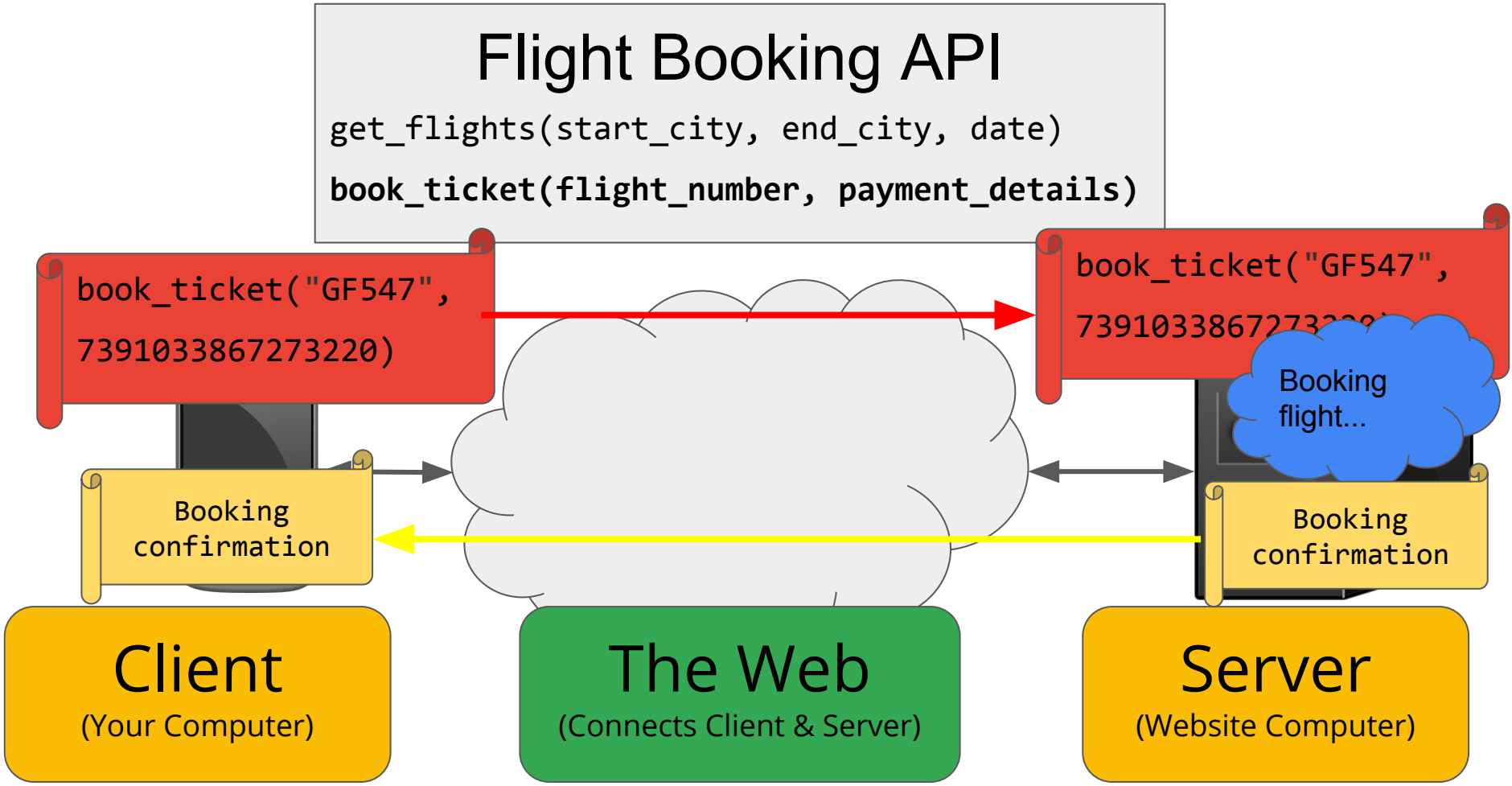
Flight Booking API
get_flights(start_city, end_city, date)
book_ticket(flight_number, payment_details)
book_ticket("GF547",
7391033867273220)
book_ticket("GF547",
Booking
flight...
Booking
confirmation
Booking
confirmation
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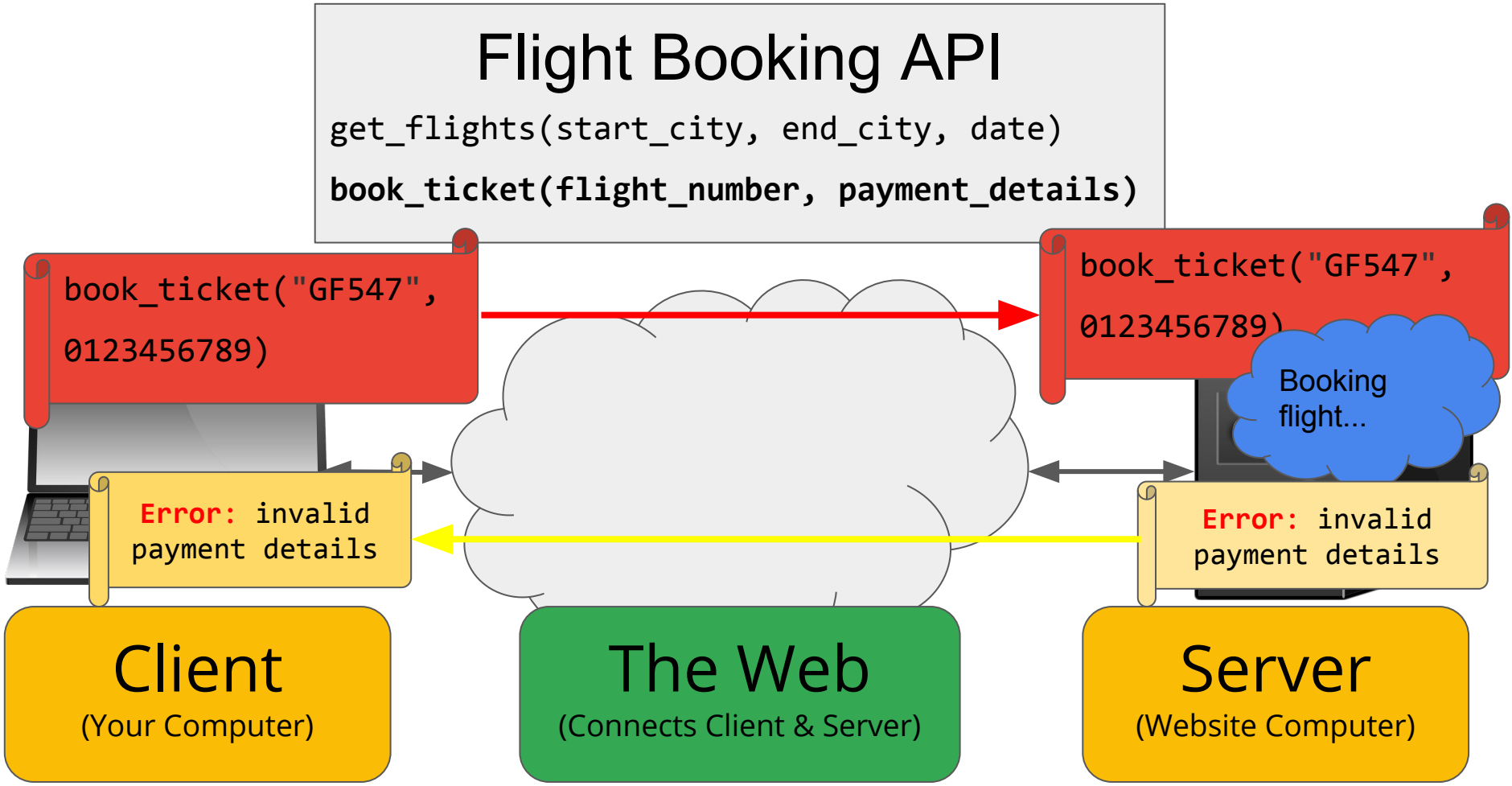
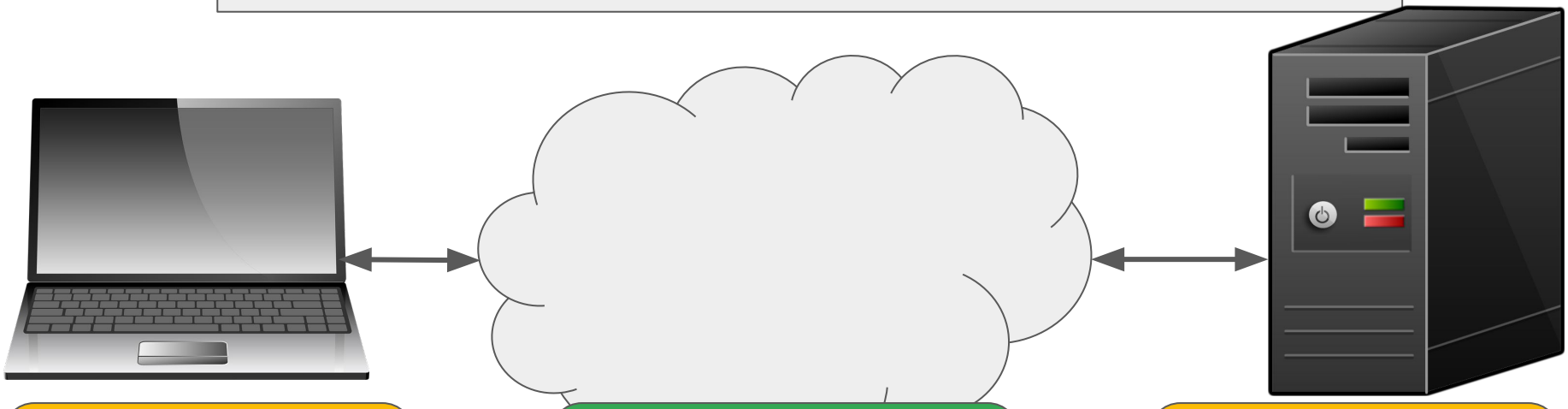

