

# AI4M\_C3\_M2\_lecture\_notebook\_negbio

September 13, 2021

## 0.1 AI for Medicine Course 3 Week 1 lecture notebook

## 0.2 Using BioC format and the NegBio Library

Welcome to this lecture notebook! You'll be exploring some of the uses of the `NegBio` library, a tool for biomedical text mining, which you will use in the graded assignment at the end of the week.

You'll be using the same dataset as in the assignment, so this is a good opportunity to become more familiar with it. - This dataset consists of 1,000 X-ray reports that have been manually labeled by a board-certified radiologist. - The reports indicate the presence or absence of several different pathologies. - You'll also have access to the extracted "Report Impression" section of each report, which is the summary provided for each X-ray.

### 0.2.1 Import Pandas and Load Dataset

```
[1]: import pandas as pd

# Read the data from file
df = pd.read_csv("stanford_report_test.csv")

# Check the num of rows, columns
print(f"dataset has shape: {df.shape}")
df.head()
```

dataset has shape: (1000, 18)

```
[1]: SimpleTestReportID                                Report Impression \
0                1.0  \n \n1.mild pulmonary edema, and cardiomegaly...
1                2.0  \n \n1.unremarkable cardiomediastinal silhouet...
2                3.0  \n1. lines and tubes are unchanged in position...
3                4.0  \n1. postoperative portable film with a right-...
4                6.0  \n \n1.single frontal view of the chest demons...

No Finding  Enlarged Cardiomediastinum  Cardiomegaly  Lung Lesion  \
0          NaN                        NaN            1.0          NaN
1          NaN                        0.0            NaN          NaN
2          NaN                        NaN            NaN          NaN
```

3	NaN	NaN	NaN	NaN
4	NaN	NaN	NaN	NaN

	Airspace Opacity	Edema	Consolidation	Pneumonia	Atelectasis	\
0	NaN	1.0	-1.0	NaN	1.0	
1	1.0	NaN	0.0	-1.0	NaN	
2	1.0	NaN	NaN	NaN	NaN	
3	1.0	1.0	NaN	NaN	1.0	
4	1.0	NaN	NaN	NaN	NaN	

	Pneumothorax	Pleural Effusion	Pleural Other	Fracture	Support Devices	\
0	NaN	1.0	NaN	NaN	1.0	
1	0.0	0.0	NaN	1.0	NaN	
2	-1.0	NaN	NaN	NaN	1.0	
3	1.0	NaN	NaN	NaN	1.0	
4	0.0	1.0	NaN	NaN	1.0	

	Report Impression Parsed	\
0	['(S1 (S (S (S (LST (LS 1.)) (NP (JJ mild) (JJ...	
1	['(S1 (S (S (NP (LST (LS 1.)) (NN unremarkable...	
2	['(S1 (S (S (LST (LS 1.)) (NP (NP (NNS lines))...	
3	['(S1 (S (S (LST (LS 1.)) (NP (NP (JJ postoper...	
4	['(S1 (S (S (NP (NP (LST (LS 1.)) (JJ single) ...	

	Report Impression DG Paths
0	['/data3/CXR-CHEST/dgs/GL66832b_GL6dd686/0.pkl...
1	['/data3/CXR-CHEST/dgs/GL6f51db_GL6f51dd/0.pkl...
2	['/data3/CXR-CHEST/dgs/GL666dde_GL6b021a/0.pkl...
3	['/data3/CXR-CHEST/dgs/GL6a8d08_GL6d5d21/0.pkl...
4	['/data3/CXR-CHEST/dgs/GL675b56_GL6f4eb9/0.pkl...

```
[2]: # Get a better view of the report impression column
for i in range(3):
    print("#####")
    print(f"Report number: {i+1}")
    print(df.loc[i, 'Report Impression'])
```

```
#####
Report number: 1
```

```
1.mild pulmonary edema, and cardiomegaly. trace pleural fluid
effusions.
```

```
2.low lung volumes with minimal basilar atelectasis.
```

```
3.no new focal consolidation.
```

4.interval placement of defibrillation pads.

#####

Report number: 2

1.unremarkable cardiomedastinal silhouette

2.diffuse reticular pattern, which can be seen with an atypical infection or chronic fibrotic change. no focal consolidation.

3.no pleural effusion or pneumothorax

4.mild degenerative changes in the lumbar spine and old right rib fractures.

#####

Report number: 3

1. lines and tubes are unchanged in position.

2. increasing retrocardiac opacity and left midlung zone opacity.

3. there is a deep left costophrenic sulcus which is increased when compared with prior films. no definite evidence of left pneumothorax. clinical correlation is recommended. if clinically indicated, consider film in expiration or decubitus views.

4. the icu team was informed of these results at 10 am on 05\_02\_2005.

## 0.2.2 Introducing BioC

Let's get started by looking at the BioC module. You'll be using BioC to convert your clinical data into a standard format that can be leveraged on more specialized libraries. This module is used for many other NLP tasks as well, such as serialization or deserialization of data. You can read more about it [here](#).

For your purposes, you're interested in the BioCCollection object, which represents a collection of documents for a project. The collection might be an entire corpus, or a partial one.

```
[3]: import bioc

collection = bioc.BioCCollection()
print(f"attributes with value: \n\n{collection.__dict__}\n")
print(f"methods and attributes: \n\n{dir(collection)}\n")
print(f"documents within collection: {collection.documents}")
```

attributes with value:

```
{'encoding': 'utf-8', 'version': '1.0', 'standalone': True, 'source': '',  
'date': '2021-09-13', 'key': '', 'infons': {}, 'documents': []}
```

methods and attributes:

```
['__class__', '__delattr__', '__dict__', '__dir__', '__doc__', '__eq__',  
 '__format__', '__ge__', '__getattribute__', '__gt__', '__hash__', '__init__',  
 '__init_subclass__', '__le__', '__lt__', '__module__', '__ne__', '__new__',  
 '__reduce__', '__reduce_ex__', '__repr__', '__setattr__', '__sizeof__',  
 '__str__', '__subclasshook__', '__weakref__', 'add_document', 'clear_infons',  
 'date', 'documents', 'encoding', 'infons', 'key', 'source', 'standalone',  
 'version']
```

documents within collection: []

### 0.2.3 Preparing the Text for BioC

When working with collections, you're mostly interested in the documents attribute and the `add_document()` method.

The BioC module gives you a standard format that allows you to apply other, more specialized libraries. Before seeing BioC in action, let's introduce `NegBio`, a tool that distinguishes negative or uncertain findings in radiology reports. It accomplishes this by using patterns on universal dependencies, instead of using rule-based methods. If you'd like to know more, check out the official github [repo](#), or the official [documentation](#).

