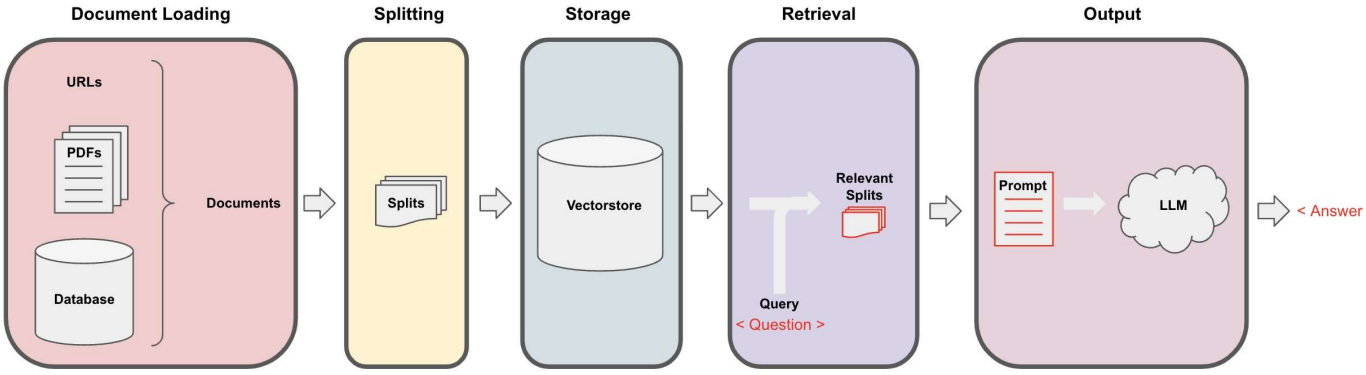
Vectorstores and Embeddings

Recall the overall workflow for retrieval augmented generation (RAG):



In [1]:
```
import os
import openai
import sys
sys.path.append('../..')

from dotenv import load_dotenv, find_dotenv
_ = load_dotenv(find_dotenv()) # read local .env file

openai.api_key  = os.environ['OPENAI_API_KEY']
```

We just discussed `Document Loading` and `Splitting`.

In [2]:
```
from langchain.document_loaders import PyPDFLoader

# Load PDF
loaders = [
    # Duplicate documents on purpose - messy data
    PyPDFLoader("docs/cs229_lectures/MachineLearning-Lecture01.pdf"),
    PyPDFLoader("docs/cs229_lectures/MachineLearning-Lecture01.pdf"),
    PyPDFLoader("docs/cs229_lectures/MachineLearning-Lecture02.pdf"),
    PyPDFLoader("docs/cs229_lectures/MachineLearning-Lecture03.pdf")
]
docs = []
for loader in loaders:
    docs.extend(loader.load())
```

In [3]:
```
# Split
from langchain.text_splitter import RecursiveCharacterTextSplitter
text_splitter = RecursiveCharacterTextSplitter(
    chunk_size = 1500,
    chunk_overlap = 150
)
```

In [4]:
```
splits = text_splitter.split_documents(docs)
```

In [5]:
```
len(splits)
```

```
209
```

Embeddings

Let's take our splits and embed them.

In [6]:
```
from langchain.embeddings.openai import OpenAIEmbeddings
embedding = OpenAIEmbeddings()
```

In [7]:
```
sentence1 = "i like dogs"
sentence2 = "i like canines"
sentence3 = "the weather is ugly outside"
```

In [8]:
```
embedding1 = embedding.embed_query(sentence1)
embedding2 = embedding.embed_query(sentence2)
embedding3 = embedding.embed_query(sentence3)
```

In [9]:
```
import numpy as np
```

In [10]:
```
np.dot(embedding1, embedding2)
```

```
0.9631853877103518
```

In [11]:
```
np.dot(embedding1, embedding3)
```

```
0.7709997651294672
```

In [12]:
```
np.dot(embedding2, embedding3)
```

```
0.7596334120325523
```

Vectorstores

In [13]:
```
# ! pip install chromadb
```

In [14]:
```
from langchain.vectorstores import Chroma
```

In [15]:
```
persist_directory = 'docs/chroma/'
```

In [16]:
```
!rm -rf ./docs/chroma  # remove old database files if any
```

In [17]:
```
vectordb = Chroma.from_documents(
    documents=splits,
    embedding=embedding,
    persist_directory=persist_directory
)
```

In [18]:
```
print(vectordb._collection.count())
```

```
209
```

Similarity Search

In [19]:
```
question = "is there an email i can ask for help"
```

In [20]:
```
docs = vectordb.similarity_search(question,k=3)
```

In [21]:
```
len(docs)
```

```
3
```

In [22]:
```
docs[0].page_content
```

```
"cs229-qa@cs.stanford.edu. This goes to an acc ount that's read by all the TA
s and me. So \nrather than sending us email individually, if you send email t
o this account, it will \nactually let us get back to you maximally quickly w
ith answers to your questions.  \nIf you're asking questions about homework p
robl ems, please say in the subject line which \nassignment and which questio
n the email refers to, since that will also help us to route \nyour question
to the appropriate TA or to me  appropriately and get the response back to \n
you quickly.  \nLet's see. Skipping ahead — let's see — for homework, one mid
term, one open and term \nproject. Notice on the honor code. So one thi ng th
at I think will help you to succeed and \ndo well in this class and even help
you to enjoy this cla ss more is if you form a study \ngroup.  \nSo start loo
king around where you' re sitting now or at the end of class today, mingle a
\nlittle bit and get to know your classmates. I strongly encourage you to for
m study groups \nand sort of have a group of people to study with and have a
group of your fellow students \nto talk over these concepts with. You can als
o  post on the class news group if you want to \nuse that to try to form a st
udy group.  \nBut some of the problems sets in this cla ss are reasonably dif
ficult.  People that have \ntaken the class before may tell you they were ver
y difficult. And just I bet it would be \nmore fun for you, and you'd probabl
y have a be tter learning experience if you form a"
```

Let's save this so we can use it later!

