Research Computing

PYTHON SENTIMENT ANALYSIS

Jacalyn Huband

Sentiment Analysis

A computational technique for detecting the polarity (i.e., positive, neutral, or negative) of the meaning associated with a phrase, sentence, paragraph, or document.

Sentiment Analysis: Types

Polarity-based:

Words are defined simply as positive, negative, or neutral

Valence-based:

Words are defined by the degree of positivity or negativity (e.g., “the worst” would be more negative than “bad”)

Sentiment Analysis: VADER

We are going to look at using a Python package, called VADER (**V**alence **A**ware **D**ictionary for s**E**ntiment **R**easoning).

From the name, you can see that it will assign degrees of positivity or negativity to text.

Sentiment Analysis

CAVEAT: Sentiment analysis is still difficult for a machine to perform. There are no definitive rules for determining the emotion of feeling behind a written expression.

The Idea behind VADER

To determine the sentiment of a text, VADER looks at individual words.

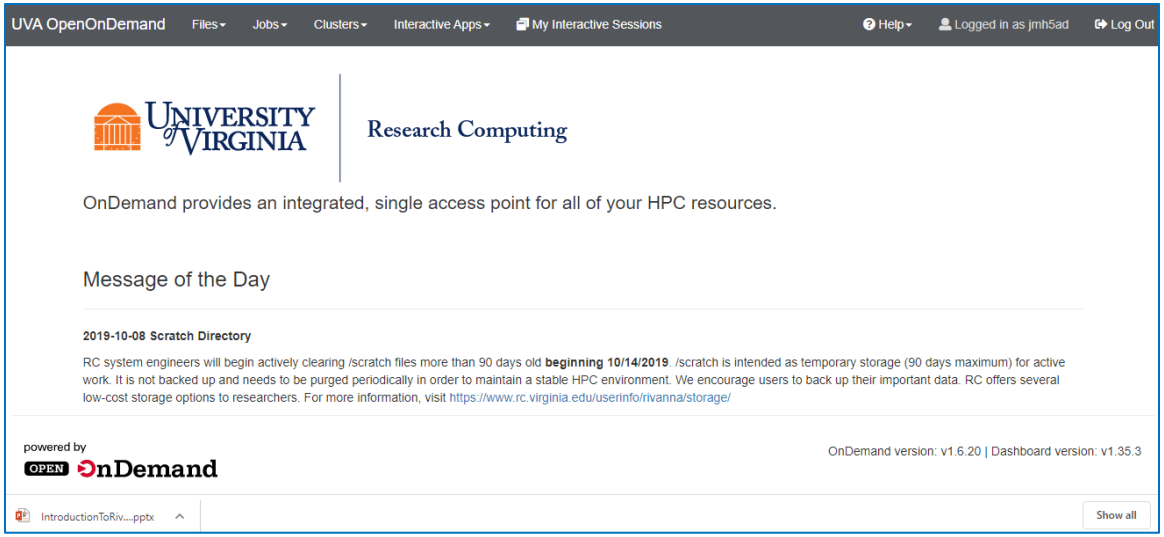
It uses a built-in lexicon – a dictionary of words where the words have a sentiment rating.

It uses the ratings to determine the percentage of the text that is positive, neutral, or negative.

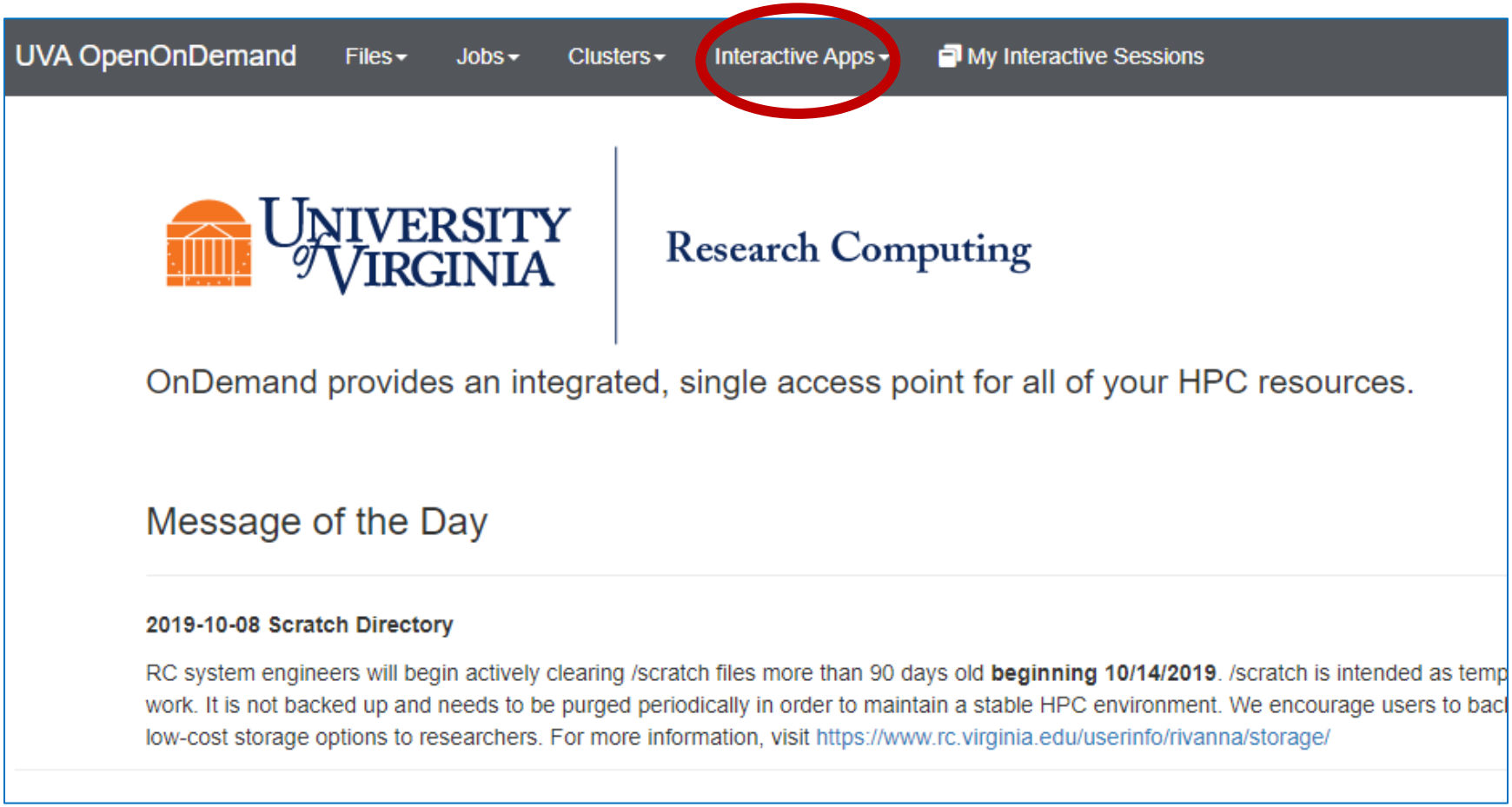
Finally, it computes an overall score between -1 (most negative) and +1 (most positive)

