Named Entity Recognition (NER):

1.1

In [1]:

```python
import spacy
from bs4 import BeautifulSoup as bs
import urllib.request as ur
import re,certifi
from pprint import pprint


# Function to scrape and output webpage content:

def scrape_site(url):
    response = ur.urlopen(url,cafile=certifi.where())
    text = response.read()
    parsed = bs(text,'lxml')
    paras = parsed.findAll('p')
    paragraphs =''
    for p in paras:
        paragraphs+=p.text
    return paragraphs

src='https://www.scientificamerican.com/article/nasas-james-webb-space-telescope-will-f

text = scrape_site(src)
pprint(text)
```

```
<ipython-input-1-f1348233a6d9>:11: DeprecationWarning: cafile, capath and cadefault are
deprecated, use a custom context instead.
  response = ur.urlopen(url,cafile=certifi.where())
('Fall Flash Sale. Save 30%Fall Flash Sale. Save 30%The observatory must '
 "complete about 50 major deployments after liftoffNASA's newest space "
 'telescope will face 29 "harrowing" days after launch as it makes its way to '
 'a deep-space destination nearly 1 million miles (1.6 million km) from Earth, '
 'the agency says in a new YouTube video.The video, called "29 Days on the '
 'Edge," was released Monday (Oct. 18). It focuses on the journey and 50 '
 'expected deployments the\xa0James Webb Space Telescope\xa0will undergo after '
 'its expected launch on Dec. 18.\xa0The telescope has been much delayed over '
 'the years due to technology challenges, the coronavirus pandemic and other '
 'issues. And there will be significant hurdles to overcome after launch as '
 'well.\xa0"We have 300 single-point failure items, and they all have to work '
 "right. When you're a million miles from the\xa0Earth, you can't send someone "
 'to fix it," Webb program director Greg Robinson says in the video.\xa0After '
 'Webb gets through that gauntlet, it will begin making observations that '
 'could transform our understanding of the cosmos. Scientists will use the '
 "telescope to learn more about the universe's early days and investigate the "
 'atmospheres and nature of distant exoplanets, among other tasks, NASA '
 'officials have said.The new nine-minute video focuses on the many '
 'technological obstacles that Webb must overcome. For example, its 21.3-foot '
 '(6.5-meter) mirror is built to "fold like origami," as the video notes, '
 'because the mirror must fit inside the payload fairing of its Arianespace '
 'Ariane 5 rocket during launch. The unfolding will need to happen in space, '
 'far from direct human assistance.The Ariane 5 must do its job on Dec. 18, of '
 "course. And Webb's own thrusters must work properly as well — particularly "
 "about 12 hours after liftoff, when they're expected to fire up and send Webb "
 'toward its deep-space destination. As Webb makes that journey, it will be '
 'pushed around by the\xa0solar wind, or the constant stream of particles '
 'coming from the sun, so the telescope will unfold a "trim tab" for '
 'stability.\xa0One of the biggest things Webb will have to unfold is a '
```

'complex,\xa0tennis court-sized sunshield array, which has 140 release '
'mechanisms, 70 hinge assemblies, 400 pulleys, 90 cables and 8 deployment '
'motors, bearing springs and gears, NASA says in the video. All of these '
'items will need to work correctly to get the sunshield unfolded so Webb can '
'do its science work.But NASA maintains that its years of training and '
'project management will assist Webb with this complex set of operations. '
'"Those two weeks after launch will be like our Super Bowl, World Cup — you '
'pick the analogy," says Amy Lo, Webb deputy director for vehicle '
'engineering, in the video. "Years of training comes down to these '
'moments."Copyright 2021\xa0Space.com, a Future company. All rights reserved. '
'This material may not be published, broadcast, rewritten or '
'redistributed.Nikk OgasaLeonard DavidLee BillingsLee BillingsDiscover '
'world-changing science. Explore our digital archive back to 1845, including '
'articles by more than 150 Nobel Prize winners.Follow usScientific american '
'arabic© 2021 Scientific American, a Division of Springer Nature America, '
'Inc.All Rights Reserved.Support science journalism.Thanks for reading '
'Scientific American. Knowledge awaits.Already a subscriber? Sign in.Thanks '
'for reading Scientific American. Create your free account or Sign in to '
'continue.See Subscription OptionsContinue reading with a Scientific American '
'subscription.You may cancel at any time.')