You'll be using the `NegBioSSplitter` object to split your text into sentences. However, in order to do this, you'll first need to convert your text into a format that BioC supports. For this you'll use the `text2bioc()` function, which transforms the text into a BioC XML file. You can go even further and convert the text into documents with the `text2document()` function.

```
[4]: from negbio.pipeline.ssplitt import NegBioSSplitter  
     from negbio.pipeline import text2bioc  
  
     splitter = NegBioSSplitter()  
     for i, report in enumerate(df["Report Impression"]):  
         document = text2bioc.text2document(str(i), report)  
         document = splitter.split_doc(document)  
         collection.add_document(document)
```

```
[5]: collection.documents
```

```
[5]: [BioCDocument[id=0,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.mild  
pulmona ... lation pads. \n  
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.mild pulmona ... and  
cardiomegaly.',infons=[],annotations=[],relations=[,],BioCSentence[offset=46,te
```

```

xt='trace pleural fluid \neffusions.',infons=[],annotations=[],relations=[],],Bi
oCSentence[offset=80,text='2.low lung volume ... ilar atelectasis.',infons=[],an
notations=[],relations=[],],BioCSentence[offset=135,text='3.no new focal consoli
dation.',infons=[],annotations=[],relations=[],],BioCSentence[offset=168,text='4
.interval placem ... ibrillation pads.',infons=[],annotations=[],relations=[],],
annotations=[],relations=[],],annotations=[],relations=[],],
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\n1.unremarkable ... b \nfractures. \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.unremarkable ...
fibrotic change.',infons=[],annotations=[],relations=[],],BioCSentence[offset=15
3,text='no focal consolidation.',infons=[],annotations=[],relations=[],],BioCSen
tence[offset=179,text='3.no pleural effu ... t rib \nfractures.',infons=[],annot
ations=[],relations=[],],annotations=[],relations=[],],annotations=[],relation
s=[],],
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tub ... m on
05_02_2005.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. lines and
tub ... nged in position.',infons=[],annotations=[],relations=[],],BioCSentence[
offset=47,text='2. increasing ret ... ung zone opacity.',infons=[],annotations=[
],relations=[],],BioCSentence[offset=113,text='3. there is a dee ... with prior
films.',infons=[],annotations=[],relations=[],],BioCSentence[offset=208,text='no
definite evide ... eft\npneumothorax.',infons=[],annotations=[],relations=[],],B
ioCSentence[offset=251,text='clinical correlation is recommended.',infons=[],ann
otations=[],relations=[],],BioCSentence[offset=288,text='if clinically\nind ...
decubitus
views.',infons=[],annotations=[],relations=[],],BioCSentence[offset=361,text='4.
the icu team w ... am on 05_02_2005.',infons=[],annotations=[],relations=[],],a
nnotations=[],relations=[],],annotations=[],relations=[],],
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postoperative ... table
technique.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1.
postoperative ... ght pneumothorax.',infons=[],annotations=[],relations=[],],Bio
CSentence[offset=97,text='2. left basilar o ... kely atelectasis.',infons=[],ann
otations=[],relations=[],],BioCSentence[offset=142,text='recommend attenti ...
ion or infection.',infons=[],annotations=[],relations=[],],BioCSentence[offset=2
58,text='3. likely mild in ... rtable technique.',infons=[],annotations=[],relat
ions=[],],annotations=[],relations=[],],annotations=[],relations=[],],
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front ... eumothorax. \n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.single front ...
the \nprior exam.',infons=[],annotations=[],relations=[],],BioCSentence[offset=1
57,text='2.stable redemons ... o the prior exam.',infons=[],annotations=[],relat
ions=[],],BioCSentence[offset=293,text='3.no evidence of pneumothorax.',infons=[
],annotations=[],relations=[],],annotations=[],relations=[],],annotations=[],r
elations=[],],
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mild pe ... solidation. \n \n

```

',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. mild pe ... s \nb  
ronchiolitis.',infons=[],annotations=[],relations=[],],BioCSentence[offset=85,te  
xt='2. no evidence of focal consolidation.',infons=[],annotations=[],relations=  
[],]],annotations=[],relations=[],],annotations=[],relations=[],],  
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bee ... ural  
thickening.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. there has  
bee ... pulmonary\nedema.',infons=[],annotations=[],relations=[],],BioCSentence  
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from  
prior.',infons=[],annotations=[],relations=[],],BioCSentence[offset=261,text='3.  
there is bilat ... eural thickening.',infons=[],annotations=[],relations=[],]],a  
nnotations=[],relations=[],],annotations=[],relations=[],],  
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plac ... rta.  
osteopenia.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. interval  
plac ... horax identified.',infons=[],annotations=[],relations=[],],BioCSentence  
[offset=171,text='2. reduced lung v ... ymal granulomata.',infons=[],annotations  
=[],relations=[],],BioCSentence[offset=289,text='left hilar\ncalcified lymph  
nodes.',infons=[],annotations=[],relations=[],],BioCSentence[offset=323,text='3.  
cardiac silhou ... ar\nconfiguration.',infons=[],annotations=[],relations=[],],B  
ioCSentence[offset=394,text='atherosclerotic aorta.',infons=[],annotations=[],re  
lations=[],],BioCSentence[offset=417,text='osteopenia.',infons=[],annotations=[  
],relations=[],],annotations=[],relations=[],],annotations=[],relations=[],],  
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eviden ... eous findings.\n  
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. no eviden ... or  
pneumothorax.',infons=[],annotations=[],relations=[],],BioCSentence[offset=98,te  
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[],],BioCSentence[offset=146,text='2. the cardiomed ... in normal limits.',info  
ns=[],annotations=[],relations=[],],BioCSentence[offset=210,text='3. no acute  
osseous findings.',infons=[],annotations=[],relations=[],],annotations=[],relat  
ions=[],],annotations=[],relations=[],],  
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\n1.stable lef ... ural effusion.\n  
\n',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n1.stable lef ...  
remity picc line.',infons=[],annotations=[],relations=[],],BioCSentence[offset=4  
8,text='2.stable cardiome ... pleural effusion.',infons=[],annotations=[],relati  
ons=[],],annotations=[],relations=[],],annotations=[],relations=[],],  
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low lung ... al effusion. \n \n  
' ,infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. low lung ...  
reater than left.',infons=[],annotations=[],relations=[],],BioCSentence[offset=8  
8,text='atelectasis versus consolidation.',infons=[],annotations=[],relations=[  
],],BioCSentence[offset=126,text='2. right-sided pleural effusion.',infons=[],an  
notations=[],relations=[],],annotations=[],relations=[],],annotations=[],relat

```

ions=[],],
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cardiomed ...
es\nunremarkable.\n',infons=[],sentences=[BioCSentence[offset=0,text='\nnormal
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nce[offset=38,text='no focal consolid ... pleural effusion.',infons=[],annotatio
ns=[],relations=[],],BioCSentence[offset=82,text='no pneumothorax.',infons=[],an
notations=[],relations=[],],BioCSentence[offset=99,text='osseous structures\nunr
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],],annotations=[],relations=[],],
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lines and ... leural
effusion.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. all lines and
... m\nthe prior
exam.',infons=[],annotations=[],relations=[],],BioCSentence[offset=80,text='2.
new small left ... pleural effusion.',infons=[],annotations=[],relations=[],],],a
nnotations=[],relations=[],],],annotations=[],relations=[],],
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\n1.compared to ... upper abdomen.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.compared to ... to
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entence[offset=190,text='2.stable cardiomedial silhouetted.',infons=[],annot
ations=[],relations=[],],BioCSentence[offset=231,text='3.persistent left ...
usion, unchanged.',infons=[],annotations=[],relations=[],],BioCSentence[offset=2
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ions=[],],],annotations=[],relations=[],],],annotations=[],relations=[],],
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',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. placemen ...
oatrial junction.',infons=[],annotations=[],relations=[],],BioCSentence[offset=7
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ions=[],],],annotations=[],relations=[],],],annotations=[],relations=[],],
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right p ... pulmonary
edema.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. large right p
... creasing in size.',infons=[],annotations=[],relations=[],],BioCSentence[offs
et=53,text='compression\natelectasis again
noted.',infons=[],annotations=[],relations=[],],BioCSentence[offset=90,text='2.
minimal interstitial pulmonary edema.',infons=[],annotations=[],relations=[],],],
annotations=[],relations=[],],],annotations=[],relations=[],],
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sided tu ... es are normal.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \nrigh-sided tu ...
theter is stable.',infons=[],annotations=[],relations=[],],BioCSentence[offset=6
0,text='the lungs \nare clear.',infons=[],annotations=[],relations=[],],BioCSent
ence[offset=83,text='there is no pleural effusion.',infons=[],annotations=[],rel