Hands-on Activity

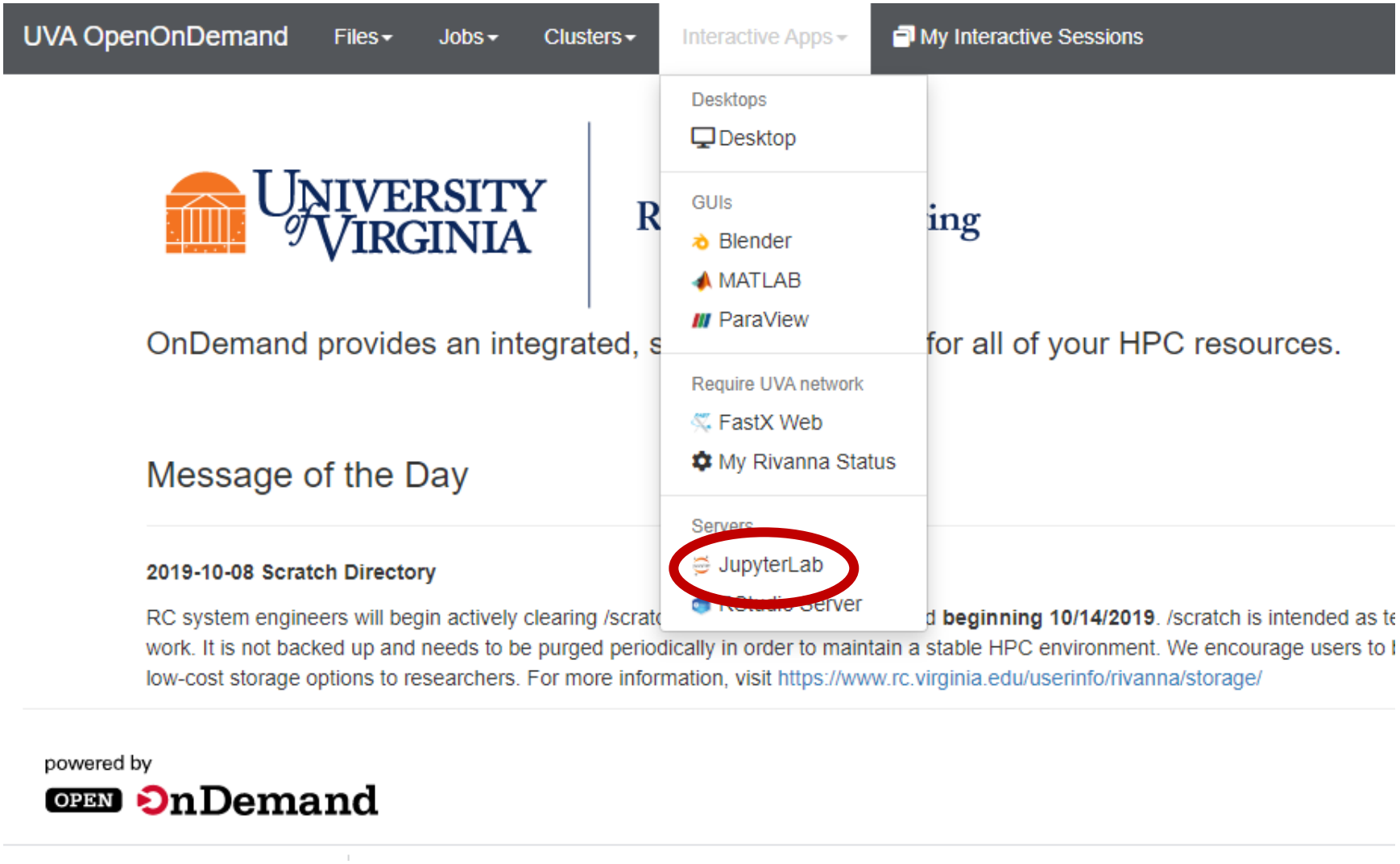
- We will be using Rivanna to run our examples.
  - To log in, open a web browser and type: https://rivanna-portal.hpc.virginia.edu
  - After entering your Netbadge credentials, you will be taken to our Rivanna Portal:



Click on “Interactive Apps”