Flight Booking API
get_flights(start_city, end_city, date)
book_ticket(flight_number, payment_details)
book_ticket("GF547", 0123456789)
book_ticket("GF547", 0123456789)
Booking flight...
Error: invalid payment details
Error: invalid payment details
Client
(Your Computer)
The Web
(Connects Client & Server)
Server
(Website Computer)

Jump to Quiz

New Flight Booking API

```
get_flights(start_city, end_city, date)
book_ticket(flight_number, num_tickets, payment_details)
```



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New Flight Booking API

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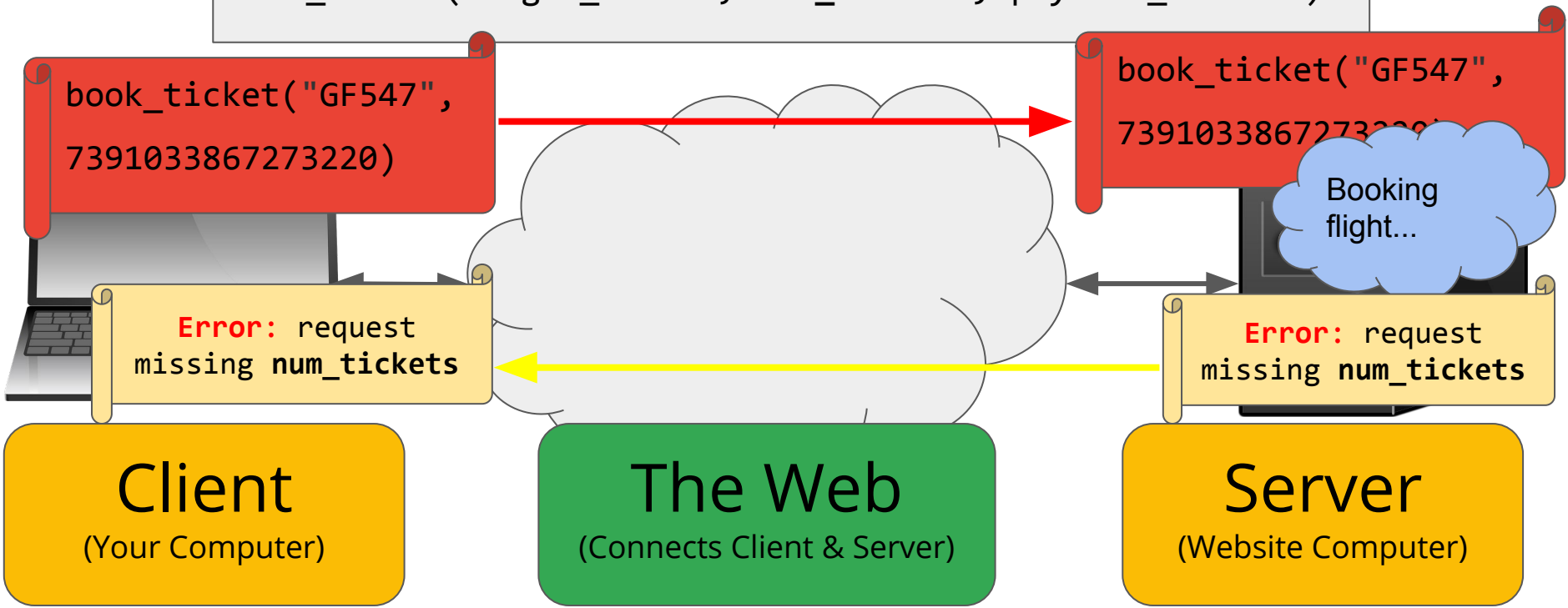


Hinge-Point Quiz

What does API stand for?

A. Autonomous Programmed Input
B. Amazing Pink Iguana
C. Application Programming Interface
D. Automatic Process Initiation

Click here to skip quiz

Hinge-Point Quiz

When might you use an API when writing a program?

A. To use features that have been coded by other people
B. To automatically complete lines of code
C. To communicate using the Internet
D. To check code for bugs

Hinge-Point Quiz

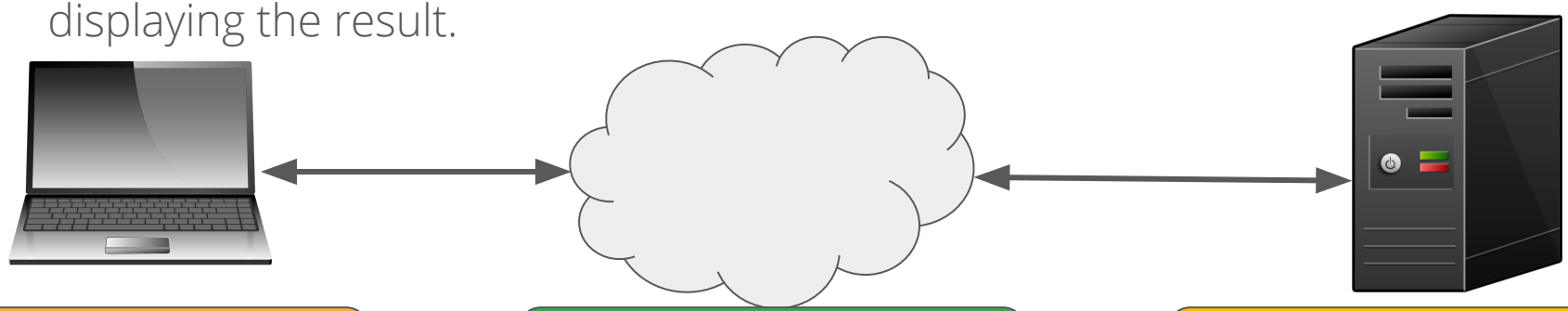
If you are a programmer, why might you implement an API?

A. To allow your programs to be executed in parallel
B. To make sure that no one else can benefit from your work
C. To allow other programmers to use your work without necessarily understanding how it works
D. To ensure that your code has no bugs

Hinge-Point Quiz

Which statement is **false**, and why?