In [2]:

```python
import nltk
from nltk.tokenize import word_tokenize
from nltk.tokenize import sent_tokenize
from nltk.tag import pos_tag
from nltk.corpus import stopwords

# To Remove Punctuation
from nltk.tokenize import RegexpTokenizer
tokenizer = RegexpTokenizer(r'\w+')
tokens= tokenizer.tokenize(text)




# Stopwords omission:

stop_words=stopwords.words('english')
def nostop(txt):
    clean= [word for word in txt if word not in stop_words]
    return clean

txt_nostop = nostop(tokens)

# Cleaned output:
sentence=(' ').join(txt_nostop)
pprint(sentence)
```

('Fall Flash Sale Save 30 Fall Flash Sale Save 30 The observatory must '
 'complete 50 major deployments liftoffNASA newest space telescope face 29 '
 'harrowing days launch makes way deep space destination nearly 1 million '
 'miles 1 6 million km Earth agency says new YouTube video The video called 29 '
 'Days Edge released Monday Oct 18 It focuses journey 50 expected deployments '
 'James Webb Space Telescope undergo expected launch Dec 18 The telescope much '
 'delayed years due technology challenges coronavirus pandemic issues And '
 'significant hurdles overcome launch well We 300 single point failure items '
 'work right When million miles Earth send someone fix Webb program director '
 'Greg Robinson says video After Webb gets gauntlet begin making observations '
 'could transform understanding cosmos Scientists use telescope learn universe '
 'early days investigate atmospheres nature distant exoplanets among tasks '
 'NASA officials said The new nine minute video focuses many technological '
 'obstacles Webb must overcome For example 21 3 foot 6 5 meter mirror built '
 'fold like origami video notes mirror must fit inside payload fairing '

```
'Arianespace Ariane 5 rocket launch The unfolding need happen space far '
'direct human assistance The Ariane 5 must job Dec 18 course And Webb '
'thrusters must work properly well particularly 12 hours liftoff expected '
'fire send Webb toward deep space destination As Webb makes journey pushed '
'around solar wind constant stream particles coming sun telescope unfold trim '
'tab stability One biggest things Webb unfold complex tennis court sized '
'sunshield array 140 release mechanisms 70 hinge assemblies 400 pulleys 90 '
'cables 8 deployment motors bearing springs gears NASA says video All items '
'need work correctly get sunshield unfolded Webb science work But NASA '
'maintains years training project management assist Webb complex set '
'operations Those two weeks launch like Super Bowl World Cup pick analogy '
'says Amy Lo Webb deputy director vehicle engineering video Years training '
'comes moments Copyright 2021 Space com Future company All rights reserved '
'This material may published broadcast rewritten redistributed Nikk '
'OgasaLeonard DavidLee BillingsLee BillingsDiscover world changing science '
'Explore digital archive back 1845 including articles 150 Nobel Prize winners '
'Follow usScientific american arabic 2021 Scientific American Division '
'Springer Nature America Inc All Rights Reserved Support science journalism '
'Thanks reading Scientific American Knowledge awaits Already subscriber Sign '
'Thanks reading Scientific American Create free account Sign continue See '
'Subscription OptionsContinue reading Scientific American subscription You '
'may cancel time')
```

1.2.1

In [3]:
```python
nlp = spacy.load('en_core_web_sm')

doc = nlp(sentence)
print('# of entities=',len(doc.ents))
print('#'*121)
for ent in doc.ents:
    print(ent.text,ent.label_)
```

```
# of entities= 56
#########################################################################################
##################################
30 CARDINAL
50 CARDINAL
29 CARDINAL
days DATE
nearly 1 million miles QUANTITY
1 6 million km QUANTITY
Earth LOC
YouTube ORG
29 Days Edge DATE
Monday DATE
Oct 18 LAW
James Webb Space PERSON
Dec 18 DATE
years DATE
300 CARDINAL
Earth LOC
Webb ORG
Greg Robinson PERSON
early days DATE
NASA ORG
nine minute TIME
Webb ORG
21 3 foot QUANTITY
6 5 meter QUANTITY
Arianespace Ariane 5 PRODUCT
Dec 18 DATE
Webb ORG
```

```
12 hours TIME
Webb ORG
Webb ORG
One CARDINAL
Webb ORG
140 CARDINAL
70 CARDINAL
400 CARDINAL
90 CARDINAL
8 CARDINAL
NASA ORG
Webb ORG
NASA ORG
years DATE
Webb ORG
two weeks DATE
Super Bowl World Cup EVENT
Amy Lo Webb PERSON
Years DATE
Nikk OgasaLeonard ORG
Explore PRODUCT
1845 DATE
150 CARDINAL
Nobel Prize WORK_OF_ART
2021 DATE
Scientific American Division ORG
Scientific American Knowledge ORG
Scientific American Create ORG
Scientific American ORG
```