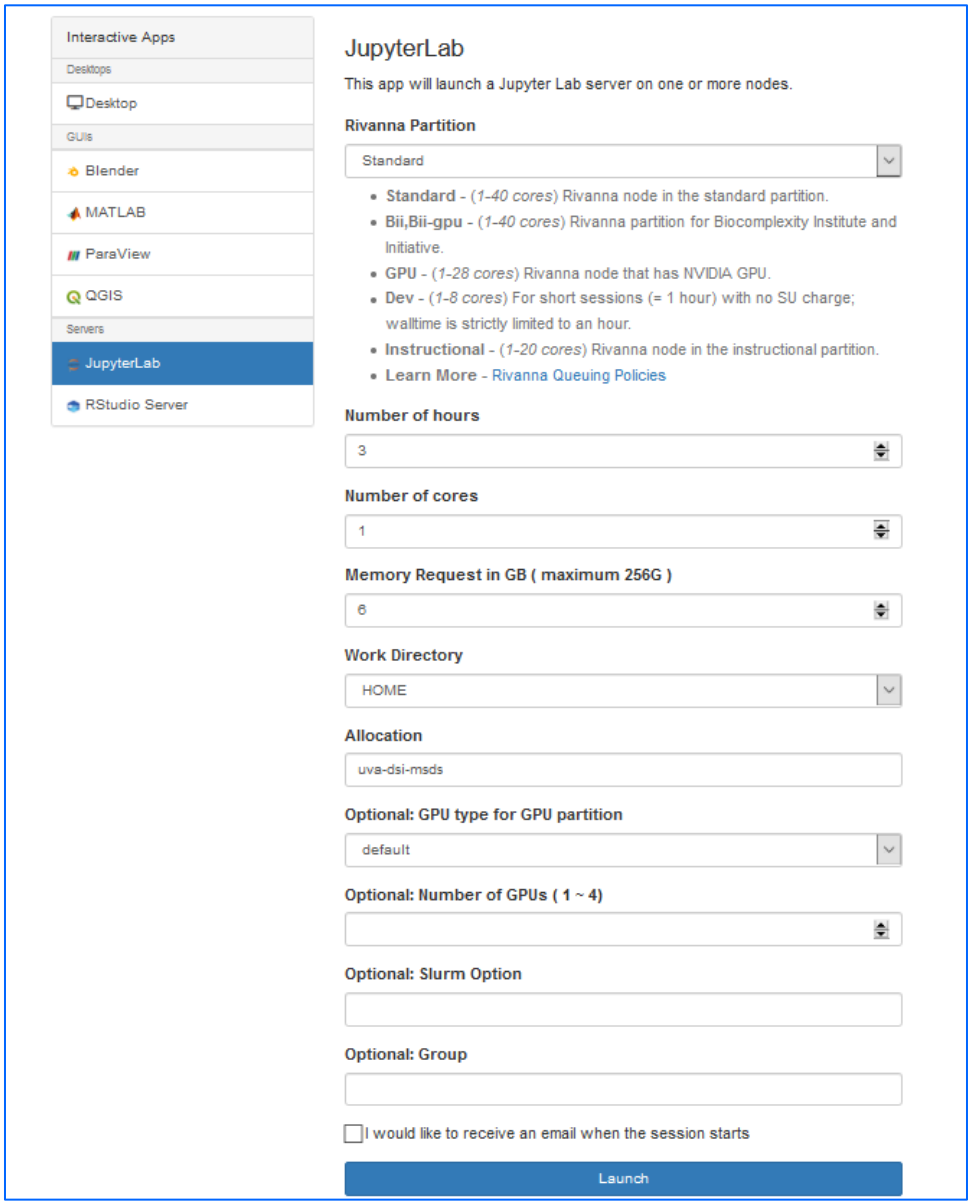


Select “JupyterLab” from the Menu

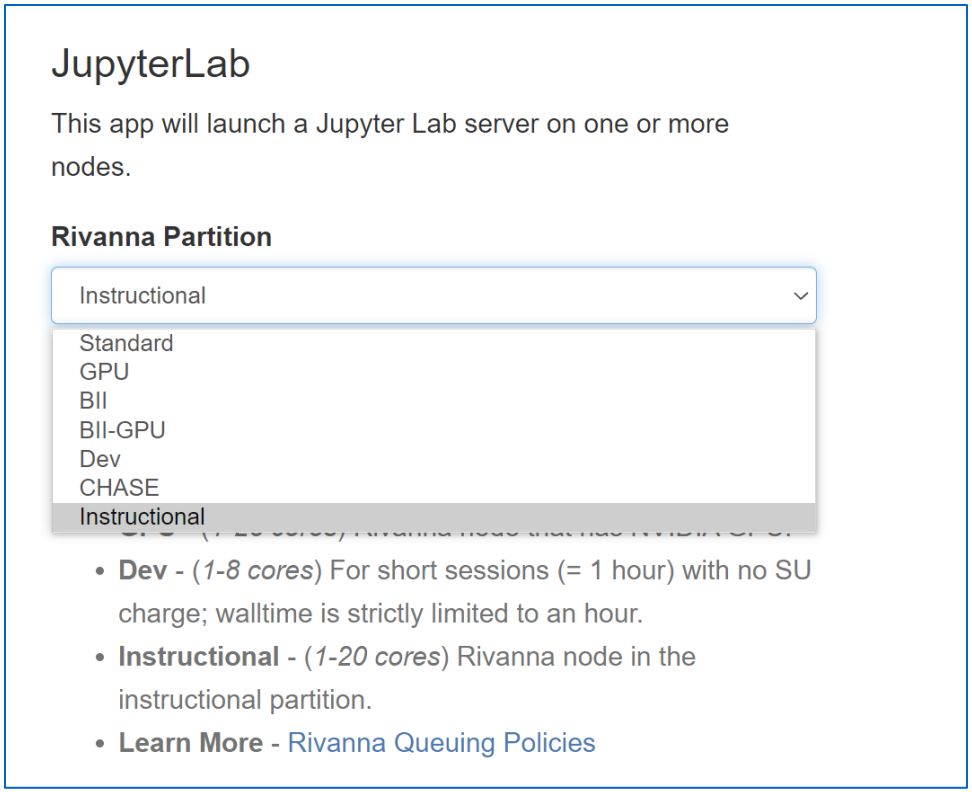


A JupyterLab web form will appear

- The Jupyter Web Form gathers information about the computing resources that you need for your Jupyter Notebook.
- Let's look at how you would fill it in!

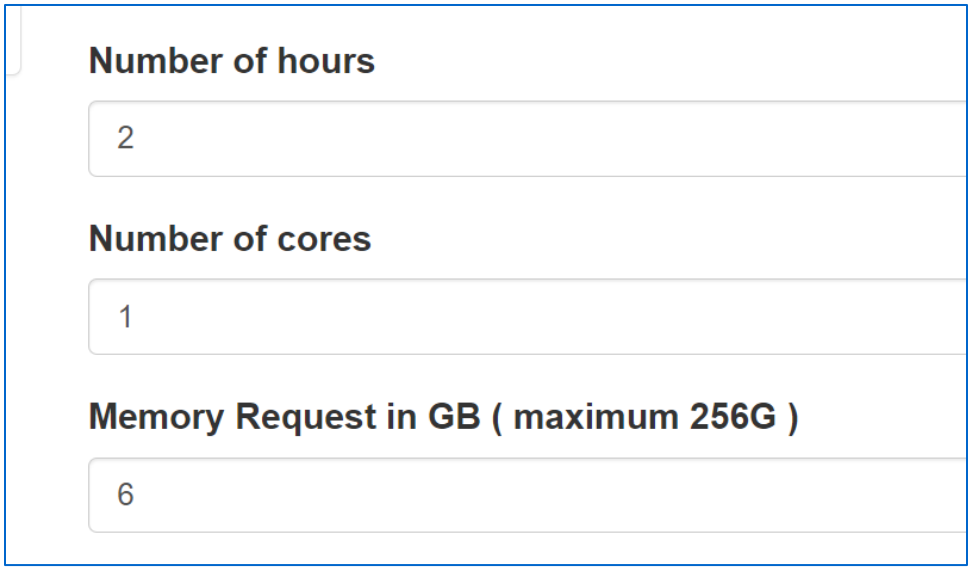


Rivanna Partition



From the drop-down menu, select the **Instructional** partition

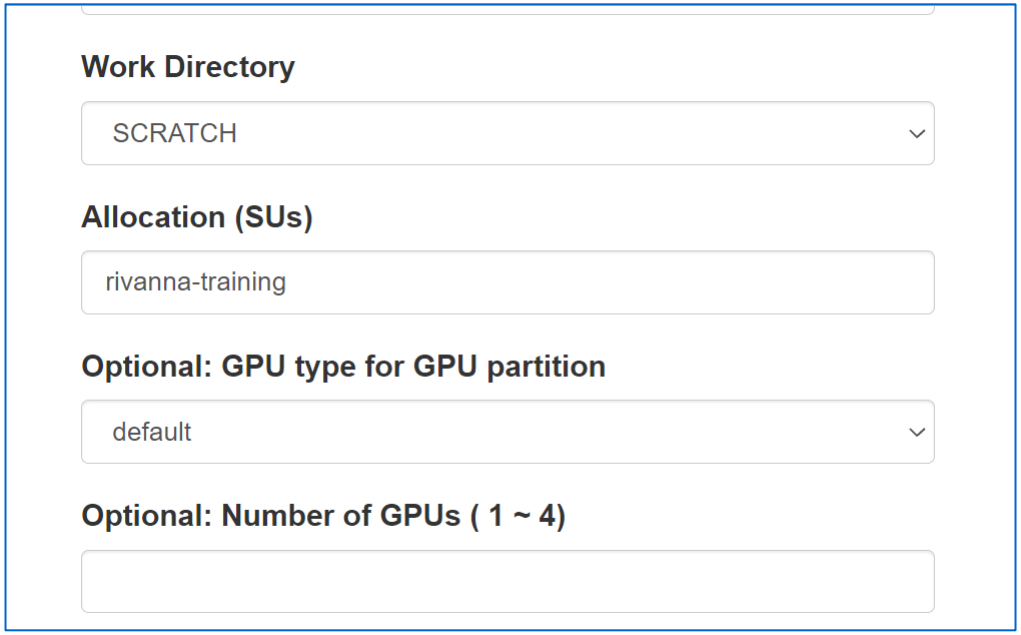
Hours, Cores, Memory



Set:

- The number of hours to **2**
- The number of cores to **1**
- The memory to **6**