A. To use a Web API, the client sends a request to the server using the Web.
B. When it receives a request, the server does any required processing.
C. When it has worked out the result, the server creates a new web page displaying the result.



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Hinge-Point Quiz

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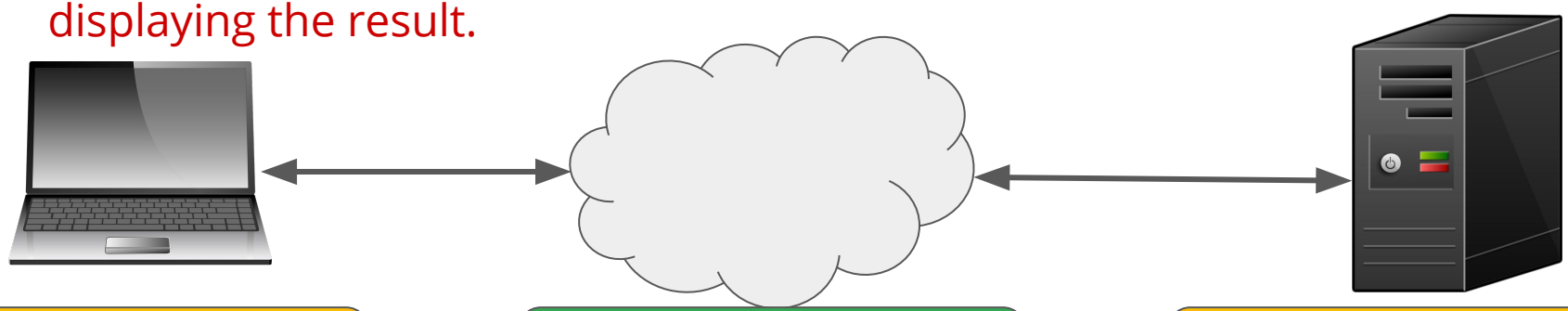

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Hinge-Point Quiz

Which statement is **false**, and why?

A. To use a Web API, the client sends a request to the server using the web.
B. When it receives a request, the server does any working out it needs to.
C. When it has worked out the result, the server ~~creates a new web page displaying the result.~~ sends the result back directly to the client.

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(Your Computer)

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Creating APIs for Game Developers



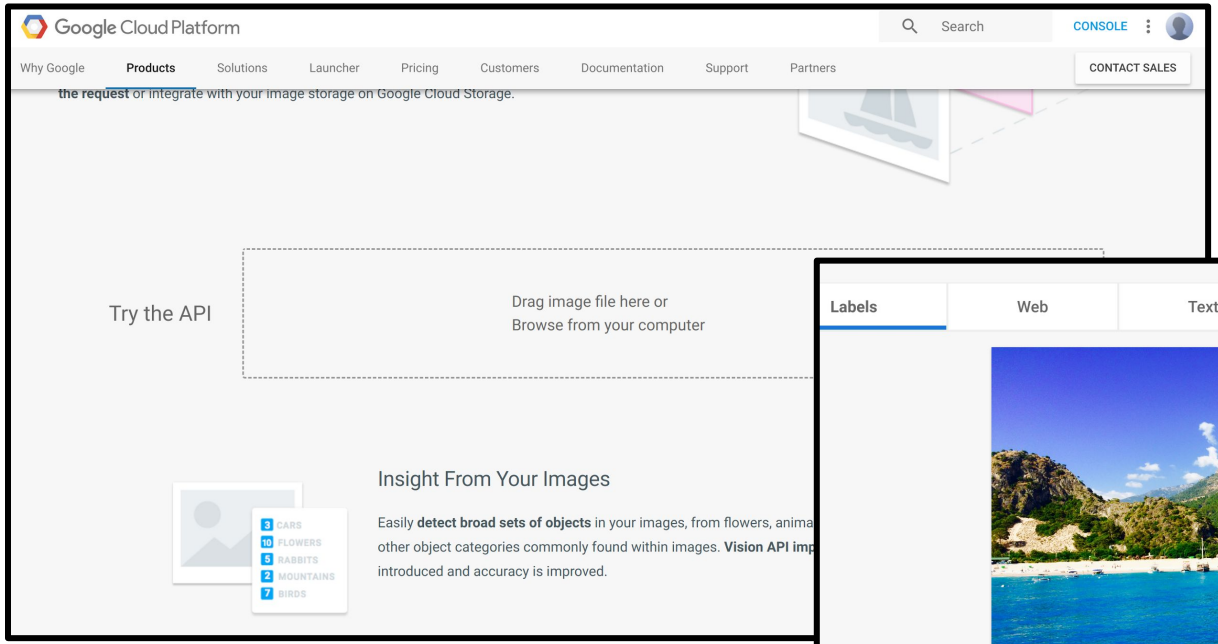


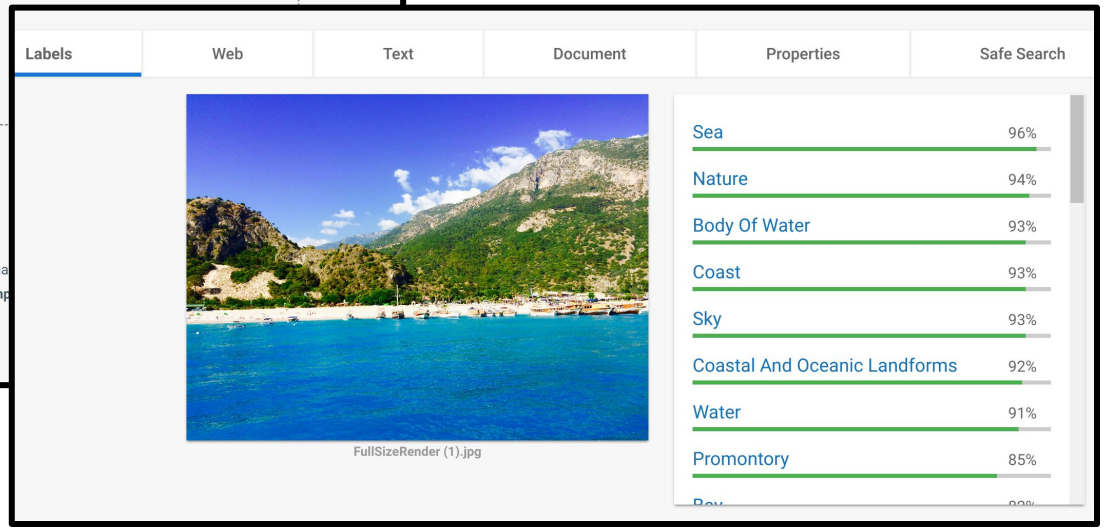
Google™



Demo: Vision API

cloud.google.com/vision/





Demo: Speech API

cloud.google.com/speech/

Powerful Speech Recognition

Google Cloud Speech API enables developers to **convert audio to text** by applying **powerful neural network models** in an easy to use API. The API **recognizes over 80 languages and variants,** to support your global user base. You can transcribe the text of users dictating to an application's microphone, enable command-and-control through voice, or transcribe audio files, among many other use cases. **Recognize audio uploaded in the request,** and integrate with your audio storage on Google Cloud Storage, by using the same technology Google uses to power its own products.