1.2.2

In [4]:
```python
from nltk.stem.wordnet import WordNetLemmatizer

lmtz = nltk.WordNetLemmatizer()

lemmatized_text=[lmtz.lemmatize(w) for w in txt_nostop]

#Most Frequent tokens
freqdist = nltk.FreqDist(lemmatized_text)
freqdist.most_common(15)
```

Out[4]:
```
[('Webb', 11),
 ('video', 7),
 ('The', 6),
 ('must', 5),
 ('launch', 5),
 ('space', 4),
 ('telescope', 4),
 ('say', 4),
 ('work', 4),
 ('Scientific', 4),
 ('American', 4),
 ('deployment', 3),
 ('million', 3),
 ('18', 3),
 ('expected', 3)]
```

1.2.3

In [5]:
```python
sents= sent_tokenize(text)
sentss=[]
```

```
for s in sents:
    tokens= tokenizer.tokenize(s)
    x=nostop(tokens)
    sentss.append(' '.join(x))

import random as rn

def choose(n):
    return rn.randint(0,n)

three_picks = []

x0=choose(len(sentss))
three_picks=sentss[x0:x0+3]
print(three_picks)
```

['The unfolding need happen space far direct human assistance The Ariane 5 must job Dec
18 course', 'And Webb thrusters must work properly well particularly 12 hours liftoff ex
pected fire send Webb toward deep space destination', 'As Webb makes journey pushed arou
nd solar wind constant stream particles coming sun telescope unfold trim tab stability']

1.2.4

In [6]:
```
from nltk.stem.wordnet import WordNetLemmatizer

lmtz = nltk.WordNetLemmatizer()

lemmatized=[]

# Lemmatizing the tokens
for s in three_picks:
    tokens= tokenizer.tokenize(s)
    x=[lmtz.lemmatize(w) for w in tokens]
    lemmatized.append(' '.join(x))

# POS Tagging
tagged = []

for s in lemmatized:
    sent = nltk.word_tokenize(s)
    sent = nltk.pos_tag(sent)
    tagged.append(sent)

pprint(tagged)
```

```
[[('The', 'DT'),
  ('unfolding', 'VBG'),
  ('need', 'NN'),
  ('happen', 'VB'),
  ('space', 'NN'),
  ('far', 'RB'),
  ('direct', 'JJ'),
  ('human', 'JJ'),
  ('assistance', 'NN'),
  ('The', 'DT'),
  ('Ariane', 'NNP'),
  ('5', 'CD'),
  ('must', 'MD'),
  ('job', 'NN'),
  ('Dec', 'NNP'),
  ('18', 'CD'),
```

```
            ('course', 'NN')],
           [('And', 'CC'),
            ('Webb', 'NNP'),
            ('thruster', 'NN'),
            ('must', 'MD'),
            ('work', 'VB'),
            ('properly', 'RB'),
            ('well', 'RB'),
            ('particularly', 'RB'),
            ('12', 'CD'),
            ('hour', 'NN'),
            ('liftoff', 'NN'),
            ('expected', 'VBN'),
            ('fire', 'NN'),
            ('send', 'VB'),
            ('Webb', 'NNP'),
            ('toward', 'IN'),
            ('deep', 'JJ'),
            ('space', 'NN'),
            ('destination', 'NN')],
           [('As', 'IN'),
            ('Webb', 'NNP'),
            ('make', 'VBP'),
            ('journey', 'NN'),
            ('pushed', 'VBN'),
            ('around', 'IN'),
            ('solar', 'JJ'),
            ('wind', 'NN'),
            ('constant', 'JJ'),
            ('stream', 'NN'),
            ('particle', 'NN'),
            ('coming', 'VBG'),
            ('sun', 'JJ'),
            ('telescope', 'NN'),
            ('unfold', 'JJ'),
            ('trim', 'JJ'),
            ('tab', 'NN'),
            ('stability', 'NN')]]
```