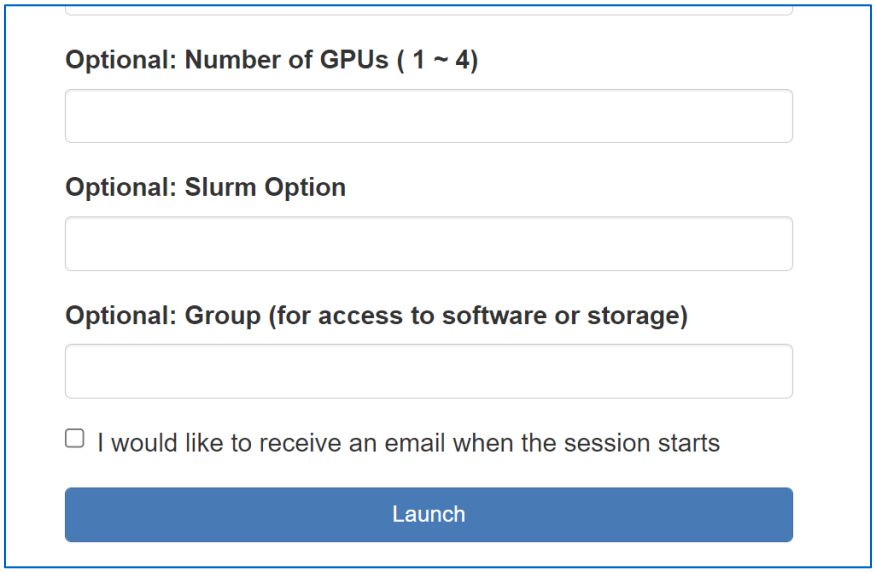
Work Directory, Allocation



Set:

- The Work Directory to **SCRATCH**
- The Allocation to **rivanna-training**

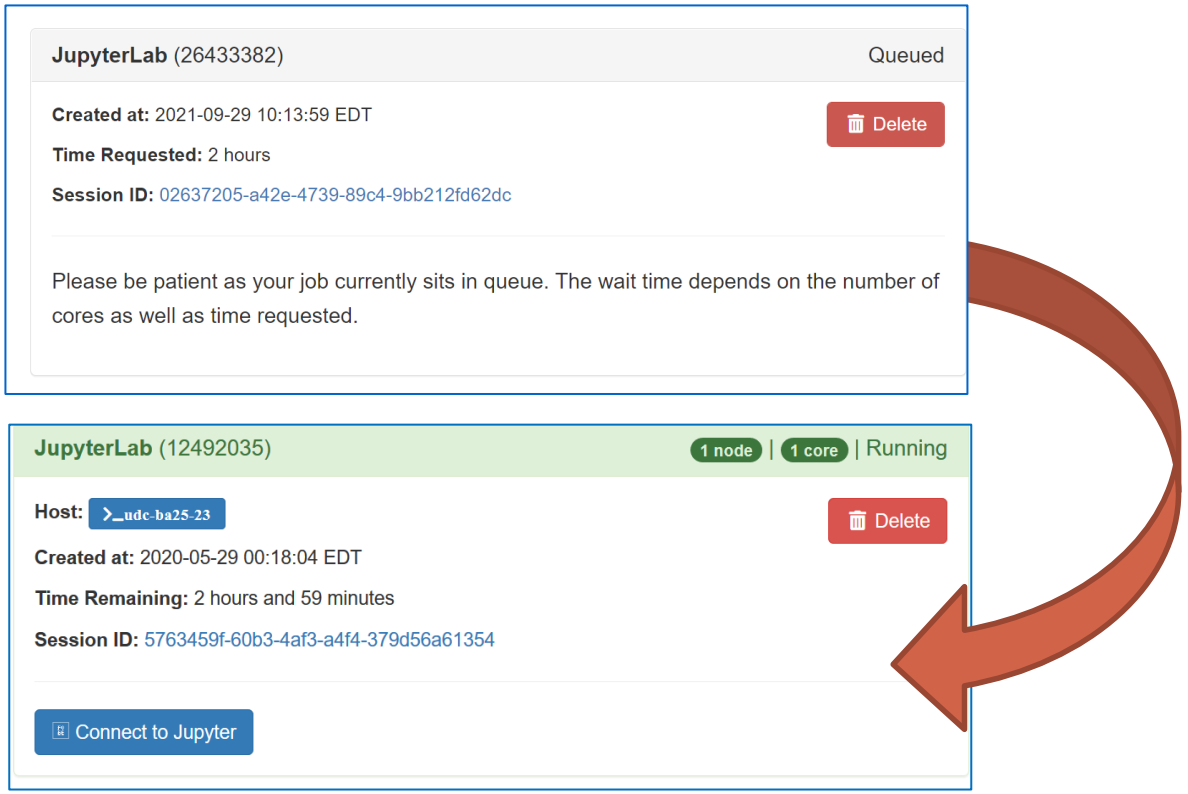
Click “Launch”



The rest of the fields can be left blank.

Scroll to the bottom of the web page and click on the **Launch** button.

Waiting for the Session to Start

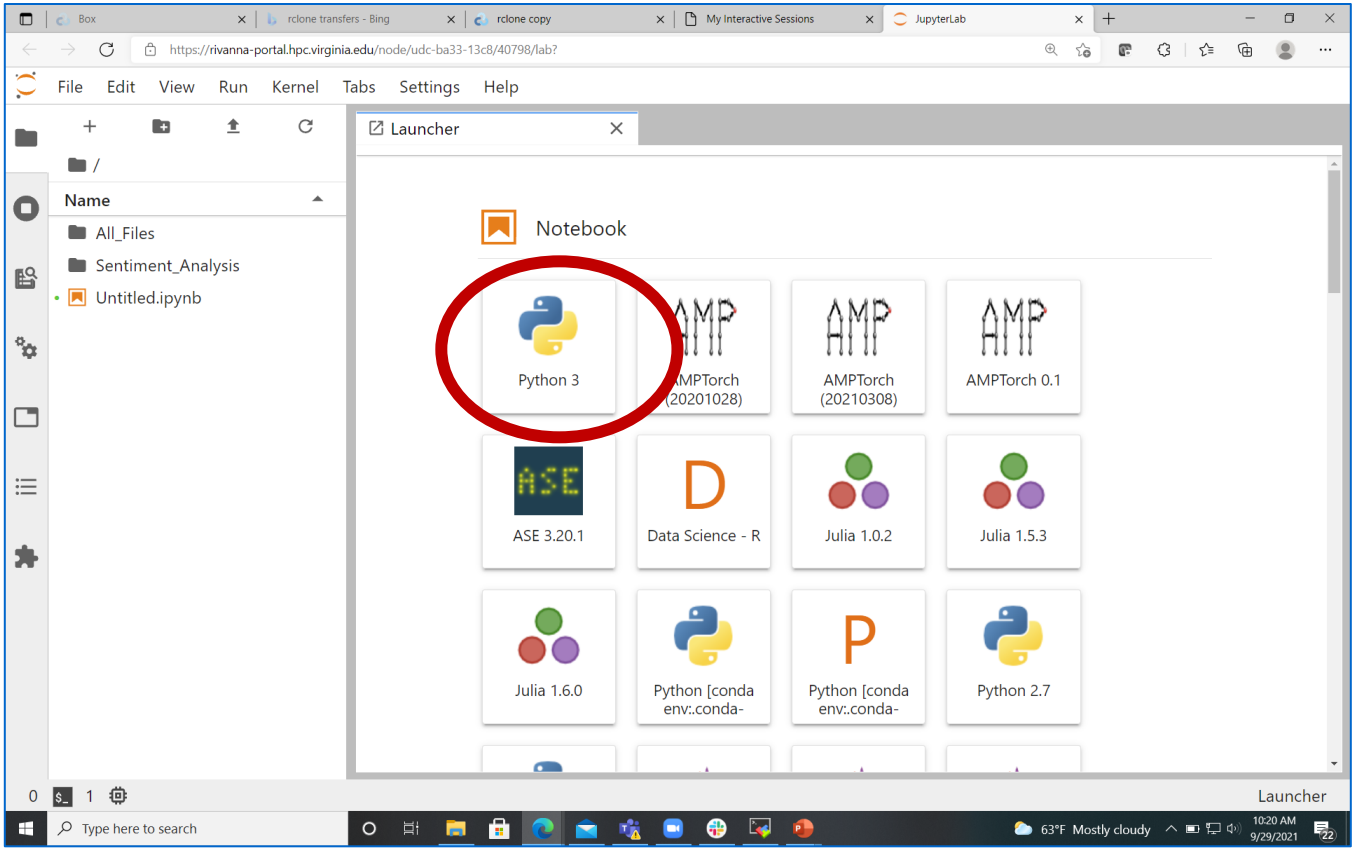


It will start with “Please be patient” statement while it finds a noded for you to run on.