In [23]:
```
vectordb.persist()
```

Failure modes

This seems great, and basic similarity search will get you 80% of the way there very easily.

But there are some failure modes that can creep up.

Here are some edge cases that can arise - we'll fix them in the next class.

In [24]:
```
question = "what did they say about matlab?"
```

In [25]:
```
docs = vectordb.similarity_search(question,k=5)
```

Notice that we're getting duplicate chunks (because of the duplicate `MachineLearning-Lecture01.pdf` in th index).

Semantic search fetches all similar documents, but does not enforce diversity.

`docs[0]` and `docs[1]` are indentical.

In [26]:
```
docs[0]
```

```
Document(page_content='those homeworks will be done in either MATLA B or in O
ctave, which is sort of — I \nknow some people call it a free ve rsion of MAT
LAB, which it sort  of is, sort of isn\'t.  \nSo I guess for those of you tha
t haven\'t s een MATLAB before, and I know most of you \nhave, MATLAB is I gu
ess part of the programming language that makes it very easy to write codes u
sing matrices, to write code for numerical routines, to move data around, to
\nplot data. And it\'s sort of an extremely easy to  learn tool to use for im
plementing a lot of \nlearning algorithms.  \nAnd in case some of you want to
work on your  own home computer or something if you \ndon\'t have a MATLAB li
cense, for the purposes of  this class, there\'s also — [inaudible] \nwrite t
hat down [inaudible] MATLAB — there\' s also a software package called Octave
\nthat you can download for free off the Internet. And it has somewhat fewer
features than MATLAB, but it\'s free, and for the purposes of  this class, it
will work for just about \neverything.  \nSo actually I, well, so yeah, just
a side comment for those of you that haven\'t seen \nMATLAB before I guess, o
nce a colleague of mine at a different university, not at \nStanford, actuall
y teaches another machine l earning course. He\'s taught it for many years.
\nSo one day, he was in his office, and an old student of his from, lik e, te
n years ago came \ninto his office and he said, "Oh, professo r, professor, t
hank you so much for your', metadata={'source': 'docs/cs229_lectures/MachineL
earning-Lecture01.pdf', 'page': 8})
```

In [27]:
```
docs[1]
```

```
Document(page_content='those homeworks will be done in either MATLA B or in O
ctave, which is sort of — I \nknow some people call it a free ve rsion of MAT
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\nSo one day, he was in his office, and an old student of his from, lik e, te
n years ago came \ninto his office and he said, "Oh, professo r, professor, t
hank you so much for your', metadata={'source': 'docs/cs229_lectures/MachineL
earning-Lecture01.pdf', 'page': 8})
```

We can see a new failure mode.

The question below asks a question about the third lecture, but includes results from other lectures as well.

In [28]:
```
question = "what did they say about regression in the third lecture?"
```

In [29]:
```
docs = vectordb.similarity_search(question,k=5)
```

In [30]:
```
for doc in docs:
    print(doc.metadata)
```

```
{'source': 'docs/cs229_lectures/MachineLearning-Lecture03.pdf', 'page': 0}
{'source': 'docs/cs229_lectures/MachineLearning-Lecture03.pdf', 'page': 14}
{'source': 'docs/cs229_lectures/MachineLearning-Lecture02.pdf', 'page': 0}
{'source': 'docs/cs229_lectures/MachineLearning-Lecture03.pdf', 'page': 6}
{'source': 'docs/cs229_lectures/MachineLearning-Lecture01.pdf', 'page': 8}
```

In [31]:
```
print(docs[4].page_content)
```

```
into his office and he said, "Oh, professo r, professor, thank you so much fo
r your
machine learning class. I learned so much from it. There's this stuff that I
learned in your
class, and I now use every day. And it's help ed me make lots of money, and h
ere's a
picture of my big house."
So my friend was very excited. He said, "W ow. That's great. I'm glad to hear
this
machine learning stuff was actually useful. So what was it that you learned?
Was it
logistic regression? Was it the PCA? Was it the data ne tworks? What was it t
hat you
learned that was so helpful?" And the student said, "Oh, it was the MATLAB."
So for those of you that don't know MATLAB yet, I hope you do learn it. It's
not hard,
and we'll actually have a short MATLAB tutori al in one of the discussion sec
tions for
those of you that don't know it.
Okay. The very last piece of logistical th ing is the discussion s ections. S
o discussion
sections will be taught by the TAs, and atte ndance at discussion sections is
optional,
although they'll also be recorded and televi sed. And we'll use the discussio
n sections
mainly for two things. For the next two or th ree weeks, we'll use the discus
sion sections
to go over the prerequisites to this class or if some of you haven't seen pro
bability or
statistics for a while or maybe algebra, we'll go over those in the discussio
n sections as a
refresher for those of you that want one.
```

Approaches discussed in the next lecture can be used to address both!

In [ ]:
```
```