```

```

ations=[],],BioCSentence[offset=114,text='bony structures are normal.',infons=[],
,annotations=[],relations=[],],annotations=[],relations=[],],annotations=[],re
lations=[],],
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right up ... ral effusion.\n \n
',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. right up ...
atrial \njunction.',infons=[],annotations=[],relations=[],],BioCSentence[offset=
83,text='2. increased air ... tion bilaterally.',infons=[],annotations=[],relat
ions=[],],BioCSentence[offset=137,text='3. stable right pleural effusion.',infon
s=[],annotations=[],relations=[],],annotations=[],relations=[],],annotations=[
],relations=[],],
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frontal an ... s abnormality.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. frontal an ...
riate \npositions.',infons=[],annotations=[],relations=[],],BioCSentence[offset=
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],BioCSentence[offset=182,text='the thoracic aort ... ic calcification.',infons
=[],annotations=[],relations=[],],BioCSentence[offset=251,text='no pulmonary
edema or pleural \neffusion.',infons=[],annotations=[],relations=[],],BioCSenten
ce[offset=294,text='3. the lungs appear
clear.',infons=[],annotations=[],relations=[],],BioCSentence[offset=324,text='4.
no acute osseous abnormality.',infons=[],annotations=[],relations=[],],annotati
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\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. small left pleural
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],],
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right ... pneumonia. \n \n
',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n \n1. right lower
lobe pneumonia.',infons=[],annotations=[],relations=[],],annotations=[],relatio
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\n1.patient ha ... edema pattern.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n1.patient ha ...
jugular catheter.',infons=[],annotations=[],relations=[],],BioCSentence[offset=9
6,text='thoracic aortic g ... xation \nhardware.',infons=[],annotations=[],relat
ions=[],],BioCSentence[offset=151,text='2.moderate bilate ... ry edema pattern.'
,infons=[],annotations=[],relations=[],],annotations=[],relations=[],],annotat
ions=[],relations=[],],
BioCDocument[id=22,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.
interval r ... effusions.\n \n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. interval r ... cal

```



```

pneumothorax.',infons=[],annotations=[],relations=[],],BioCSentence[offset=96,te
xt='2. no significan ... leural effusions.',infons=[],annotations=[],relations=
[],]],annotations=[],relations=[],]],annotations=[],relations=[],],
BioCDocument[id=23,infons=[],passages=[BioCPassage[offset=0,text='\n
\n1.cardiomedias ... the skeleton.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.cardiomedias ... s
thoracic aorta.',infons=[],annotations=[],relations=[],],BioCSentence[offset=102
,text='lungs appear
clear.',infons=[],annotations=[],relations=[],],BioCSentence[offset=123,text='no
\nconsolidation ... pulmonary edema.',infons=[],annotations=[],relations=[],],B
ioCSentence[offset=190,text='mild \ndegenerativ ... of the skeleton.',infons=[
],annotations=[],relations=[],]],annotations=[],relations=[],]],annotations=[,re
lations=[],],
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plac ... is
appreciated.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. interval
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[offset=112,text='no evidence of\npu ... pleural effusion.',infons=[],annotation
s=[],relations=[],],BioCSentence[offset=164,text='2.no focal conso ... uggest p
neumonia.',infons=[],annotations=[],relations=[],],BioCSentence[offset=212,text=
'3. no evidence of pneumothorax.',infons=[],annotations=[],relations=[],],BioCSe
ntence[offset=244,text='no acute cardiopu ... y is appreciated.',infons=[],annot
ations=[],relations=[],]],annotations=[],relations=[],]],annotations=[],relation
s=[],],
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lung ... ural effusion.\n \n',infons=[],sentences=[BioCSentence[offset=0,text='
\n \n1. low lung ... ft hemidiaphragm.',infons=[],annotations=[],relations=[],
],BioCSentence[offset=75,text='bilateral lower l ... r \nconsolidation.',infons=
[],annotations=[],relations=[],],BioCSentence[offset=154,text='a dedicated two v
... wo possibilities.',infons=[],annotations=[],relations=[],],BioCSentence[offs
et=252,text='2. worrisome 1.7 ... right upper lobe.',infons=[],annotations=[],r
elations=[],],BioCSentence[offset=306,text='cannot exclude \nneoplasm.',infons=[
],annotations=[],relations=[],],BioCSentence[offset=334,text='3. small right
pleural effusion.',infons=[],annotations=[],relations=[],]],annotations=[],relat
ions=[],]],annotations=[],relations=[],],
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reposition ... equent film.\n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. reposition ...
right chest
tube.',infons=[],annotations=[],relations=[],],BioCSentence[offset=48,text='2.
interval decr ... subsequent film.',infons=[],annotations=[],relations=[],]],an
notations=[],relations=[],]],annotations=[],relations=[],],
BioCDocument[id=27,infons=[],passages=[BioCPassage[offset=0,text=' \n \ndiffuse
coars ... procedural ct.\n \n',infons=[],sentences=[BioCSentence[offset=0,text='
\n \ndiffuse coars ... ial lung disease.',infons=[],annotations=[],relations=[
],BioCSentence[offset=128,text='no \ndefinite pneu ... all soft tissues.',infons
=[],annotations=[],relations=[],],BioCSentence[offset=314,text='three

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embolizatio ... e left lung base.',infons=[],annotations=[],relations=[],],BioCSentence[offset=369,text='ill-defined conso ... genic malignancy.',infons=[],annotations=[],relations=[],],BioCSentence[offset=556,text='recommend repeat ... traprocedural ct.',infons=[],annotations=[],relations=[],],annotations=[],relations=[],],annotations=[],relations=[],],

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BioCDocument[id=431,infons=[],passages=[BioCPassage[offset=0,text='\ntwo views of the ... is\nunremarkable.\n',infons=[],sentences=[BioCSentence[offset=0,text='\ntwo views of the ... chronic changes.',infons=[],annotations=[],relations=[],],BioCSentence[offset=169,text='no focal air spac ... ies or effusions.',infons=[],annotations=[],relations=[],],BioCSentence[offset=212,text='cardiomediastinal ... is\nunremarkable.',infons=[],annotations=[],relations=[],],],annotations=[],relations=