After a minute or so, it will transition to a form with a “Connect to Jupyter” button.

Click on the “Connect to Jupyter” button.

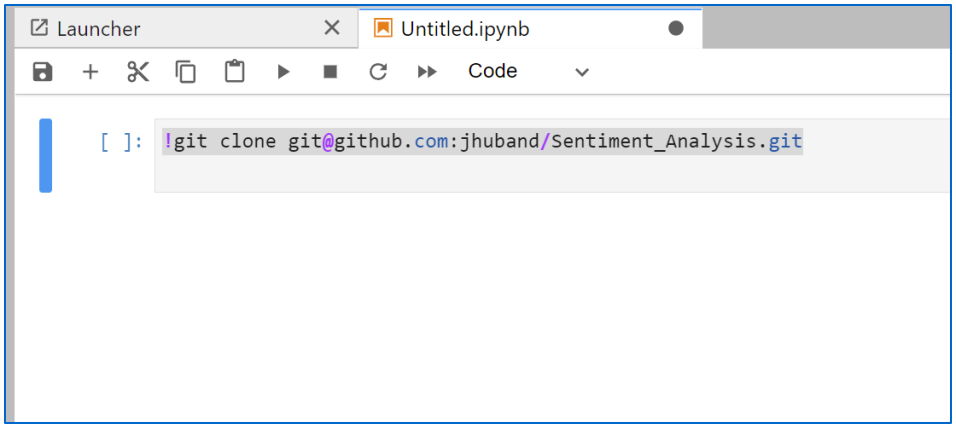
Almost There!



Click on the **Python 3** tile to start a Python Notebook

Get copy of Notebooks we are using

- Type: git@github.com:jhuband/Sentiment_Analysis.git
- Then, press Ctrl Enter



- This will create a folder, called Sentiment Analysis, that has notebooks and data.

Hands-on Activity

- Install the VADER package:

```
!pip install vaderSentiment
```

- Or, if you are on Rivanna:

```
!pip install --user vaderSentiment
```

Simple Example of VADER

Python

```
from vaderSentiment.vaderSentiment import
SentimentIntensityAnalyzer

#Set up analyzer
analyzer = SentimentIntensityAnalyzer()

#Feed in a sentence
sentence = "I hate scary movies."
score = analyzer.polarity_scores(sentence)
print(score)
```

Simple Example of VADER

Python

```
from vaderSentiment.vaderSentiment import
SentimentIntensityAnalyzer

#Set up analyzer
analyzer = SentimentIntensityAnalyzer()

#Feed in a sentence
sentence = "I hate scary movie
score = analyzer.polarity_scor
print(score)
```

Result:
{'neg': 0.775, 'neu': 0.225, 'pos': 0.0, 'compound': -0.7845}

The Results

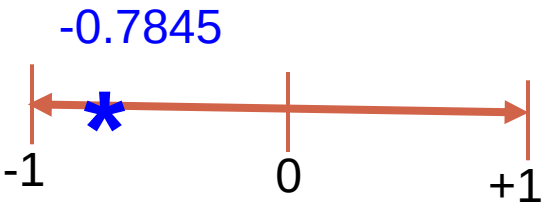
- The `polarity_score` function returns a dictionary with the percentages of negative, neutral, and positive sentiment, and the compound score.
- In this example, we have

  negative: 0.775,

  neutral: 0.225,

  positive: 0.0,

  compound: -0.7845



More power behind VADER

- VADER uses more than just the sentiment ratings of words.
  - It also looks at capitalizations and some punctuations.
  - To determine the sentiment of some text, VADER looks at individual words.

Hands-on Activity

- In the previous example, change the sentence to the following: “I HATE scary movies!” and rerun the analyzer.
- Did the compound score change?

Hands-on Activity

- Read in emma_chapter_one.txt
- Run it through the analyzer.
- From the compound score, what can you say about the sentiment of the document?

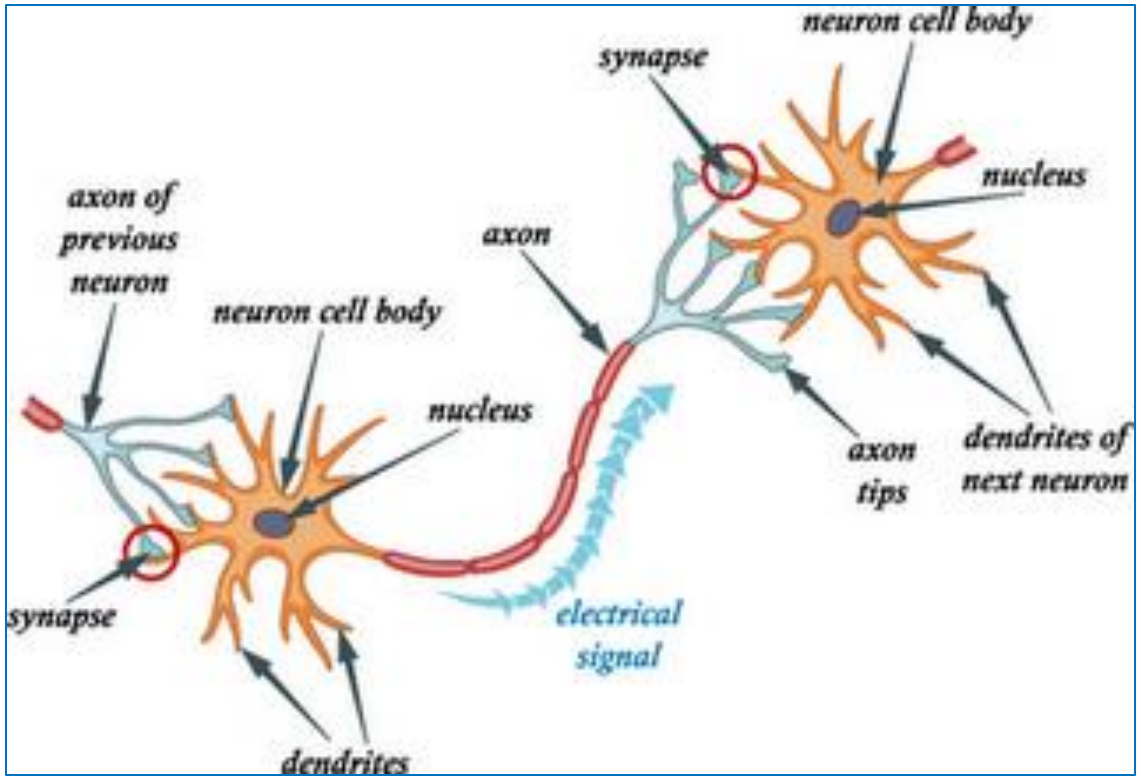
Repeat for MLK_speech.txt and The_Raven.txt

NEURAL NETWORKS

Neural Network

A computational model used in machine learning which is based on the biology of the human brain.