Convert your speech to text right now

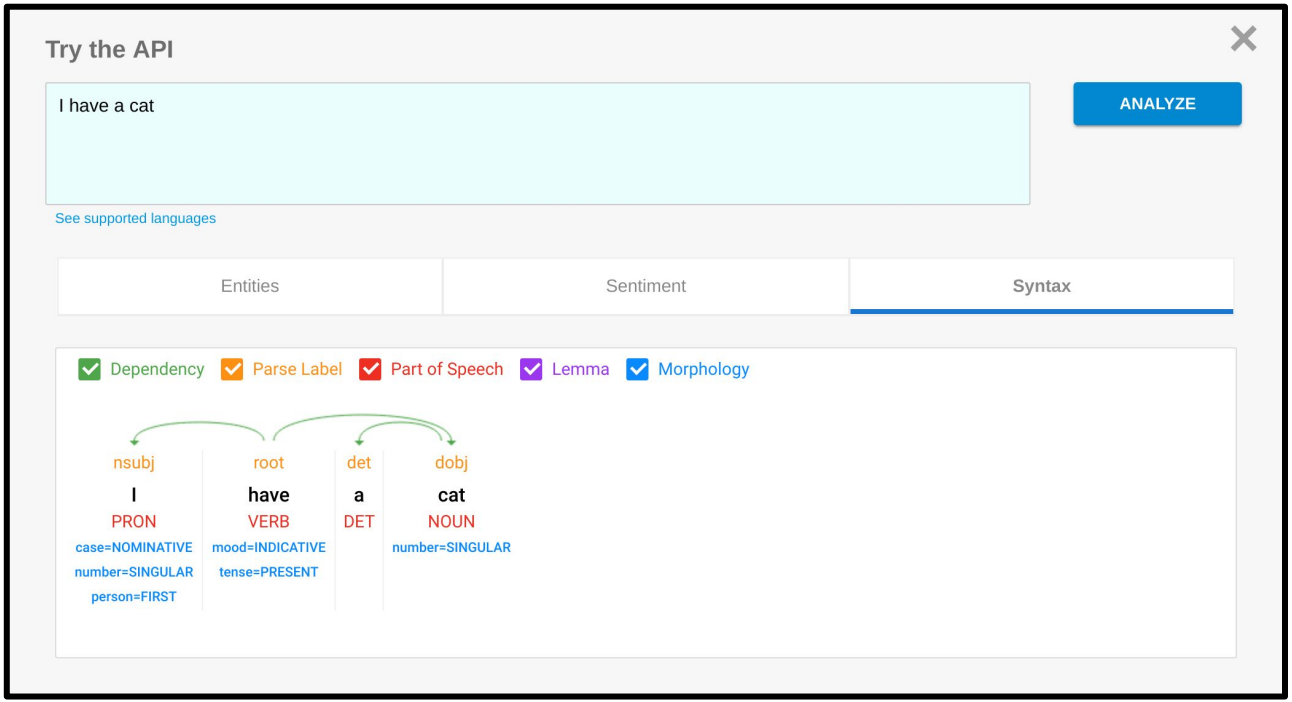
Select a language and click "Start Now" to begin recording

English (Great Britain)

START NOW

Demo: Natural Language Understanding API

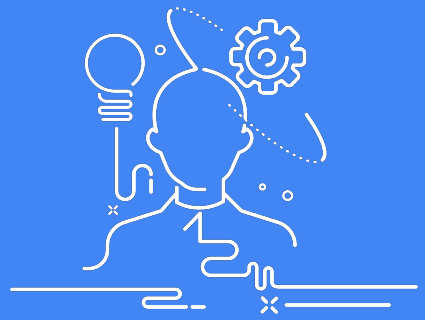
cloud.google.com/natural-language/



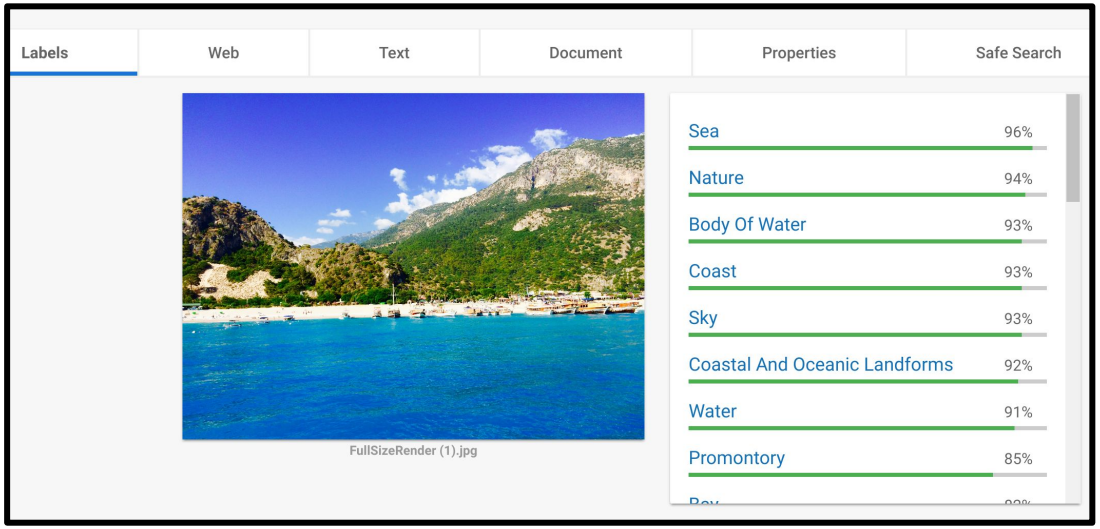
Which CloudML APIs could each application use?

Application	Vision	Speech	Natural Language
			

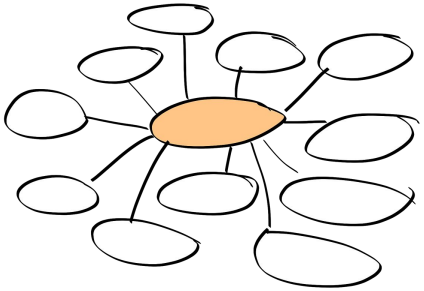
Designing a Machine Learning App



What can we make?



Brainstorming App Ideas



In small groups, brainstorm **simple** and **achievable** app ideas that you can build in 60 minutes.

The app should:

Examples:

- *An app that detects whether a dog is in an image*
- *An app that counts the number of people in an image*
- *An app that detects whether a specific word is said in a sound recording*

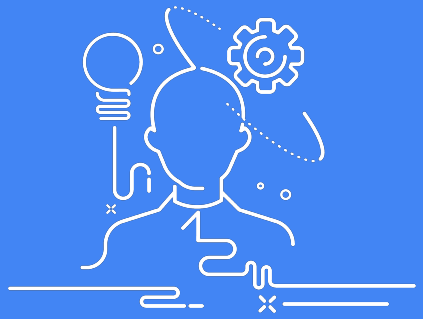
Finalize Your App Idea

Spend 2 minutes agreeing as a group what your final idea will be.

Sharing Your App Ideas

Each group takes about 30 seconds to share their app idea.