1.2.5

In [7]:
```python
for s in range(len(lemmatized)):
    print('K = ',s+1)
    print('#'*121)
    doc = nlp(sentence)
    for ent in doc.ents:
        print(ent.text,ent.label_)
    print('#'*121)
```

```
K =  1
#########################################################################################################################
#################################
30 CARDINAL
50 CARDINAL
29 CARDINAL
days DATE
nearly 1 million miles QUANTITY
1 6 million km QUANTITY
Earth LOC
YouTube ORG
29 Days Edge DATE
```

Monday DATE
Oct 18 LAW
James Webb Space PERSON
Dec 18 DATE
years DATE
300 CARDINAL
Earth LOC
Webb ORG
Greg Robinson PERSON
early days DATE
NASA ORG
nine minute TIME
Webb ORG
21 3 foot QUANTITY
6 5 meter QUANTITY
Arianespace Ariane 5 PRODUCT
Dec 18 DATE
Webb ORG
12 hours TIME
Webb ORG
Webb ORG
One CARDINAL
Webb ORG
140 CARDINAL
70 CARDINAL
400 CARDINAL
90 CARDINAL
8 CARDINAL
NASA ORG
Webb ORG
NASA ORG
years DATE
Webb ORG
two weeks DATE
Super Bowl World Cup EVENT
Amy Lo Webb PERSON
Years DATE
Nikk OgasaLeonard ORG
Explore PRODUCT
1845 DATE
150 CARDINAL
Nobel Prize WORK_OF_ART
2021 DATE
Scientific American Division ORG
Scientific American Knowledge ORG
Scientific American Create ORG
Scientific American ORG
##
##################################
K = 2
##
##################################
30 CARDINAL
50 CARDINAL
29 CARDINAL
days DATE
nearly 1 million miles QUANTITY
1 6 million km QUANTITY
Earth LOC
YouTube ORG
29 Days Edge DATE
Monday DATE
Oct 18 LAW
James Webb Space PERSON
Dec 18 DATE

years DATE
300 CARDINAL
Earth LOC
Webb ORG
Greg Robinson PERSON
early days DATE
NASA ORG
nine minute TIME
Webb ORG
21 3 foot QUANTITY
6 5 meter QUANTITY
Arianespace Ariane 5 PRODUCT
Dec 18 DATE
Webb ORG
12 hours TIME
Webb ORG
Webb ORG
One CARDINAL
Webb ORG
140 CARDINAL
70 CARDINAL
400 CARDINAL
90 CARDINAL
8 CARDINAL
NASA ORG
Webb ORG
NASA ORG
years DATE
Webb ORG
two weeks DATE
Super Bowl World Cup EVENT
Amy Lo Webb PERSON
Years DATE
Nikk OgasaLeonard ORG
Explore PRODUCT
1845 DATE
150 CARDINAL
Nobel Prize WORK_OF_ART
2021 DATE
Scientific American Division ORG
Scientific American Knowledge ORG
Scientific American Create ORG
Scientific American ORG
##
#################################
K = 3
##
#################################
30 CARDINAL
50 CARDINAL
29 CARDINAL
days DATE
nearly 1 million miles QUANTITY
1 6 million km QUANTITY
Earth LOC
YouTube ORG
29 Days Edge DATE
Monday DATE
Oct 18 LAW
James Webb Space PERSON
Dec 18 DATE
years DATE
300 CARDINAL
Earth LOC
Webb ORG

```
Greg Robinson PERSON
early days DATE
NASA ORG
nine minute TIME
Webb ORG
21 3 foot QUANTITY
6 5 meter QUANTITY
Arianespace Ariane 5 PRODUCT
Dec 18 DATE
Webb ORG
12 hours TIME
Webb ORG
Webb ORG
One CARDINAL
Webb ORG
140 CARDINAL
70 CARDINAL
400 CARDINAL
90 CARDINAL
8 CARDINAL
NASA ORG
Webb ORG
NASA ORG
years DATE
Webb ORG
two weeks DATE
Super Bowl World Cup EVENT
Amy Lo Webb PERSON
Years DATE
Nikk OgasaLeonard ORG
Explore PRODUCT
1845 DATE
150 CARDINAL
Nobel Prize WORK_OF_ART
2021 DATE
Scientific American Division ORG
Scientific American Knowledge ORG
Scientific American Create ORG
Scientific American ORG
########################################################################################
##################################
```