Neurons in the Brain

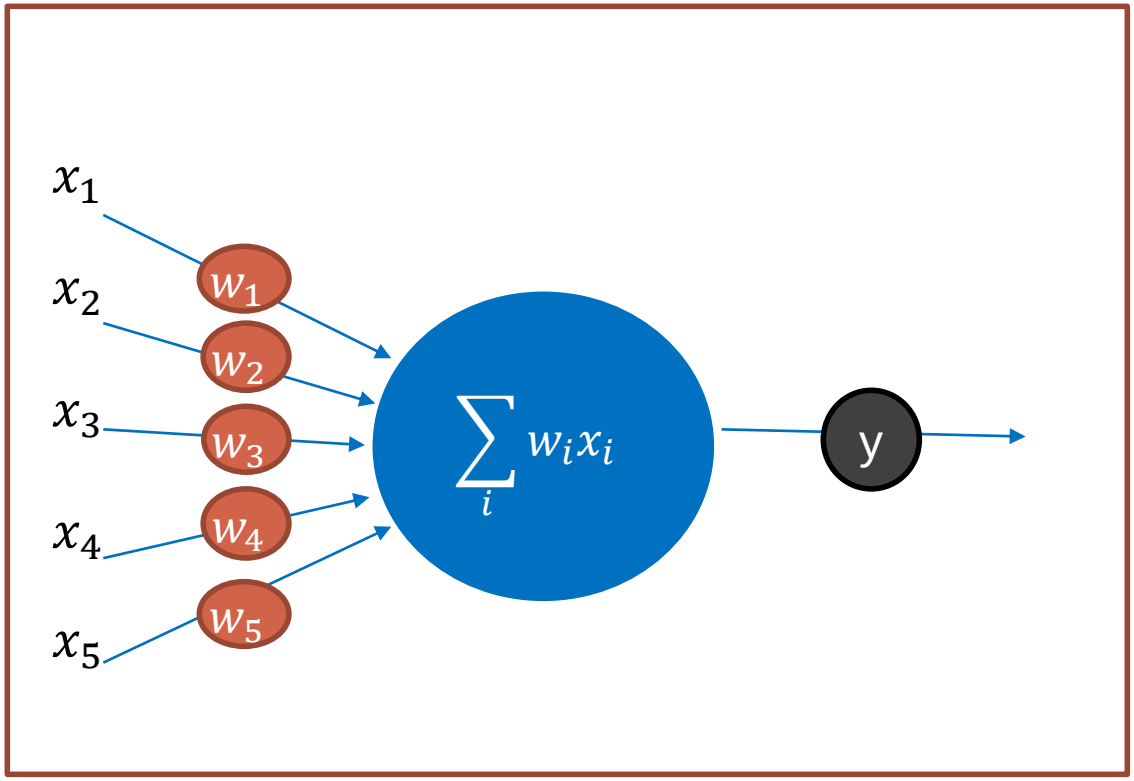


A neurons continuously receives signals, processes the information, and fires out another signal.

The human brain has about 86 billion neurons, according to Dr. Suzana Herculano-Houzel

Diagram borrowed from http://study.com/academy/lesson/synaptic-cleft-definition-function.html

Simulation of a Neuron

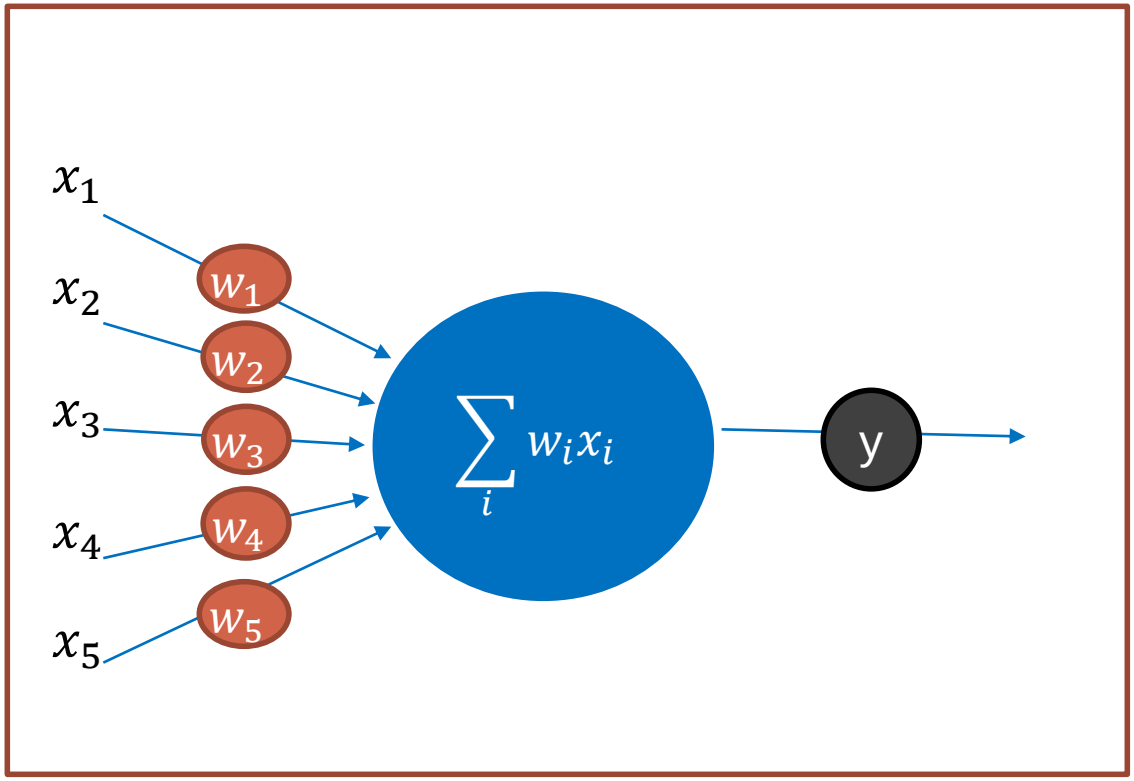


The “incoming signals” could be values from a data set(s).

A simple computation (like a weighted sum) is performed by the “nucleus”.

The result, y, is “fired out”.