```

ions=[],],annotations=[],relations=[],],
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and t ... ion, unchanged.\n
',infons=[],sentences=[BioCSentence[offset=0,text='\n 1. lines and t ... nged
in position.',infons=[],annotations=[],relations=[],],BioCSentence[offset=50,te
t='2. persistent bi ... usion, unchanged.',infons=[],annotations=[],relations=[
],],annotations=[],relations=[],],annotations=[],relations=[],],
BioCDocument[id=433,infons=[],passages=[BioCPassage[offset=0,text='\n 1.
single port ... he prior study.\n
',infons=[],sentences=[BioCSentence[offset=0,text='\n 1. single port ...
support devices.',infons=[],annotations=[],relations=[],],BioCSentence[offset=11
7,text='bilateral upper l ... bullae resection.',infons=[],annotations=[],relati
ons=[],],BioCSentence[offset=201,text='persistent right ... a appears stable.',
infons=[],annotations=[],relations=[],],BioCSentence[offset=321,text='left upper
lobe\np ... is are unchanged.',infons=[],annotations=[],relations=[],],BioCSente
nce[offset=383,text='2. follow up sin ... \nthe prior study.',infons=[],annotat
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[]],
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moderate r ... otherorax.\n \n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. moderate r ... ded
pneumothorax.',infons=[],annotations=[],relations=[],],annotations=[],relations
=[],],annotations=[],relations=[],],
BioCDocument[id=435,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.left-
sided p ... be obtained.\n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.left-sided p ...
left lung region.',infons=[],annotations=[],relations=[],],BioCSentence[offset=1
00,text='this is favored t ... be consolidation.',infons=[],annotations=[],relat
ions=[],],BioCSentence[offset=163,text='an underlying mass is not excluded.',inf
ons=[],annotations=[],relations=[],],BioCSentence[offset=200,text='clinical
\ncorrelation suggested.',infons=[],annotations=[],relations=[],],BioCSentence[o
ffset=234,text='a post treatment ... ould be obtained.',infons=[],annotations=[
],relations=[],],annotations=[],relations=[],],annotations=[],relations=[],],
BioCDocument[id=436,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.
grossly un ... appearance. \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. grossly un ...
parietal pleura.',infons=[],annotations=[],relations=[],],BioCSentence[offset=13
3,text='lungs \nare otherwise grossly
clear.',infons=[],annotations=[],relations=[],],BioCSentence[offset=171,text='2.
cardiomediast ... us in appearance.',infons=[],annotations=[],relations=[],],an
notations=[],relations=[],],annotations=[],relations=[],],
BioCDocument[id=437,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.
clear lung ... cardiomegaly.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. clear
lungs.',infons=[],annotations=[],relations=[],],BioCSentence[offset=20,text='no
significant pu ... edema as queried.',infons=[],annotations=[],relations=[],],Bi
oCSentence[offset=65,text='2. unchanged cardiomegaly.',infons=[],annotations=[]

```

```
,relations=[],],annotations=[],relations=[],],annotations=[],relations=[],],
BioCDocument[id=438,infons=[],passages=[BioCPassage[offset=0,text=' \n \n 1.
right up ... ient is able.\n \n
',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. right up ...
atrial \njunction.',infons=[],annotations=[],relations=[],],BioCSentence[offset=
81,text='2. low lung volu ... nary vasculature.',infons=[],annotations=[],relat
ions=[],],BioCSentence[offset=142,text='this \nreticular p ... ytical infection.
',infons=[],annotations=[],relations=[],],BioCSentence[offset=246,text='recommen
d repeat ... patient is able.',infons=[],annotations=[],relations=[],],],annota
tions=[],relations=[],],annotations=[],relations=[],],
BioCDocument[id=439,infons=[],passages=[BioCPassage[offset=0,text=' \n \n 1.
no sig ... ly evaluated.\n \n
',infons=[],sentences=[BioCSentence[offset=0,text=' \n \n 1. no sig ...
leural \neffusion.',infons=[],annotations=[],relations=[],],BioCSentence[offset=
155,text='stable cardiomediastinal silhouette.',infons=[],annotations=[],relatio
ns=[],],BioCSentence[offset=195,text='2. nasogastric tube in stable position.',
infons=[],annotations=[],relations=[],],BioCSentence[offset=237,text='drain
projecting ... letely evaluated.',infons=[],annotations=[],relations=[],],],anno
tations=[],relations=[],],annotations=[],relations=[],],
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worsening ... described. \n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1. worsening ... ung
as described.',infons=[],annotations=[],relations=[],],],annotations=[],relations
=[],],annotations=[],relations=[],],
BioCDocument[id=441,infons=[],passages=[BioCPassage[offset=0,text='\n1.
redemonstrati ... line
unchanged.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1.
redemonstrati ... the lower
lobes.',infons=[],annotations=[],relations=[],],BioCSentence[offset=89,text='no
definite focal ... of\nconsolidation.',infons=[],annotations=[],relations=[],],B
ioCSentence[offset=131,text='no edema.',infons=[],annotations=[],relations=[],],
BioCSentence[offset=141,text='there are no effusions.',infons=[],annotations=[],
relations=[],],BioCSentence[offset=165,text='2. cardiomegaly unchanged.',infons=
[],annotations=[],relations=[],],BioCSentence[offset=192,text='3. left upper ext
... c line unchanged.',infons=[],annotations=[],relations=[],],],annotations=[],r
elations=[],],annotations=[],relations=[],],
BioCDocument[id=442,infons=[],passages=[BioCPassage[offset=0,text='\n1.
endotracheal ... ce is
unchanged.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. endotracheal
... above the carina.',infons=[],annotations=[],relations=[],],BioCSentence[offs
et=68,text='nasogastric tube ... rossly unchanged.',infons=[],annotations=[],re
lations=[],],BioCSentence[offset=112,text='left internal jug ... of the clavicl
e.',infons=[],annotations=[],relations=[],],BioCSentence[offset=221,text='2.
persistent lef ... air bronchograms.',infons=[],annotations=[],relations=[],],Bi
oCSentence[offset=288,text='again noted is le ... a or mediastinum.',infons=[],a
nnotations=[],relations=[],],BioCSentence[offset=411,text='the\nappearance is un
changed.',infons=[],annotations=[],relations=[],],],annotations=[],relations=[],],
```