Build Our Apps



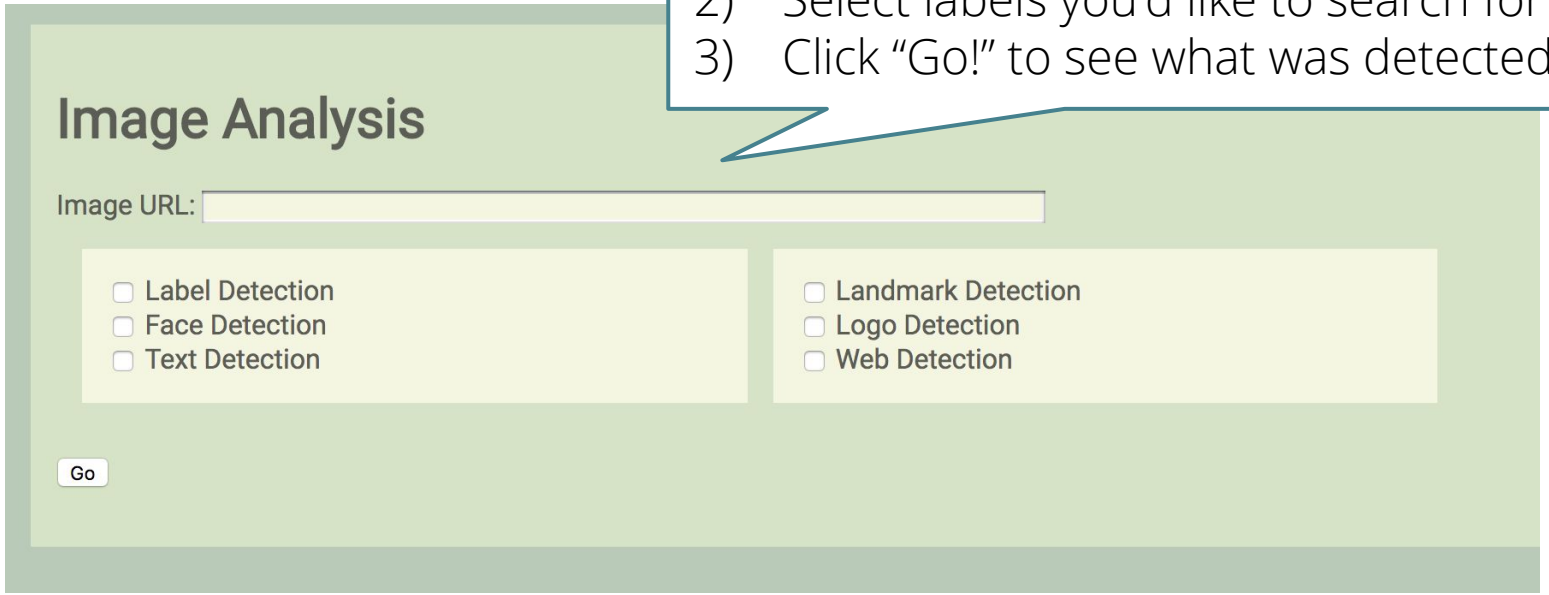
Introduction to the Web App

Given an image passed as input, attempt to detect different types of features, such as:

- Labels
- Faces
- Text
- Logos
- Landmarks
- Web annotations
- Properties (such as dominant color in the image)

Getting Started with the App

1) Add a web link to an image
2) Select labels you'd like to search for
3) Click "Go!" to see what was detected



What labels would you give this image?

Example Image Labeling: Nature Scene

Image Analysis

Image URL: https://static.pexels.com/photos/60006/spring-tree-flowers-meadow-60006.jpeg

- [x] Label Detection
- [ ] Face Detection
- [ ] Text Detection
- [ ] Landmark Detection
- [ ] Logo Detection
- [ ] Web Detection

Go

Label results detected: green, grass, flower, field, meadow, vegetation, ecosystem, spring, grassland, wildflower, sunlight, lawn, flora, leaf, morning, tree, plant, dandelion, daisy, landscape, grass family, computer wallpaper and moisture

See results here

Another Example: Times Square, New York

Image Analysis

Image URL: https://upload.wikimedia.org/wikipedia/commons/thumb/4/47/New_york_times_square-teraba

- [x] Label Detection
- [x] Face Detection
- [x] Text Detection
- [x] Landmark Detection
- [x] Logo Detection
- [ ] Web Detection

Go

Label results detected:
metropolitan area, city, urban area, landmark, metropolis, crowd, skyscraper, infrastructure, downtown, pedestrian, cityscape, street, daytime, night, building, advertising, tower block, town square, sky, recreation, tree, skyline, pedestrian crossing and evening

Landmark results detected:
Times Square, Times Square and Musical theatre

Text results detected:

Helped injured opponent win. SPORTSMANSHIP BE MUSICAL VAL MAXIMUM PERFORMANCE ES mer a axell

No results for face detection and logo detection

Results are further categorized by label type (e.g., “landmark”)

Try it Yourself

Test the app at:

https://get-started-with-ml-apis.appspot.com/

Starter Code Structure

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

Download a .zip of the starter code.

Starter Code Structure - **app.yaml**

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

The app's settings are configured here.

- App ID
- Version
- Handlers for each URL path

Starter Code Structure - **appengine_config.py**

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

Python module configuration, allowing users to specify values for constants and “hook” some functions for use.

appengine_config also imports useful libraries in lib/ (listed below).

Starter Code Structure - **back-end.py**

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

Logic and data-access layer of the app.

Calls to the Cloud Vision wrapper come from here, as do functions implementing result parsing and printing.

Starter Code Structure - **front-end/**

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

Presentation layer of the app.

The three files in this directory work together to construct the “front-end”:

1. HTML: content and structure of page
2. CSS: adds style
3. JS: gets elements, listens to actions

Starter Code Structure - **lib/**

```
Project
 +-- app.yaml
 +-- appengine_config.py
 +-- back-end.py
 +-- front-end/
     |
     +-- main.html
     +-- main.css
     +-- main.js
 +-- lib/
```

Directory of libraries needed by our app (e.g. `googleapiclient`).

Import declaration is found in `appengine_config.py`

The Cloud Vision Wrapper

Built with Google Cloud Endpoints, it provides an API you can use in your app to call functions implemented by the Cloud Vision API:

- `detect_faces`
- `detect_labels`
- `detect_landmarks`
- `detect_logos`
- `detect_text`
- `detect_properties`
- `detect_web`
- `detect_crop_hints`
- `detect_document`

These functions accept a link to an image on the Web.

Calling a Function from the Cloud Vision Wrapper

The functions in the API can be called from your code as follows:

```
request_url = wrapper_url + '/' + function_req_map[feature]
                        + '?imageURL=' + uri + '&key=' + api_key
request = urllib2.Request(request_url)
response = urllib2.urlopen(request).read()
```

- `wrapper_url` refers to the URL of the Cloud Vision Wrapper.
- `function_req_map[feature]` is the name of the specific API you want to call (e.g., `detectFaces`).
- *`uri`* is the URL of the image you want to classify.
- *`api_key`* is the API key.
- `urllib2.Request` constructs the request to the API.
- `urllib2.urlopen` captures the response returned by the API.

Detect Functions in the Cloud Vision Wrapper

Each of the `detect` functions in the wrapper follows a similar pattern:

1. Check if the image at input url is null; if so, throw an exception.
2. Set up the Cloud Vision API client.
3. Read in provided input image.
4. Check for unsafe content in the image; if unsafe content is found, return without calling API detection functions.
5. Call the Cloud Vision API to detect labels using the client in step 2.
6. Extract labels from result object.
7. Return labels.

Project Ideas

Front-end: Modify the user interface (look-and-feel) part of the app, e.g.:

- Change colors; move input field; change options' display; restyle results page
- Allow the user to upload multiple images at a time; return results in downloadable files (one for each photo)

Back-end: Modify calls to Vision wrapper, result parsing and printing, e.g.:

- Change the formatting of Cloud Vision wrapper results for printing
- Add recommendations to the user according to results. For example, if the user requests "Label Detection" and one of the labels is "city," suggest they try "Landmark Detection" as well to get more specific labels.

Consult the Web App Student Guide for guidance while working on your project

Presenting our Apps

- What changes did you make to the app?
- What successes did you achieve?
- What challenges did you face?
- How did using an API simplify the process of building an image-recognition app?

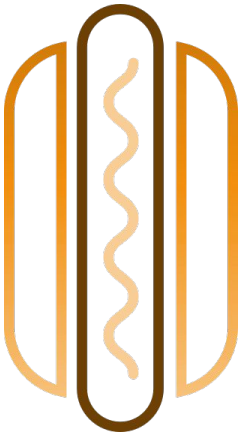
Getting Started with Machine Learning

Session 1: Understanding Machine Learning

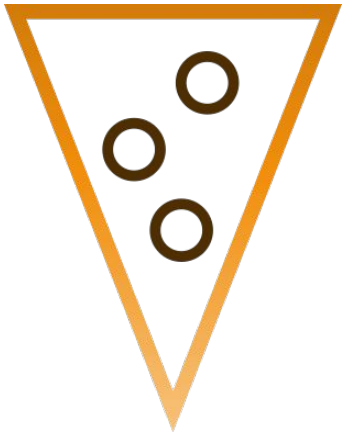
An Initiative by **Al Bayt Mitwahid** in UAE
Innovation Hub
powered by Google

Learning Objective

By the end of the session, you will have run a machine learning experiment to classify foods as **pizza** or **not pizza**