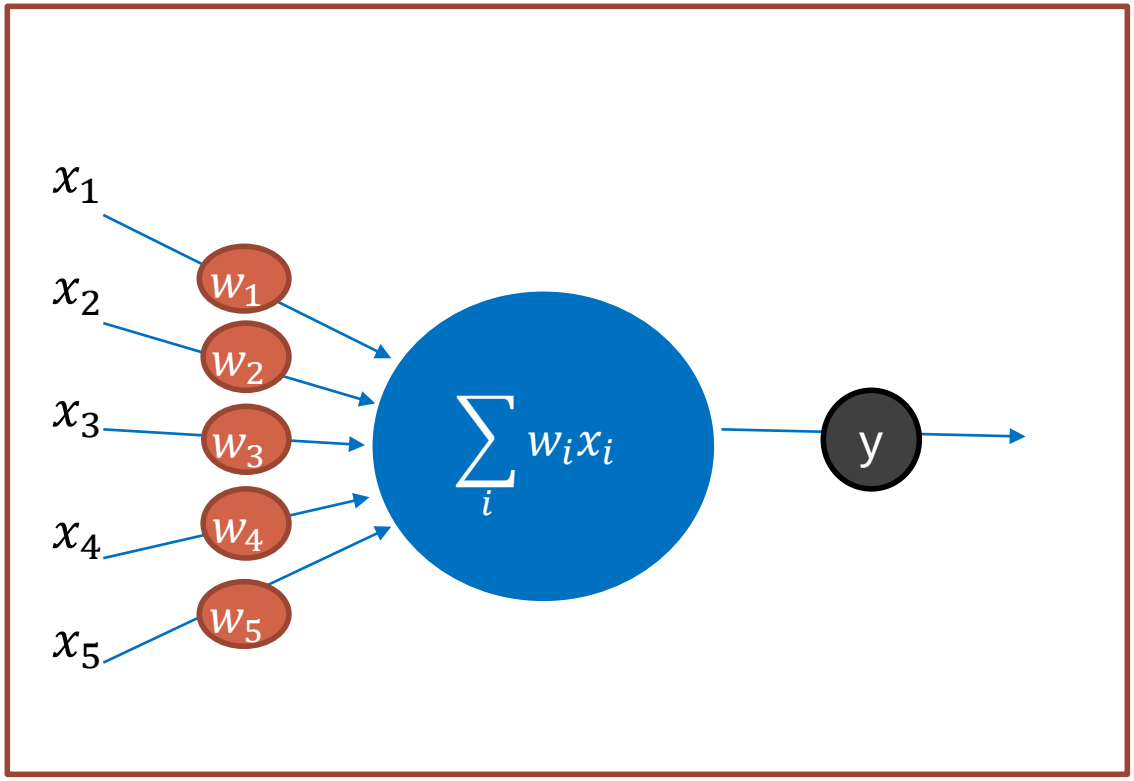
Simulation of a Neuron



In general, the weights (w_i) are not known.

If we have enough examples with inputs (x_i) and the generated output (y), we could compute estimates for the weights

Simulation of a Neuron

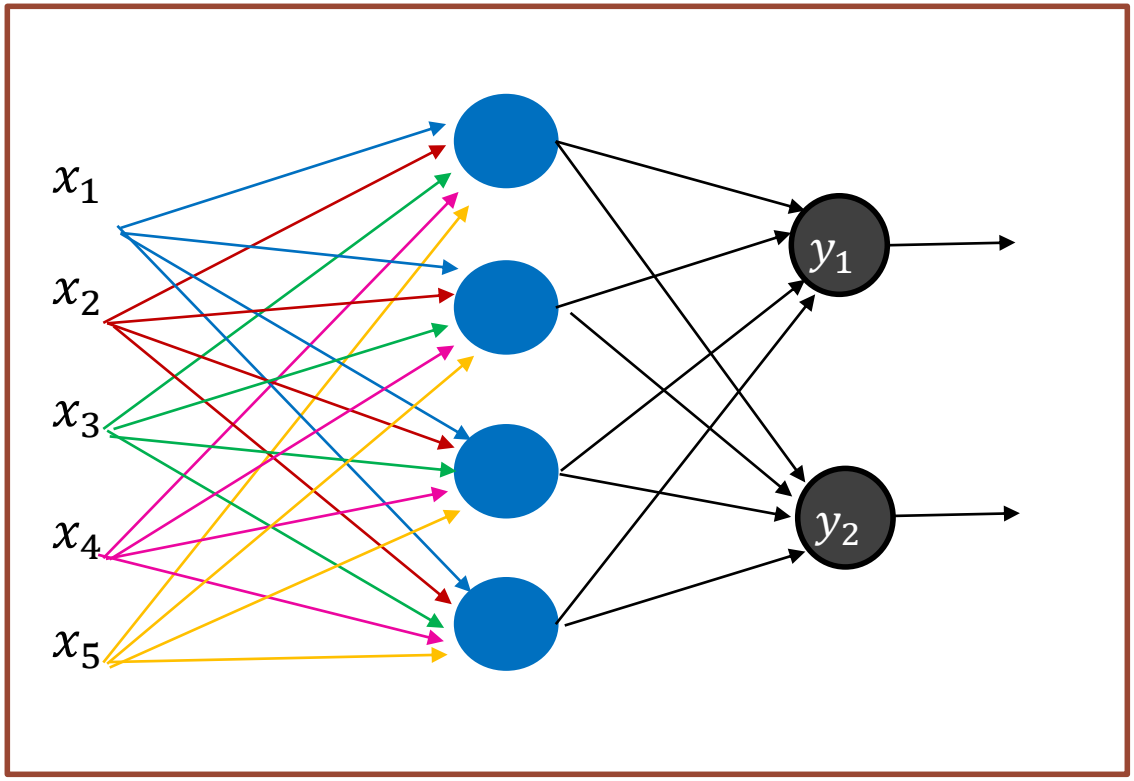


The process of estimating the weights, based on sets of known inputs and outputs is called the *training* of the model.

Simulation of a Single Neuron

A single neuron does not provide much information (often times, a 0/1 value)

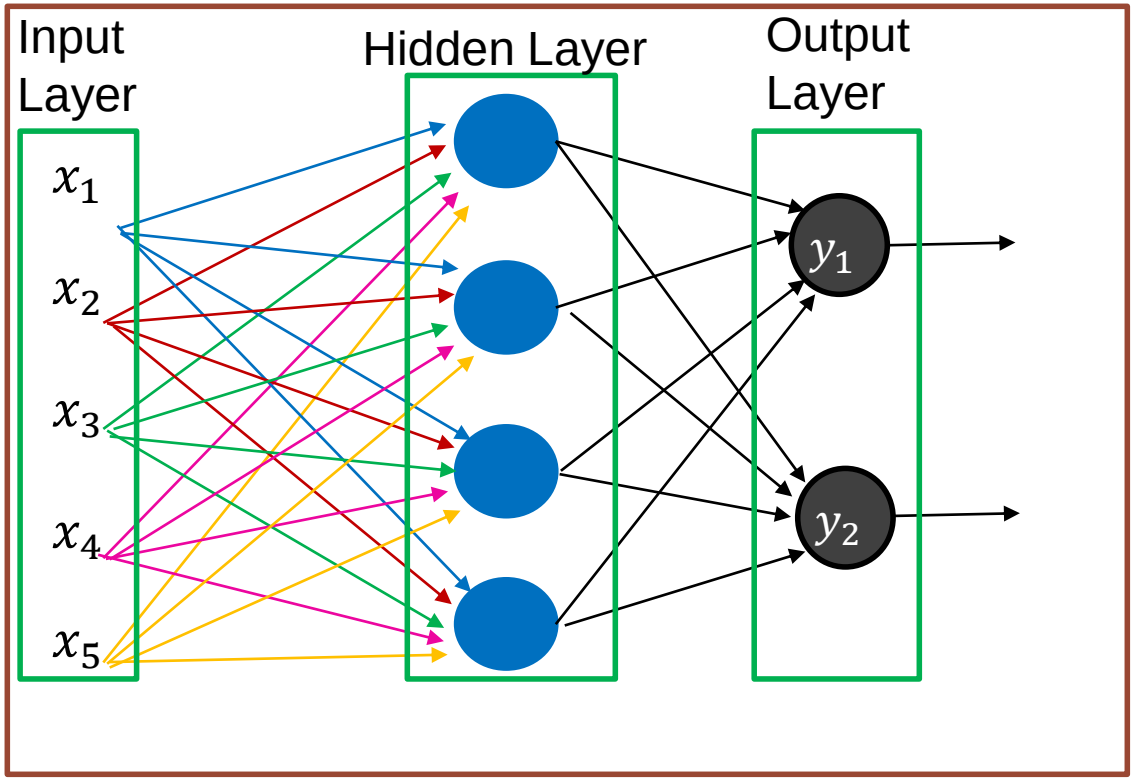
A Network of Neurons



Different computations with different weights can be performed to produce different outputs.

This is called a feedforward network because all values progress from the input to the output.