```

],annotations=[],relations=[],],
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interval r ... sis.\n \n \n \n \n \n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.  interval r ...
sided chest
tube.',infons=[],annotations=[],relations=[],],BioCSentence[offset=50,text='no
associated pneumothorax.',infons=[],annotations=[],relations=[],],BioCSentence[o
ffset=80,text='2.  retrocardiac ... with atelectasis.',infons=[],annotations=[
,relations=[],]],annotations=[],relations=[],]],annotations=[],relations=[],],
  BioCDocument[id=444,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.
consolidat ... : (650)
736-1173\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.  consolidat
... leural effusions.',infons=[],annotations=[],relations=[],],BioCSentence[offs
et=104,text='physician to phys ... e: (650) 736-1173',infons=[],annotations=[,r
elations=[],]],annotations=[],relations=[],]],annotations=[],relations=[],],
  BioCDocument[id=445,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.  two
upright ... horacic spine.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.  two upright ... or
consolidation.',infons=[],annotations=[],relations=[],],BioCSentence[offset=178,
text='2.  no pleural ef ... or pneumothorax
.',infons=[],annotations=[],relations=[],],BioCSentence[offset=222,text='3.
mild degenera ... e thoracic spine.',infons=[],annotations=[],relations=[],]],an
notations=[],relations=[],]],annotations=[],relations=[],],
  BioCDocument[id=446,infons=[],passages=[BioCPassage[offset=0,text='\n1.
persistent, s ... r
calcification.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1.
persistent, s ... ion seen as
well.',infons=[],annotations=[],relations=[],],BioCSentence[offset=105,text='no
gross consolidation.',infons=[],annotations=[],relations=[],],BioCSentence[offse
t=129,text='cardiomediastinal ... from prior exam.',infons=[],annotations=[,re
lations=[],],BioCSentence[offset=183,text='incidentally\nnote ... known chronici
ty.',infons=[],annotations=[],relations=[],],BioCSentence[offset=302,text='2.  a
supine and l ... pneumoperitoneum.',infons=[],annotations=[],relations=[],],BioC
Sentence[offset=403,text='copious stool see ... and rectosigmoid.',infons=[,ann
otations=[],relations=[],],BioCSentence[offset=467,text='gas is noted with ... h
and the rectum.',infons=[],annotations=[],relations=[],],BioCSentence[offset=515
,text='no findings to su ... owel\nobstruction.',infons=[],annotations=[,relati
ons=[],],BioCSentence[offset=557,text='there are compres ... mbar spine noted.',
infons=[],annotations=[,relations=[],],BioCSentence[offset=631,text='post-
surgical changes of the pelvis.',infons=[,annotations=[,relations=[],],BioCSen
tence[offset=668,text='mild to\nmoderate vascular calcification.',infons=[,anno
tations=[,relations=[],]],annotations=[,relations=[],]],annotations=[,relatio
ns=[],],
  BioCDocument[id=447,infons=[],passages=[BioCPassage[offset=0,text='\n
\nnegative chest ... ly questioned.\n
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \nnegative
chest.',infons=[,annotations=[,relations=[],],BioCSentence[offset=20,text='no

```



pleural effusi ... cally questioned.',infons=[],annotations=[],relations=[],],a  
nnotations=[],relations=[],],annotations=[],relations=[],],  
BioCDocument[id=448,infons=[],passages=[BioCPassage[offset=0,text='\n  
\n1.single front ... er quadrant. \n  
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.single front ...  
iocephalic veins.',infons=[],annotations=[],relations=[],],BioCSentence[offset=1  
66,text='2.lungs demonstra ... iastinal contour.',infons=[],annotations=[],relat  
ions=[],],BioCSentence[offset=250,text='no focal airspace opacity.',infons=[],an  
notations=[],relations=[],],BioCSentence[offset=278,text='trace left \npleural e  
ffusion.',infons=[],annotations=[],relations=[],],BioCSentence[offset=308,text='  
no pneumothorax, ... supine technique.',infons=[],annotations=[],relations=[],],  
BioCSentence[offset=392,text='3.visualized osse ... t upper quadrant.',infons=[  
],annotations=[],relations=[],],annotations=[],relations=[],],annotations=[],r  
elations=[],],  
BioCDocument[id=449,infons=[],passages=[BioCPassage[offset=0,text='\n \n1.lines  
and tu ... consolidation.\n  
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.lines and tu ...  
nged in position.',infons=[],annotations=[],relations=[],],BioCSentence[offset=4  
9,text='persistent low lu ... kely atelectasis.',infons=[],annotations=[],relati  
ons=[],],BioCSentence[offset=139,text='interval increase ... us consolidation.',  
infons=[],annotations=[],relations=[],],annotations=[],relations=[],],annotati  
ons=[],relations=[],],  
BioCDocument[id=450,infons=[],passages=[BioCPassage[offset=0,text='\n \n 1.  
single se ... ral effusion.\n \n  
' ,infons=[],sentences=[BioCSentence[offset=0,text='\n \n 1. single se ... ided  
chest  
tubes.',infons=[],annotations=[],relations=[],],BioCSentence[offset=178,text='no  
evidence of pneumothorax.',infons=[],annotations=[],relations=[],],BioCSentence[  
offset=210,text='2. stable mild c ... pulmonary edema.',infons=[],annotations=  
[],relations=[],],BioCSentence[offset=278,text='stable mild eleva ...  
etrocardiac area.',infons=[],annotations=[],relations=[],],BioCSentence[offset=3  
91,text='interval slight \n ... right lung  
base.',infons=[],annotations=[],relations=[],],BioCSentence[offset=458,text='3.  
stable small right pleural effusion.',infons=[],annotations=[],relations=[],],a  
nnotations=[],relations=[],],annotations=[],relations=[],],  
BioCDocument[id=451,infons=[],passages=[BioCPassage[offset=0,text='\n  
\n1.portable sem ... identified. \n  
\n',infons=[],sentences=[BioCSentence[offset=0,text='\n \n1.portable sem ...  
tube and ng tube.',infons=[],annotations=[],relations=[],],BioCSentence[offset=1  
17,text='2.redemonstration ... pleural effusion.',infons=[],annotations=[],relat  
ions=[],],BioCSentence[offset=240,text='in the \nsetting o ... monary contusion.  
' ,infons=[],annotations=[],relations=[],],BioCSentence[offset=333,text='3.no  
definitive r ... x are identified.',infons=[],annotations=[],relations=[],],ann  
otations=[],relations=[],],annotations=[],relations=[],],  
BioCDocument[id=452,infons=[],passages=[BioCPassage[offset=0,text='\n1. right  
upper e ... pulmonary  
edema.\n',infons=[],sentences=[BioCSentence[offset=0,text='\n1. right upper e