1.2.6

In [8]:
```python
from spacy import displacy
from collections import Counter

#len(article.ents)
for s in range(len(lemmatized)):
    print('K = ',s+1)
    print('#'*124)
    doc = nlp(lemmatized[s])
    # Entities labels
    displacy.render(nlp(str(nlp(lemmatized[s]))), jupyter=True, style='ent')
    # Dependencies
    displacy.render(nlp(str(doc)), style='dep', jupyter = True, options = {'distance':
    print('#'*124)
```
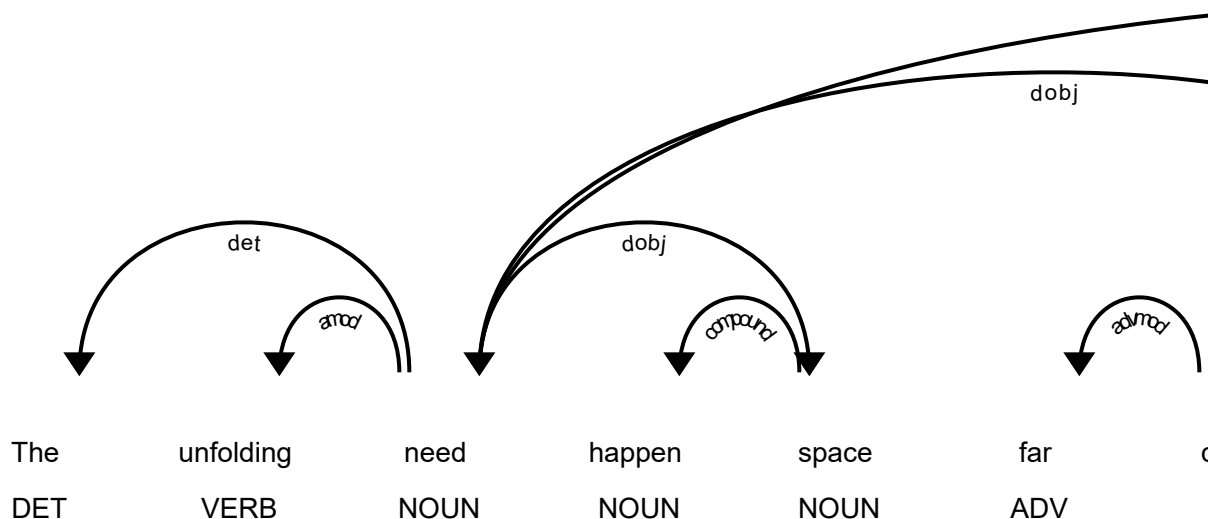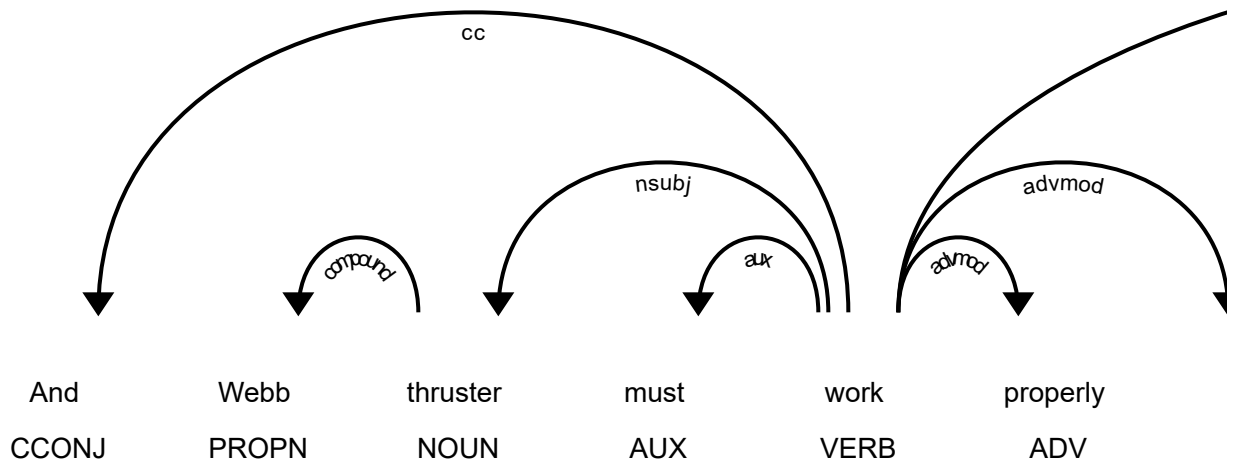
```
K =  1
########################################################################################
####################################
```