Not-Pizza

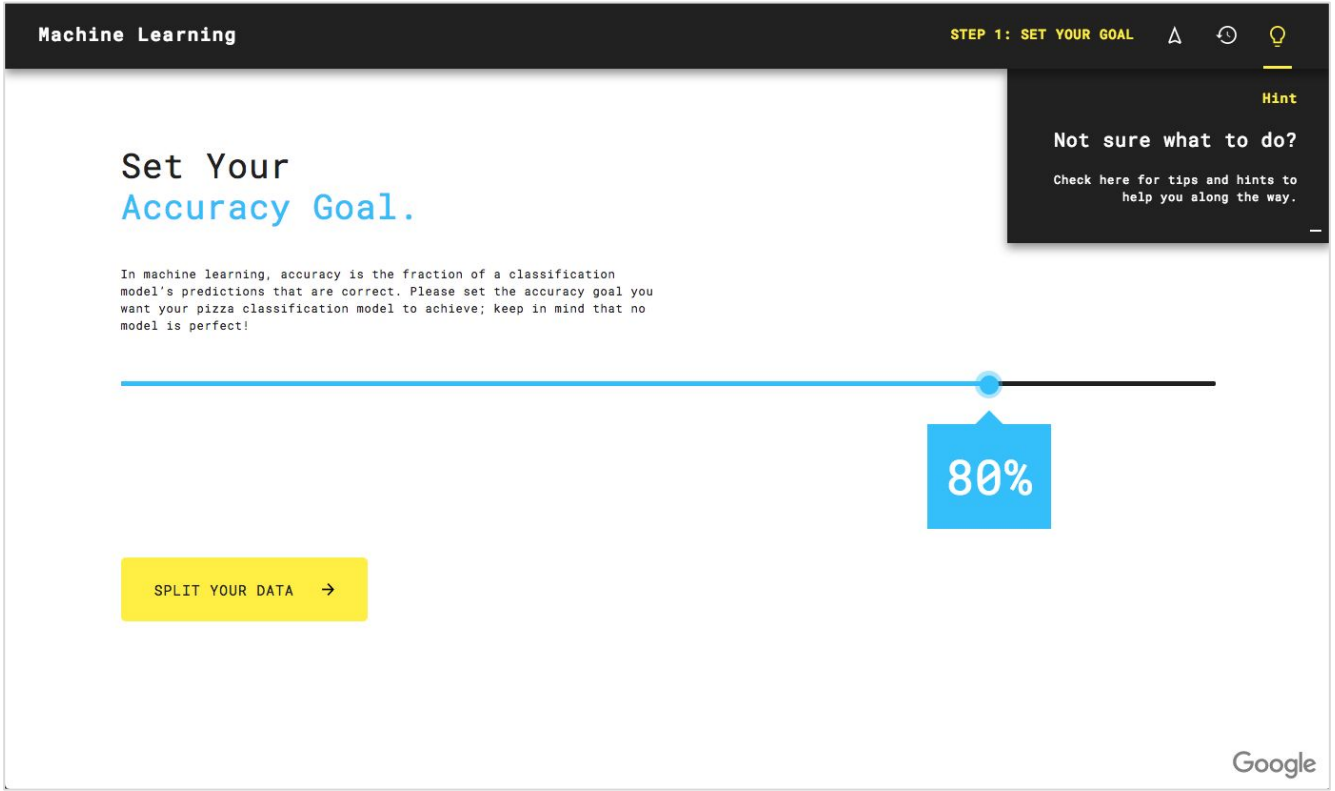


Pizza

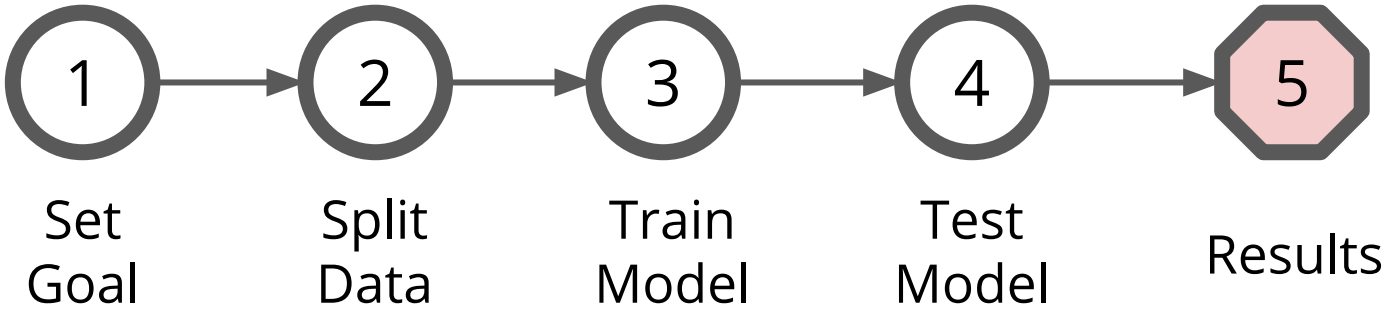
Pair Work: Run an ML Experiment

1. Find a partner
2. Go to https://sliceofml.withgoogle.com/
3. Click "Let's do this"

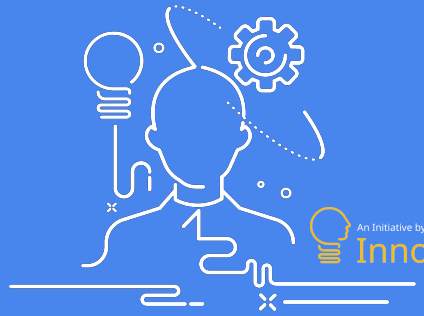
Pair Work: Set an Accuracy Goal



Pair Work: Run an ML Experiment



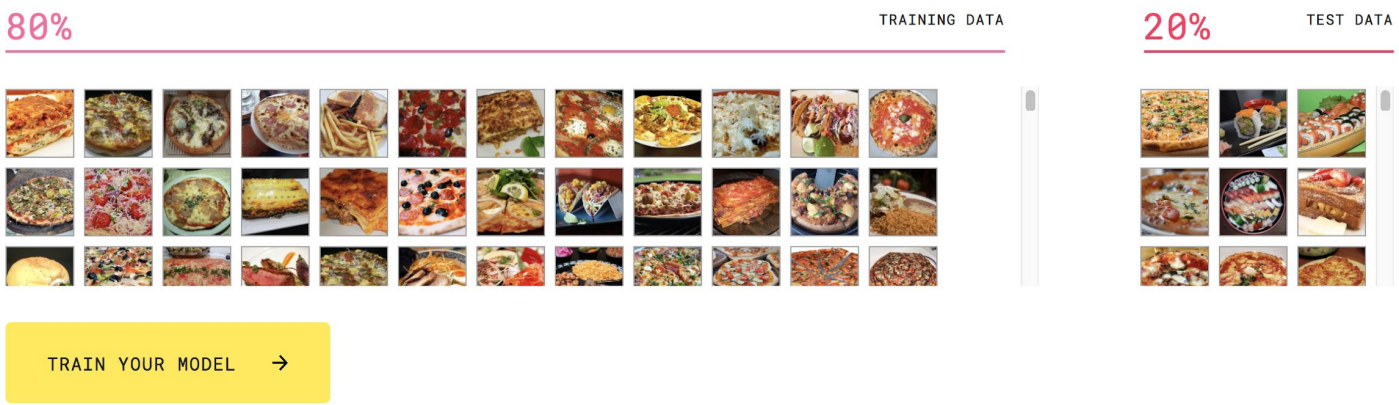
Debrief



An Initiative by **Al Bayt Mitwahid** in UAE
Innovation Hub
powered by Google

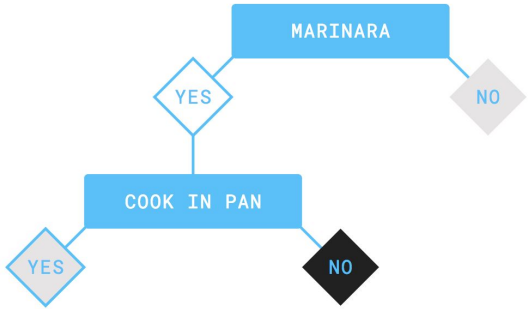
Debrief: Our First Experiment

- Why divide data into training and testing sets? What's the goal of each?



Debrief: Our First Experiment

- How does the decision tree work?

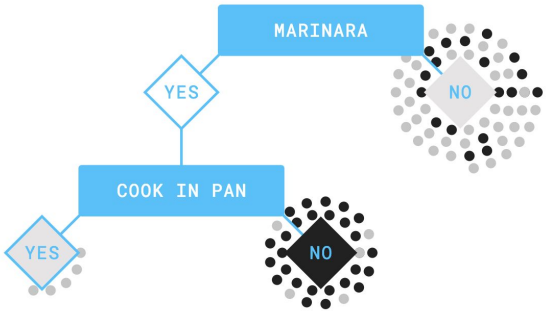


CARBS	MEAT	CHEESE	ROUND	MARINARA	CALORIES	METHOD	ORIGIN	IS PIZZA
YES	YES	YES	NO	YES	774	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	601	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	376	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	822	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	737	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	611	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	906	STOVETOP	ITALY	NO

0 PIZZA / 28 NOT PIZZA

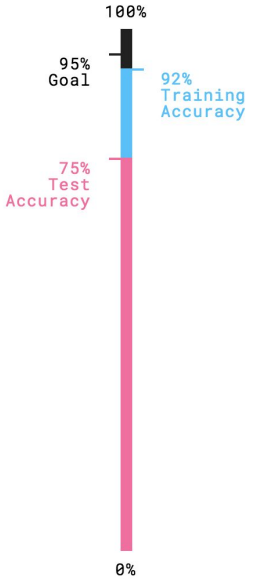
Debrief: Our First Experiment

- Why might we have gotten different accuracy results on the training and testing data?

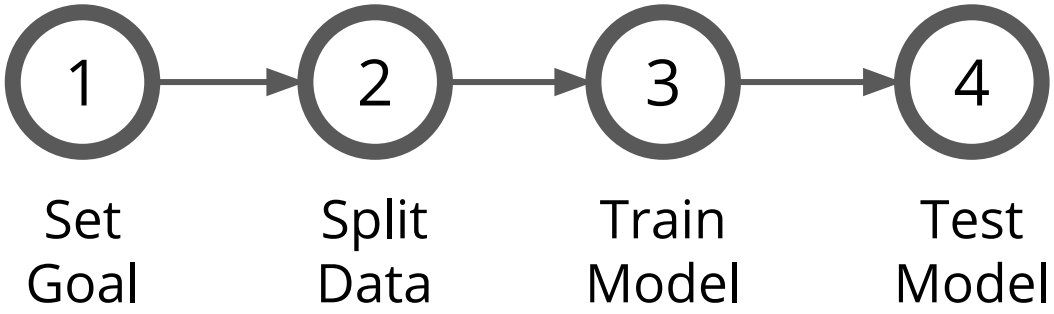


CARBS	MEAT	CHEESE	ROUND	MARINARA	CALORIES	METHOD	ORIGIN	IS PIZZA
NO	YES	NO	NO	YES	925	STOVETOP	ITALY	NO
NO	YES	NO	NO	YES	624	STOVETOP	ITALY	NO
NO	YES	NO	NO	YES	249	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	996	STOVETOP	ITALY	NO
YES	YES	YES	NO	YES	537	STOVETOP	ITALY	NO

0 PIZZA / 5 NOT PIZZA

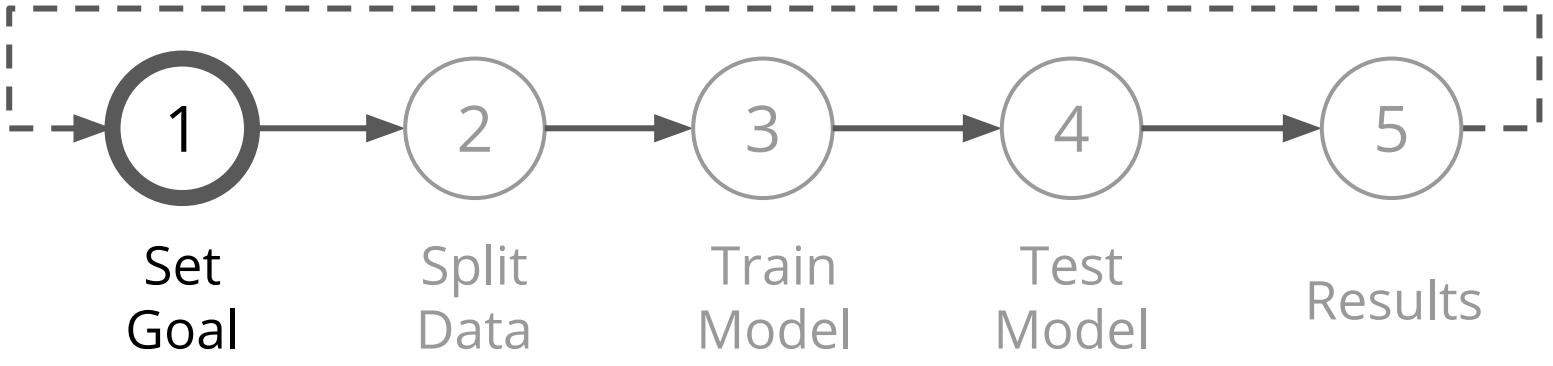


Debrief: Our First Experiment

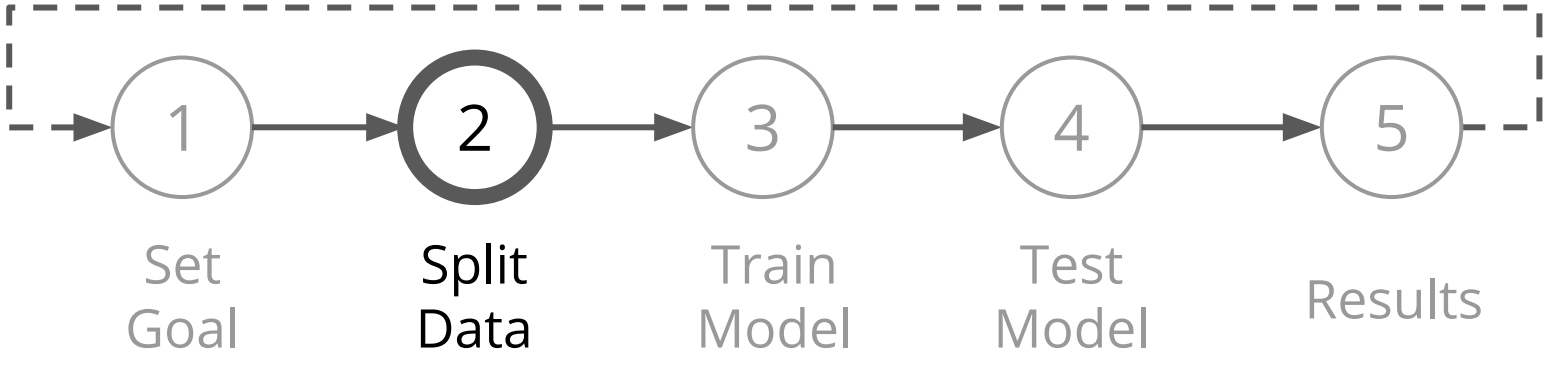


How might you refine the experiment to get your model's training and testing accuracy to be 90% or more?

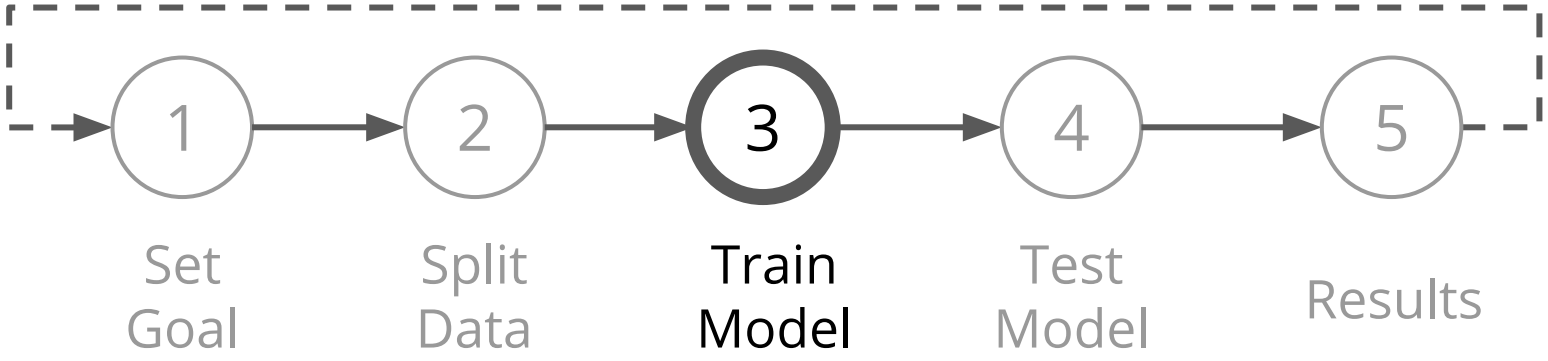
Run More Experiments

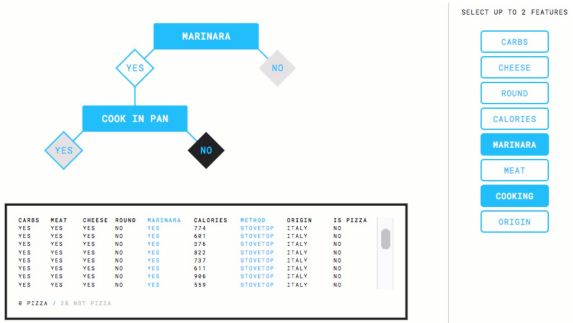


Run More Experiments

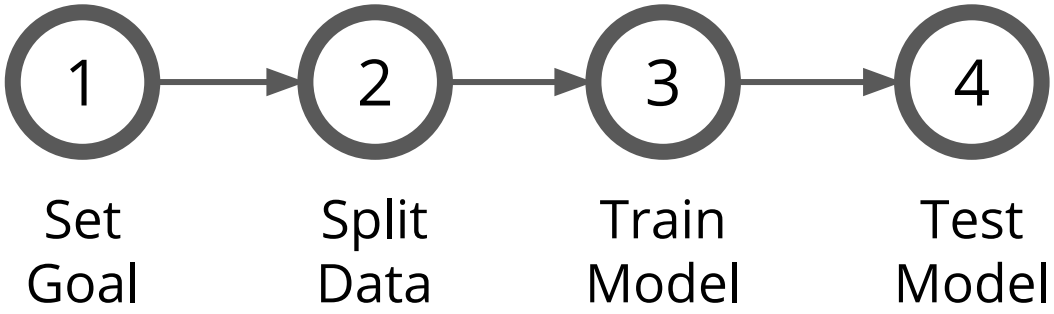


Run More Experiments





Run More Experiments



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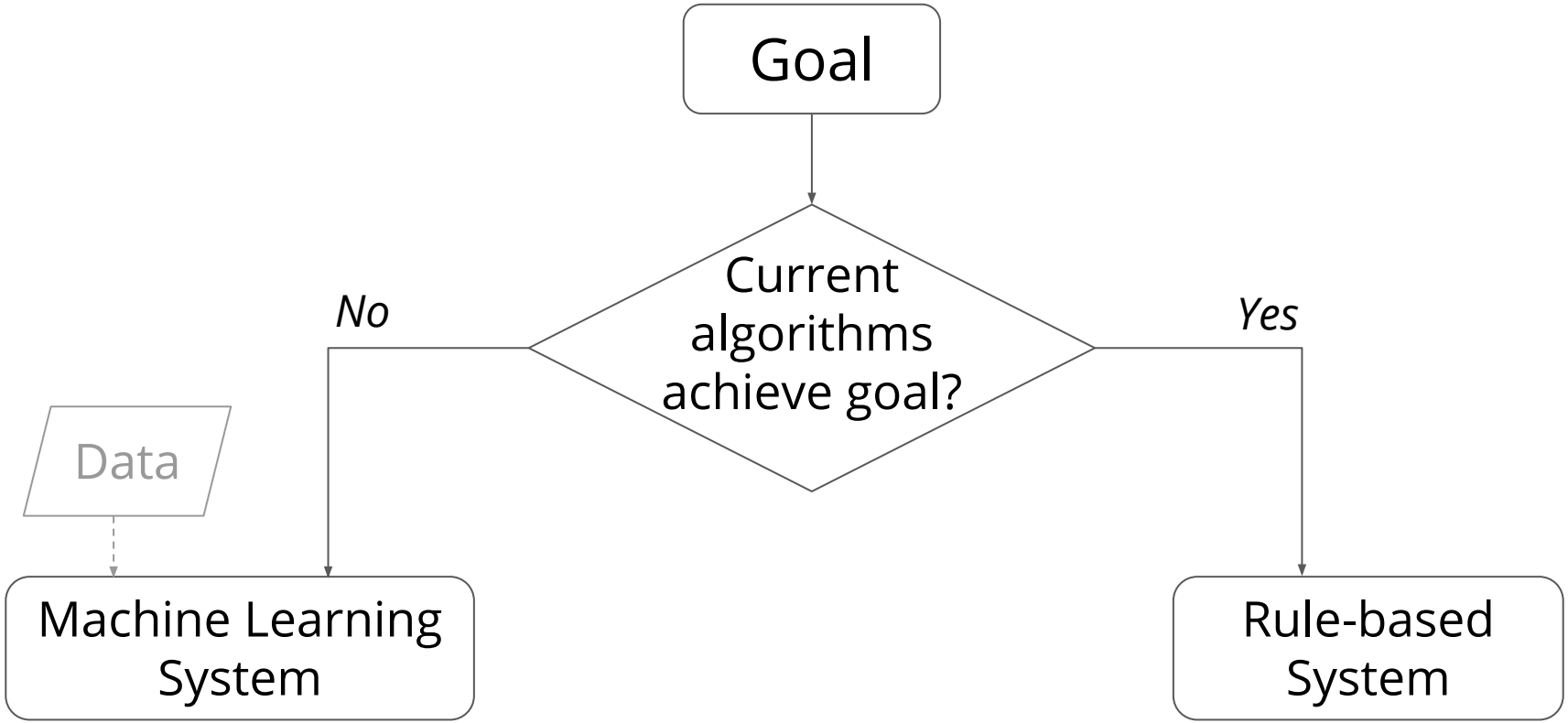
Debrief


Goal
Current algorithms achieve goal?
No
Yes
Data
Machine Learning System
Rule-based System

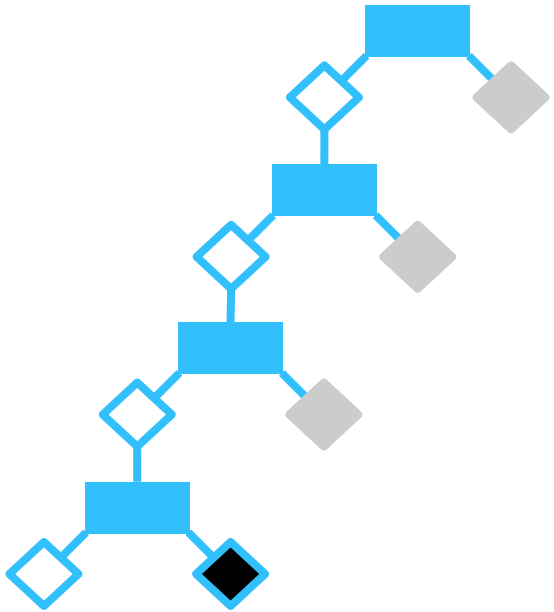
Debrief

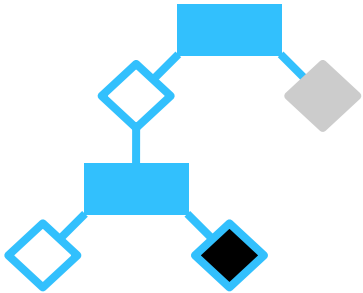
- Training Data
- Test Data

Risk of overfitting

Poor quality model

Debrief





Getting Started with Machine Learning