```
[8]: collection.documents[0].passages[0].sentences
```

```
[8]: [BioCSentence[offset=0,text='\n \n1.mild pulmona ... and
cardiomegaly.',infons=[],annotations=[],relations=[]],
BioCSentence[offset=46,text='trace pleural fluid
\neffusions.',infons=[],annotations=[],relations=[]],
BioCSentence[offset=80,text='2.low lung volume ... ilar
atelectasis.',infons=[],annotations=[],relations=[]],
BioCSentence[offset=135,text='3.no new focal
consolidation.',infons=[],annotations=[],relations=[]],
BioCSentence[offset=168,text='4.interval placem ... ibrillation
pads.',infons=[],annotations=[],relations=[]]]
```

Each sentence stores information about the text, offset, relations and annotations. Let's check the sentences saved in the first document of our collection:

```
[9]: for i,s in enumerate(collection.documents[0].passages[0].sentences):
      print(f"sentence number {i + 1}: {s.text}\n")
      print("#####\n")
```

sentence number 1:

1.mild pulmonary edema, and cardiomegaly.

#####

sentence number 2: trace pleural fluid  
effusions.

#####

sentence number 3: 2.low lung volumes with minimal basilar atelectasis.

#####

sentence number 4: 3.no new focal consolidation.

#####

sentence number 5: 4.interval placement of defibrillation pads.

#####

### 0.2.5 Cleaning up with the clean() function

Notice how the first report impression, which had two sentences, was split successfully. However, the newlines have not been trimmed. The `clean()` function from the previous lecture notebook will come in handy here. Let's bring it back out of the toolbox and apply it in this notebook!

```
[10]: import re
def clean(sentence):
    lower_sentence = sentence.lower()
    corrected_sentence = re.sub('and/or', 'or', lower_sentence)
    corrected_sentence = re.sub('(?!<=[a-zA-Z])/(?!<=[a-zA-Z])', ' or ',
    ↪corrected_sentence)
    clean_sentence = corrected_sentence.replace("..", ".")
    punctuation_spacer = str.maketrans({key: f"{key} " for key in ".,,"})
    clean_sentence = clean_sentence.translate(punctuation_spacer)
    clean_sentence = ' '.join(clean_sentence.split())
    return clean_sentence
```

### 0.2.6 Exercise

Now that you've spent some time exploring how the NegBio library works, let's try it out on your data.

You'll determine whether a given report impression can tell you if a patient has an existing condition, while taking into account whether there was negation or uncertainty in the findings. For this task, you'll use these predetermined categories:

```
[11]: CATEGORIES = ["Cardiomegaly", "Lung Lesion", "Airspace Opacity", "Edema",
                    "Consolidation", "Pneumonia", "Atelectasis", "Pneumothorax",
                    "Pleural Effusion", "Pleural Other", "Fracture"]
```

### 0.2.7 Import NegBio Dependencies

Next you'll import everything you need for this task. Don't be alarmed by the declared paths below the imports! They're just mapping the path to various files that NegBio relies on.

```
[12]: from pathlib2 import Path
from negbio.main_chexpert import pipeline
from negbio.pipeline.parse import NegBioParser
from negbio.chexpert.stages.load import NegBioLoader
from negbio.chexpert.stages.extract import NegBioExtractor
from negbio.chexpert.stages.classify import ModifiedDetector
from negbio.chexpert.stages.aggregate import NegBioAggregator
from negbio.pipeline.ptb2ud import NegBioPtb2DepConverter, Lemmatizer

PARSING_MODEL_DIR = "~/.local/share/bllipparser/GENIA+PubMed"
```

```
CHEXPERT_PATH = "NegBio/negbio/chexpert/"
MENTION_PATH = f"{CHEXPERT_PATH}phrases/mention"
UNMENTION_PATH = f"{CHEXPERT_PATH}phrases/"
NEG_PATH = f'{CHEXPERT_PATH}patterns/negation.txt'
PRE_NEG_PATH = f'{CHEXPERT_PATH}patterns/pre_negation_uncertainty.txt'
POST_NEG_PATH = f'{CHEXPERT_PATH}patterns/post_negation_uncertainty.txt'
```

The encoding of information within these files is beyond the scope of this notebook, but if you're really curious about the contents you could do something like this to see more:

```
!cat $NEG_PATH
```

```
[13]: !cat $NEG_PATH
```

```
# No definite XXX
({} > {} {lemma:/definite/}) > {dependency:/neg/} {}

# No obvious XXX
({} > {} {lemma:/obvious/}) > {dependency:/neg/} {}

{} > {dependency:/amod|nsubj/} {lemma:/normal|unremarkable/}
{} < {dependency:/amod|nsubj/} {lemma:/normal|unremarkable/}
({} > {} {}) < {dependency:/nsubj|dobj/} {lemma:/unremarkable|normal/}
{} < {} ({} > {dependency:/amod/} {lemma:/normal|unremarkable/})
{} < {} ({} < {dependency:/nsubj/} {lemma:/normal|unremarkable/})
{} < {dependency:/conj:no/} {}
{} < {} ({} < {dependency:/conj:or/} ({} > {} {lemma:/no/}))
{} < {dependency:/nsubj/} ({lemma:/limit.*/} > {} {lemma:/upper/} & >
{dependency:/nmod:of/} {lemma:/normal/} & > {dependency:/case/}
{lemma:/at|within/})
{} < {} ({dependency:/exclude/} < {} ({} > {} {lemma:/no/}))