The unfolding need happen space far direct human assistance The Ariane 5 must job   Dec 18

DATE   course

dobj

det

dobj

amod

compound

advmod

The	unfolding	need	happen	space	far	(
DET	VERB	NOUN	NOUN	NOUN	ADV	

```
####################################################################################
####################################
K  =  2
####################################################################################
####################################
```

And   Webb **ORG**   thruster must work properly well particularly   12 hour **TIME**   liftoff expected

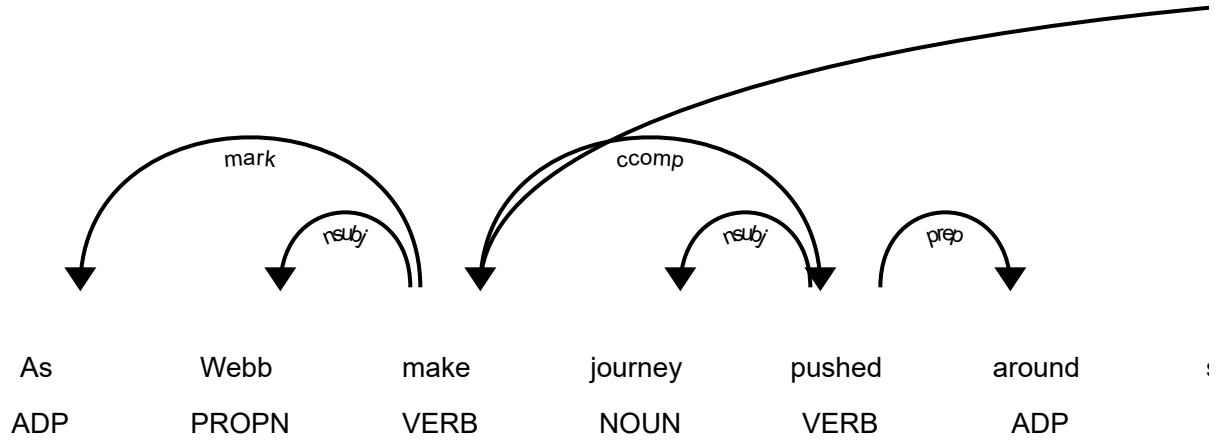fire send   Webb **ORG**   toward deep space destination

Dependency parse:

And	Webb	thruster	must	work	properly
CCONJ	PROPN	NOUN	AUX	VERB	ADV

Labels: cc, compound, nsubj, aux, advmod, advmod

```
######################################################################################
####################################
K =  3
######################################################################################
####################################
C:\Users\Ashraf's Laptop\AppData\Roaming\Python\Python38\site-packages\spacy\displacy\__
init__.py:191: UserWarning: [W006] No entities to visualize found in Doc object. If this
is surprising to you, make sure the Doc was processed using a model that supports named
entity recognition, and check the `doc.ents` property manually if necessary.
  warnings.warn(Warnings.W006)
```

As Webb make journey pushed around solar wind constant stream particle coming sun telescope

unfold trim tab stability

As	Webb	make	journey	pushed	around
ADP	PROPN	VERB	NOUN	VERB	ADP

```
################################################################################
####################################
```

1.2.7

In [16]:
```python
full_doc = displacy.render(nlp(str(' '.join(sentss))), jupyter=True, style='ent')
print(full_doc)
print('#'*124)
#displacy.render(full_doc, style='dep', jupyter = True, options = {'distance': 100})
displacy.render(nlp(str(' '.join(sentss))),style='dep', jupyter = True, options = {'dis
```

Fall Flash Sale Save 30 Fall Flash Sale Save 30 **CARDINAL** The observatory must complete 50

CARDINAL major deployments liftoffNASA newest space telescope face 29 **CARDINAL**

harrowing days **DATE** launch makes way deep space destination nearly 1 million miles

QUANTITY 1 6 million km **QUANTITY** Earth **LOC** agency says new YouTube **ORG** video

The video called 29 Days Edge **DATE** released Monday **DATE** Oct 18 **LAW** It focuses

journey 50 expected deployments James Webb Space **PERSON** Telescope undergo expected

launch Dec 18 **DATE** The telescope much delayed years **DATE** due technology challenges

coronavirus pandemic issues And significant hurdles overcome launch well We 300 **CARDINAL**

single point failure items work right When million miles Earth **LOC** send someone fix Webb