A Network of Neuron



A neural network has a single hidden layer

A network with two or more hidden layers is called a *deep neural network*.

LONG SHORT-TERM MEMORY

What is Long Short-Term Memory?

An example of a recurrent neural network that can handle sequences of data.

The sequences can have dependencies based on time or distance.

These networks can be used to analyze text, videos, and time-series data.

The Idea behind LSTMs

Often times information builds upon previous information.

Example: What would be the next word in the sentence

"The clouds are in the _____"

The Idea behind LSTMs

The more distant the relevant information, the less likely a recurrent neural network will determine the relationship.

Example: What would be the next word in the sentence

> “I grew up in Mexico. It was a wonderful childhood, and I am fluent in _____”

The Idea behind LSTMs

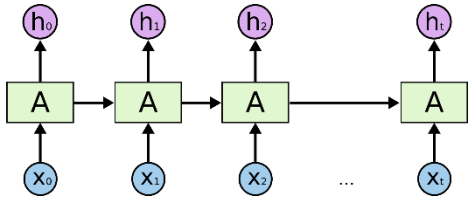
Perhaps a more relevant example:

To fully understand *The Avengers: Endgame*, you would need to watch several of the previous Avenger movies.

Images borrowed from:
https://en.wikipedia.org/wiki/Thor_(Marvel_Cinematic_Universe)
https://alteregocomics.com/avengers-infinity-war-thor-1-6-scale-figure/
https://nytimespost.com/avengers-endgame-chris-hemsworth-reveals-the-worst-part-about-fat-thor/

The Idea behind LSTMs

A Recurrent Neural Network (RNN) passes on information



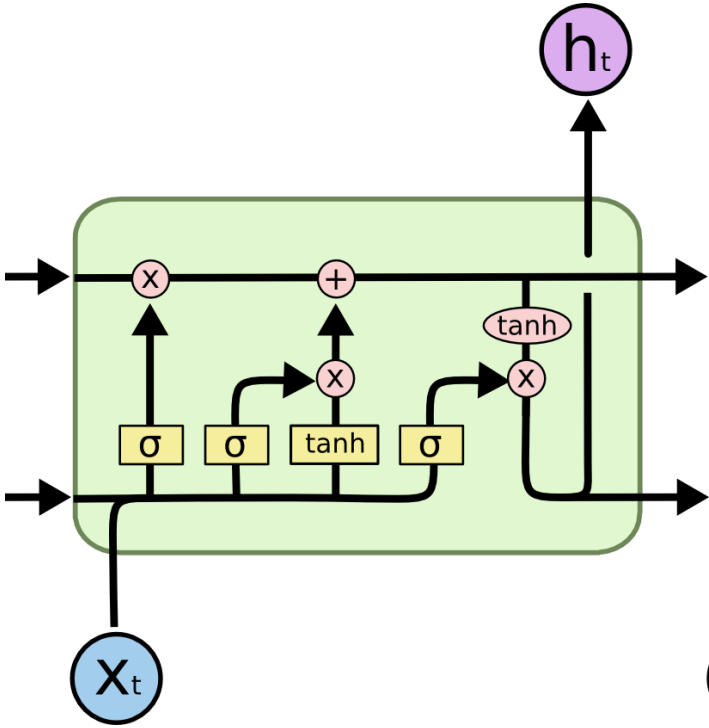
A drawback for RNNs is that the more distant the information, the more likely the information will be forgotten.

LSTMs must have a mechanism to maintain a history of what has gone before each object.

They do this by adding more detailed structures within each node..

Building Blocks of LSTMs

- The nodes, called cells, process the inputs in 4 ways.
  1. Determine which current information should be thrown away (forget gate)
  2. Determine what new information should be kept (input gate)
  3. Update the current state of the cell
  4. Determine what information will be passed on (output gate)



Images borrowed from
https://colah.github.io/posts/2015-08-Understanding-LSTMs/

Coding LSTM: General Steps

1. Load the tensor flow/keras packages
2. Read in the data
3. Pre-process the data
   a. Simplify to lower case and remove punctuation
   b. Tokenize into words and convert to sequences
   c. Split into training data & testing data
4. Define the model
5. Configure the Learning Process

6. Fit the model to the training data
7. Apply the model to test data & evaluate results

1. Load Keras Packages

Python

```
import numpy as np
import pandas as pd


from sklearn.feature_extraction.text import
CountVectorizer
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential
from keras.layers import Dense, Embedding, LSTM,
SpatialDropout1D
from sklearn.model_selection import train_test_split
from keras.utils.np_utils import to_categorical
import re
```

2. Read in the Data

Python

```
data = pd.read_csv('Sentiment.csv')

# Keep only the necessary columns
data = data[['text','sentiment']]
print(data.head())
```

3a. Pre-process Data: Simplify

Python

```
# Remove tweets that are neutral, non-alphanumeric data
# the RT at the start, and convert to lower case

data = data[data.sentiment != "Neutral"]
data['text'] = data['text'].apply((lambda x:
re.sub('[^a-zA-z0-9\s]','',x)))
data['text'] = data['text'].apply((lambda x:
re.sub('^RT','',x)))
data['text'] = data['text'].apply(lambda x: x.lower())
```

3b. Pre-process Data: Sequences

Python

```
max_words = 2000  #The 2000 most frequently used words
tokenizer = Tokenizer(num_words=max_words, split=' ')
tokenizer.fit_on_texts(data['text'].values)

X = tokenizer.texts_to_sequences(data['text'].values)
X = pad_sequences(X)

Y = pd.get_dummies(data['sentiment']).values
```

3c. Pre-process Data: Split

Python

```
X_train, X_test, Y_train, Y_test =
train_test_split(X,Y, test_size = 0.33, random_state =
42)
print(X_train.shape,Y_train.shape)
print(X_test.shape,Y_test.shape)
```

4. Define the Model

Python

```
embed_dim = 128
lstm_out = 196


model = Sequential()
model.add(Embedding(max_words, embed_dim,input_length =
X.shape[1]))
model.add(SpatialDropout1D(0.4))
model.add(LSTM(lstm_out, dropout=0.2,
recurrent_dropout=0.2))
model.add(Dense(2,activation='softmax'))
```

5. Configure the Learning Process

Python

```
model.compile(loss = 'binary_crossentropy',
optimizer='adam',metrics = ['accuracy'])
print(model.summary())
```

6. Fit the Model

Python

```
num_epochs = 7
batch_size = 32
model.fit(X_train, Y_train, epochs = num_epochs,
batch_size=batch_size, verbose = 1)
```

7. Apply the Model to Test Data

Python

```
score,acc = model.evaluate(X_test, Y_test, verbose = 2,
batch_size = batch_size)


print("score: %.2f" % (score))
print("acc: %.2f" % (acc))
```

Bonus Step: Apply model to new item

Python

```
twt = ['Meetings: Because none of us is as dumb as all
of us.']

# Pre-process tweet
twt = re.sub('[^a-zA-z0-9\s]','',twt[0].lower())
twt = tokenizer.texts_to_sequences(twt)
twt = pad_sequences(twt, maxlen=28, value=0)
```

Bonus Step: Apply model to new item

Python

```
# Run through the model
sentiment = model.predict(twt,batch_size=1,verbose =
2)[0]

#State result
if(np.argmax(sentiment) == 0):
    print("**The tweet is negative.**")
elif (np.argmax(sentiment) == 1):
    print("**The tweet is positive,**")
```

Activity: LSTM Program

- Make sure that you can run the LSTM code:

Python
`LSTM_example.ipynb`

QUESTIONS?