({lemma:/silhouette/} > {} {}) < {dependency:/dobj|nsubj/} {lemma:/obscure/}

({} > {dependency:/amod/} {lemma:/normal|unremarkable/}) <
{dependency:/dobj|nsubj/} {lemma:/demonstrate.*|show|present|display/}
{} < {dependency:/nmod:of/} ( {lemma:/appearance/} > {dependency:/amod/}
{lemma:/normal/} & < {dependency:/dobj/}
{lemma:/demonstrate.*|show|present|display/})

{} < {dependency:/amod/} ({} < {dependency:/dep|nsubj/}
{lemma:/normal|unremarkable/})
{} < {dependency:/amod/} ({} > {dependency:/neg/} {lemma:/no/})
{} < {dependency:/amod/}({lemma:/finding.*/} < {dependency:/dobj/}
({lemma:/acute/} > {dependency:/nsubj/} {lemma:/no/}))
{} < {dependency:/amod/} ({lemma:/structure.*/} < {dependency:/dep|nsubj/})
```

```

({lemma:/appear/} > {dependency:/xcomp/} {lemma:/normal|unremarkable/}))

{} < {dependency:/compound/} ({} > {dependency:/neg/} {})
{} < {dependency:/nsubj/} {lemma:/absent/}
{} < {dependency:/amod/} ({} < {dependency:/nmod:of/} ({lemma:/evidence/} >
{dependency:/case/} {lemma:/without/}))
{} < {dependency:/amod/} ({} < {dependency:/nmod:of/} ({lemma:/evidence/} >
{dependency:/neg/} {}))

# XXX within normal limits
{} < {} ({} < {} ({lemma:/show|demonstrate|present/} >
{dependency:/nmod:within/} ({lemma:/limit.*/} > {} {lemma:/normal/})))
({} > {} {}) > {dependency:/nmod:within/} {lemma:/limit.*/}
{} < {dependency:/nsubj/} ({lemma:/limit.*/} > {} {lemma:/upper/} & >
{dependency:/nmod:of/} {lemma:/normal/} & > {dependency:/case/}
{lemma:/at|within/})
{} < {} ({} < {dependency:/nsubj/} ({lemma:/limit.*/} > {} {lemma:/upper/} & >
{dependency:/nmod:of/} {lemma:/normal/} & > {dependency:/case/}
{lemma:/at|within/}))
{} < {} ({} < {dependency:/nsubj/} ({lemma:/limit.*/} > {dependency:/amod/}
{lemma:/normal/} & > {dependency:/case/} {lemma:/at|within/}))
({lemma:/vascularity/} > {dependency:/amod/} {lemma:/pulmonary/}) >
{dependency:/amod/} {lemma:/normal/}
{} < {dependency:/dobj|nsubj/} ({} > {dependency:/nmod:within/}
({lemma:/limit.*/} > {} {lemma:/normal/}))
{} > {dependency:/nmod:within/} ({lemma:/limit.*/} > {dependency:/amod/}
{lemma:/normal/})
{} > {} ({lemma:/limit/} > {} {lemma:/normal/})

# XXX is/appears/are/appear/remain/remains (now, otherwise) normal/unremarkable
{} < {} ({lemma:/appear|remain/} > {} {lemma:/normal|unremarkable/})

# XXX is/appears/are/appear/remain/remains (now, otherwise) within normal limits
{} > {} ({lemma:/remain|appear/} > {} ({lemma:/limit/} > {} {lemma:/normal/}))

# rather than XXX
{} < {dependency:/conj:negcc/} {}
{} < {dependency:/nmod:without/} {}

{} < {dependency:/nmod:without|nmod:of/} {lemma:/clear|clearing/}=key
{} < {dependency:/nmod:out/} {lemma:/rule/}=key

# removal of XXX
{} < {dependency:/nmod:of/}
{lemma:/history|free|disappearance|resolution|drainage|resolution|removal/}
{} < {dependency:/nmod:for/} {lemma:/negative/}

```

```

# exclude XXX
{} <{} {lemma:/exclude/}

{} <{dependency:/advmod|dep|conj:or/} {lemma:/no/}

# XXX has resolved
{} <{dependency:/nsubj/} ({lemma:/resolve/}=key >{dependency:/aux/} {}))

# there is no XXX
{} <{dependency:/nsubj/} ({lemma:/be/} >{} {lemma:/no/})

# without evidence|finding of|for XXX
{} <{dependency:/nmod:of|nmod:for/} ({lemma:/evidence|finding/}
<{dependency:/nmod:without/} {}))

# without development of XXX
{} < {dependency:/nmod:of/} ({lemma:/development/} > {} {lemma:/without/})

# No development of XXX
{} < {dependency:/nmod:of/} ({lemma:/development/} > {} {lemma:/no/})

# no evidence of|for XXX
{} <{dependency:/nmod:of|nmod:for/} ({lemma:/evidence/} >{dependency:/neg/} {}))

# without evidence|finding of|for XXX
{} <{dependency:/nmod:of|nmod:for/} ({lemma:/evidence|finding/} >{}
{lemma:/without/})

# no focus of XXX
{} <{dependency:/nmod:of/} ({lemma:/focus/} >{dependency:/neg/} {}))
{} <{dependency:/nmod:of/} ({lemma:/focus/} >{} {lemma:/no/})

# no moderate to XXX
{} <{dependency:/nmod:to/} ({lemma:/moderate/} >{dependency:/neg/} {}))

# no evidence of developing XXX
{} <{} ({lemma:/developing/} <{} ({lemma:/evidence/}
<{dependency:/nmod:without/} {}))
{} <{} ({lemma:/developing/} <{} ({lemma:/evidence/} >{} {lemma:/no/}))

# no focal XXX
{} <{dependency:/dobj/} ({} >{dependency:/nsubj/} {lemma:/no/})

# XXX is previously demonstrated/visualized
{} <{dependency:/dobj|nsubjpass/} ({lemma:/demonstrate|visualize/} >{}
{lemma:/previously/})

# there is no NN to suggest/explain XXX

```

```

{} < {} ({lemma:/suggest|explain|diagnose/} < {} ({tag:/V.*/} > {} ({tag:/N.*/}
> {} {lemma:/no/})))

# no NN to suggest/explain XXX
{} < {} ({lemma:/suggest|explain|diagnose/} < {} ({tag:/N.*/} > {}
{lemma:/no/}))

# no area of XXX
{} < {dependency:/nmod:of/} ({lemma:/area/} > {dependency:/compound/}
{lemma:/no/})

# XXX is not enlarged
{} < {dependency:/nsubjpass/} ({lemma:/enlarge/} > {dependency:/neg/} {})

# without development of XXX
{} < {dependency:/nmod:of/} ({lemma:/development/} > {dependency:/case/}
{lemma:/without/})

# XXX removed
{} < {} {lemma:/remove/}
{} > {} {lemma:/remove/}

# XXX is no longer seen
{} < {dependency:/nsubjpass/} ({lemma:/see/} > {} ({} > {dependency:/neg/}
{lemma:/no/}))
{} < {dependency:/nsubjpass/} ({lemma:/see/} > {} {lemma:/no/})

# without evidence seen for XXX
{} < {} ({lemma:/see/} > {} ({} > {} ({lemma:/evidence/} > {}
{lemma:/without/})))
{} < {} ({lemma:/see/} > {} ({lemma:/evidence/} > {} {lemma:/without/}))

# normal/unremarkable appearance of XXX
{} < {} ({lemma:/appearance/} > {} {lemma:/normal|unremarkable/})

# normal/unremarkable XXX | XXX is/appears normal/unremarkable
# make more general
{} > {} {lemma:/normal|unremarkable/}
{} < {} {lemma:/normal|unremarkable/}

# XXX has/have cleared
# cleared XXX
{} < {} {lemma:/clear/}
{} > {} {lemma:/clear/}

# no obvious associated XXX
{} < {} ({lemma:/associate.*/} > {} ({lemma:/obvious/} > {dependency:/neg/} {}))
{} > {dependency:/neg/} {} & > {} {lemma:/obvious/} & > {} {lemma:/associate.*/}

```



```
# XXX with interval resolution
{} > {} ({lemma:/resolution/} > {} {lemma:/interval/})
```

```
# no XXX / general negative case
{} > {dependency:/neg/} {}
{} > {} {lemma:/no/}
{} > {dependency:/case/} {lemma:/without/}
```

Running this process for the entire dataset is very slow (~1.5 hr on a fast laptop!) so let's slice it to showcase how NegBio works. Let's start with 50 random observations.

```
[14]: sampled_df = df.sample(50)
```

Also, let's recreate the code from the beginning of the notebook as a function, including the `clean()` function as well.

```
[15]: def get_bioc_collection(df):
    collection = bioc.BioCCollection()
    splitter = NegBioSSplitter()
    for i, report in enumerate(df["Report Impression"]):
        document = text2bioc.text2document(str(i), clean(report))
        document = splitter.split_doc(document)
        collection.add_document(document)
    return collection
```

Here, you'll repeat your process from earlier by converting the report impression strings into a BioC XML format which NegBio can read.

```
[16]: collection = get_bioc_collection(sampled_df)
```

Now let's instantiate NegBio's lemmatizer.

The process of lemmatization refers to returning the dictionary form of a word (or lemma) by removing inflectional endings. It's very cool and you can read more about it [here](#).

```
[17]: lemmatizer = Lemmatizer()
```

Next you'll instantiate NegBio's converter to convert from parse tree to universal dependencies. This is done using the Stanford converter, which you can find more information about [here](#).

The parse tree used here is the [Penn Treebank](#). In general terms, a treebank is an annotated text corpus that includes analysis beyond part-of-speech tagging. They've become very valuable resources to NLP research in recent years.

Universal dependencies, or UD, provide a powerful framework for annotating grammar across different languages. Read more about them [here](#).

```
[18]: ptb2dep = NegBioPtb2DepConverter(lemmatizer, universal=True)
```

You've already seen the splitter in action before, so you can skip it.

```
[19]: ssplitter = NegBioSSplitter(newline=True)
```

Now you'll instantiate the parser and the loader.

Under the hood, you're using the [BLIPP reranking parser](#), which is a statistical natural language parser.

The loader, as you might imagine, loads the reports into memory.

Over all of this, the [chexpert-labeler](#) is used. This labeler extracts observations from radiology reports specifically, and can provide a vocabulary appropriate to the clinical context.

```
[20]: parser = NegBioParser(model_dir=PARSING_MODEL_DIR)
      loader = NegBioLoader()
```

The extractor is what extracts the observations from the report impressions.

```
[21]: extractor = NegBioExtractor(Path(MENTION_PATH), Path(UNMENTION_PATH))
```

The negator will determine whether negation or uncertainty exists in the context of the observations provided by the extractor.

```
[22]: neg_detector = ModifiedDetector(PRE_NEG_PATH, NEG_PATH, POST_NEG_PATH)
```

The aggregator then aggregates these observations if they belong to the same category.

```
[23]: aggregator = NegBioAggregator(CATEGORIES)
```

## 0.2.8 Putting it all together

Finally, you'll put everything together using the pipeline function, which takes as arguments all of the objects you've instantiated so far. Then you'll get a nice, clean DataFrame with your result:

```
[24]: collection = pipeline(collection, loader, ssplitter, extractor,
                           parser, ptb2dep, neg_detector, aggregator,
                           verbose=True)
```

```
100%|          | 50/50 [00:57<00:00, 1.16s/it]
```

```
[25]: negbio_pred = pd.DataFrame()
      for doc in collection.documents:
          dictionary = {}
          for key, val in doc.infons.items():
              dictionary[key[9:]] = val
          negbio_pred = negbio_pred.append(dictionary, ignore_index=True)
      negbio_pred = negbio_pred.replace(
          "Positive", True).replace(
          "Negative", False).replace("Uncertain", False).fillna(False)
```

```
[26]: negbio_pred.head()
```

```
[26]:   Airspace Opacity  Atelectasis  Fracture  Consolidation  Pneumonia  \
0             True         True      True         False      False
1             True        False      False         False        True
2             False        False      False         False      False
3             False        False      False         False      False
4             False        False      False         False      False

      Pleural Effusion  Pneumothorax  Cardiomegaly  Edema  Lung Lesion  \
0             False         False         False  False         False
1             False         False         False  False         False
2             True         True         False  False         False
3             False         False          True  False         False
4             False         False         False  False         False

      Pleural Other
0             False
1             False
2             False
3             False
4             False
```

Now you can check every entry in the report impressions for the presence of a condition, while knowing that negation has been taken into account. Really cool!

**Congratulations on finishing this notebook!!!** This was a very high-level explanation of everything that NegBio does and as you may have noticed, this library leverages many other great tools and libraries. Hopefully, it was a good introduction to how it works. **Nice work, keep it up!**