ORG program director Greg Robinson **PERSON** says video After Webb gets gauntlet begin
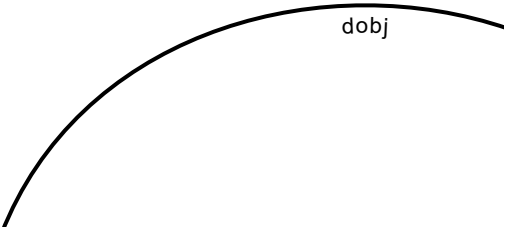
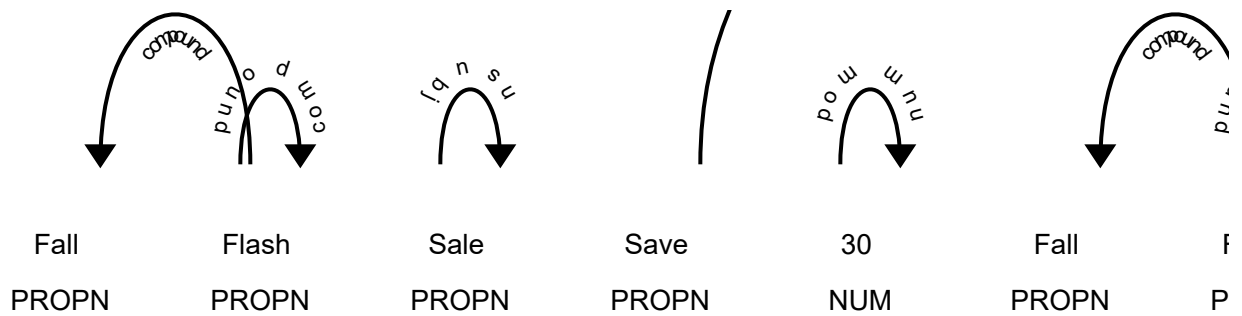making observations could transform understanding cosmos Scientists use telescope learn universe

early days **DATE** investigate atmospheres nature distant exoplanets among tasks NASA **ORG**

officials said The new nine minute **TIME** video focuses many technological obstacles Webb **ORG** must overcome For example 21 3 foot **QUANTITY** 6 5 meter **QUANTITY** mirror built fold like origami video notes mirror must fit inside payload fairing Arianespace Ariane 5 **PRODUCT** rocket launch The unfolding need happen space far direct human assistance The Ariane 5 must job Dec 18 **DATE** course And Webb **ORG** thrusters must work properly well particularly 12 hours **TIME** liftoff expected fire send Webb **ORG** toward deep space destination As Webb **ORG** makes journey pushed around solar wind constant stream particles coming sun telescope unfold trim tab stability One **CARDINAL** biggest things Webb **ORG** unfold complex tennis court sized sunshield array 140 **CARDINAL** release mechanisms 70 **CARDINAL** hinge assemblies 400 **CARDINAL** pulleys 90 **CARDINAL** cables 8 **CARDINAL** deployment motors bearing springs gears NASA **ORG** says video All items need work correctly get sunshield unfolded Webb **ORG** science work But NASA **ORG** maintains years **DATE** training project management assist Webb **ORG** complex set operations Those two weeks **DATE** launch like Super Bowl World Cup **EVENT** pick analogy says Amy Lo Webb **PERSON** deputy director vehicle engineering video Years **DATE** training comes moments Copyright 2021 Space com Future company All rights reserved This material may published broadcast rewritten redistributed Nikk OgasaLeonard **ORG** DavidLee BillingsLee BillingsDiscover world changing science Explore **PRODUCT** digital archive back 1845 **DATE** including articles 150 **CARDINAL** Nobel Prize **WORK_OF_ART** winners Follow usScientific american arabic 2021 **DATE** Scientific American Division **ORG** Springer Nature America Inc All Rights Reserved Support science journalism Thanks reading Scientific American Knowledge **ORG** awaits Already subscriber Sign Thanks reading Scientific American Create **ORG** free account Sign continue See Subscription OptionsContinue reading Scientific American **ORG** subscription You may cancel time

None
###
####################################

dobj

Fall   Flash   Sale   Save   30   Fall

PROPN   PROPN   PROPN   PROPN   NUM   PROPN

Part II

In [10]:
```python
full_txt = str(' '.join(sentss))

def redacter(text):
    doc = nlp(text)
    doc2=full_txt.split(' ')
    for ent in doc.ents:
        if ent.label_ == 'PERSON':
            doc2[ent.start]='[REDACTED]'

    return ' '.join(doc2)

redacted = redacter(full_txt)
print('Redacted Output:\n')
print(redacted)
print('#'*124+'\n')
print('Original:\n')
print(full_txt)
```

Redacted Output:

Fall Flash Sale Save 30 Fall Flash Sale Save 30 The observatory must complete 50 major deployments liftoffNASA newest space telescope face 29 harrowing days launch makes way deep space destination nearly 1 million miles 1 6 million km Earth agency says new YouTube video The video called 29 Days Edge released Monday Oct 18 It focuses journey 50 expected deployments [REDACTED] Webb Space Telescope undergo expected launch Dec 18 The telescope much delayed years due technology challenges coronavirus pandemic issues And significant hurdles overcome launch well We 300 single point failure items work right When million miles Earth send someone fix Webb program director [REDACTED] Robinson says video After Webb gets gauntlet begin making observations could transform understanding cosmos Scientists use telescope learn universe early days investigate atmospheres nature distant exoplanets among tasks NASA officials said The new nine minute video focuses many technological obstacles Webb must overcome For example 21 3 foot 6 5 meter mirror built fold like origami video notes mirror must fit inside payload fairing Arianespace Ariane 5 rocket launch The unfolding need happen space far direct human assistance The Ariane 5 must job Dec 18 course And Webb thrusters must work properly well particularly 12 hours liftoff expected fire send Webb toward deep space destination As Webb makes journey pushed around solar wind constant stream particles coming sun telescope unfold trim tab stability One biggest things Webb unfold complex tennis court sized sunshield array 140 release mechanisms 70 hinge assemblies 400 pulleys 90 cables 8 deployment motors bearing springs gears NASA says video All items need work correctly get sunshield unfolded Webb science work But NASA maintains years training project management assist Webb complex set operations Those two weeks launch like Super Bowl World Cup pick analogy says [REDACTED] Lo Webb deputy director vehicle engineering video Years training comes moments Copyright 2021

###
######################################

Original:

Fall Flash Sale Save 30 Fall Flash Sale Save 30 The observatory must complete 50 major deployments liftoffNASA newest space telescope face 29 harrowing days launch makes way deep space destination nearly 1 million miles 1 6 million km Earth agency says new YouTube video The video called 29 Days Edge released Monday Oct 18 It focuses journey 50 expected deployments James Webb Space Telescope undergo expected launch Dec 18 The telescope much delayed years due technology challenges coronavirus pandemic issues And significant hurdles overcome launch well We 300 single point failure items work right When million miles Earth send someone fix Webb program director Greg Robinson says video After Webb gets gauntlet begin making observations could transform understanding cosmos Scientists use telescope learn universe early days investigate atmospheres nature distant exoplanets among tasks NASA officials said The new nine minute video focuses many technological obstacles Webb must overcome For example 21 3 foot 6 5 meter mirror built fold like origami video notes mirror must fit inside payload fairing Arianespace Ariane 5 rocket launch The unfolding need happen space far direct human assistance The Ariane 5 must job Dec 18 course And Webb thrusters must work properly well particularly 12 hours liftoff expected fire send Webb toward deep space destination As Webb makes journey pushed around solar wind constant stream particles coming sun telescope unfold trim tab stability One biggest things Webb unfold complex tennis court sized sunshield array 140 release mechanisms 70 hinge assemblies 400 pulleys 90 cables 8 deployment motors bearing springs gears NASA says video All items need work correctly get sunshield unfolded Webb science work But NASA maintains years training project management assist Webb complex set operations Those two weeks launch like Super Bowl World Cup pick analogy says Amy Lo Webb deputy director vehicle engineering video Years training comes moments Copyright 2021 Space com Future company All rights reserved This material may published broadcast rewritten redistributed Nikk OgasaLeonard DavidLee BillingsLee BillingsDiscover world changing science Explore digital archive back 1845 including articles 150 Nobel Prize winners Follow usScientific american arabic 2021 Scientific American Division Springer Nature America Inc All Rights Reserved Support science journalism Thanks reading Scientific American Knowledge awaits Already subscriber Sign Thanks reading Scientific American Create free account Sign continue See Subscription OptionsContinue reading Scientific American subscription You may cancel time

In [ ]: