

NLP

```
In [1]: import warnings  
  
warnings.filterwarnings("ignore", category=UserWarning)
```

```
In [2]: #setup  
!pip3 install spacy
```

Requirement already satisfied: spacy in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (3.7.5)

Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (3.0.12)

Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (1.0.5)

Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (1.0.10)

Requirement already satisfied: cymem<2.1.0,>=2.0.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (2.0.8)

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Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (1.1.3)

Requirement already satisfied: srsly<3.0.0,>=2.4.3 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (2.4.8)

Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (2.0.10)

Requirement already satisfied: weasel<0.5.0,>=0.1.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (0.4.1)

Requirement already satisfied: typer<1.0.0,>=0.3.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (0.12.3)

Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (4.66.4)

Requirement already satisfied: requests<3.0.0,>=2.13.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (2.32.2)

Requirement already satisfied: pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (2.8.2)

Requirement already satisfied: jinja2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (3.1.4)

Requirement already satisfied: setuptools in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (65.5.0)

Requirement already satisfied: packaging>=20.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (24.0)

Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (3.4.0)

Requirement already satisfied: numpy>=1.19.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy) (1.26.4)

Requirement already satisfied: language-data>=1.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from langcodes<4.0.0,>=3.2.0->spacy) (1.2.0)

Requirement already satisfied: annotated-types>=0.4.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy) (0.7.0)

Requirement already satisfied: pydantic-core==2.20.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy) (2.20.1)

Requirement already satisfied: typing-extensions>=4.6.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy) (4.11.0)

Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (3.3.2)

Requirement already satisfied: idna<4,>=2.5 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (3.7)

Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (2.2.1)

Requirement already satisfied: certifi>=2017.4.17 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy) (2024.2.2)

Requirement already satisfied: blis<0.8.0,>=0.7.8 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from thinc<8.3.0,>=8.2.2->spacy) (0.7.11)

Requirement already satisfied: confection<1.0.0,>=0.0.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from thinc<8.3.0,>=8.2.2->spacy) (0.1.5)

Requirement already satisfied: colorama in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from tqdm<5.0.0,>=4.38.0->spacy) (0.4.6)

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Requirement already satisfied: shellingham>=1.3.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from typer<1.0.0,>=0.3.0->spacy) (1.5.4)
Requirement already satisfied: rich>=10.11.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from typer<1.0.0,>=0.3.0->spacy) (13.7.1)
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Requirement already satisfied: MarkupSafe>=2.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from jinja2->spacy) (2.1.5)
Requirement already satisfied: marisa-trie>=0.7.7 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from language-data>=1.2->langcodes<4.0.0,>=3.2.0->spacy) (1.2.0)
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Requirement already satisfied: mdurl~=0.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from markdown-it-py>=2.2.0->rich>=10.11.0->typer<1.0.0,>=0.3.0->spacy) (0.1.2)

[notice] A new release of pip is available: 24.0 -> 24.2

[notice] To update, run: python.exe -m pip install --upgrade pip

In [3]: !python -m spacy download en_core_web_md

Collecting en-core-web-md==3.7.1

Using cached https://github.com/explosion/spacy-models/releases/download/en_core_web_md-3.7.1/en_core_web_md-3.7.1-py3-none-any.whl (42.8 MB)

Requirement already satisfied: spacy<3.8.0,>=3.7.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from en-core-web-md==3.7.1) (3.7.5)

Requirement already satisfied: spacy-legacy<3.1.0,>=3.0.11 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.0.12)

Requirement already satisfied: spacy-loggers<2.0.0,>=1.0.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.0.5)

Requirement already satisfied: murmurhash<1.1.0,>=0.28.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.0.10)

Requirement already satisfied: cymem<2.1.0,>=2.0.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.0.8)

Requirement already satisfied: preshed<3.1.0,>=3.0.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.0.9)

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Requirement already satisfied: wasabi<1.2.0,>=0.9.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.1.3)

Requirement already satisfied: srsly<3.0.0,>=2.4.3 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.4.8)

Requirement already satisfied: catalogue<2.1.0,>=2.0.6 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.0.10)

Requirement already satisfied: weasel<0.5.0,>=0.1.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.4.1)

Requirement already satisfied: typer<1.0.0,>=0.3.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.12.3)

Requirement already satisfied: tqdm<5.0.0,>=4.38.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (4.66.4)

Requirement already satisfied: requests<3.0.0,>=2.13.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.32.2)

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Requirement already satisfied: jinja2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.1.4)

Requirement already satisfied: setuptools in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (65.5.0)

Requirement already satisfied: packaging>=20.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (24.0)

Requirement already satisfied: langcodes<4.0.0,>=3.2.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.4.0)

Requirement already satisfied: numpy>=1.19.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.26.4)

Requirement already satisfied: language-data>=1.2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from langcodes<4.0.0,>=3.2.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.2.0)

Requirement already satisfied: annotated-types>=0.4.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.7.0)

Requirement already satisfied: pydantic-core==2.20.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.20.1)

Requirement already satisfied: typing-extensions>=4.6.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from pydantic!=1.8,!1.8.1,<3.0.0,>=1.7.4->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (4.11.0)

Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.3.2)

Requirement already satisfied: idna<4,>=2.5 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.7)

Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from requests<3.0.0,>=2.13.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.2.1)

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Requirement already satisfied: confection<1.0.0,>=0.0.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from thinc<8.3.0,>=8.2.2->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.1.5)

Requirement already satisfied: colorama in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from tqdm<5.0.0,>=4.38.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.4.6)

Requirement already satisfied: click>=8.0.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (8.1.7)

Requirement already satisfied: shellingham>=1.3.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.5.4)

Requirement already satisfied: rich>=10.11.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (13.7.1)

Requirement already satisfied: cloudpathlib<1.0.0,>=0.7.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from weasel<0.5.0,>=0.1.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.18.1)

Requirement already satisfied: smart-open<8.0.0,>=5.2.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from weasel<0.5.0,>=0.1.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (7.0.4)

Requirement already satisfied: MarkupSafe>=2.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from jinja2->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.1.5)

Requirement already satisfied: marisa-trie>=0.7.7 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from language-data>=1.2->langcodes<4.0.0,>=3.2.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.2.0)

Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from rich>=10.11.0->typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (3.0.0)

Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from rich>=10.11.0->typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (2.18.0)

Requirement already satisfied: wrapt in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from smart-open<8.0.0,>=5.2.1->weasel<0.5.0,>=0.1.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (1.16.0)

Requirement already satisfied: mdurl~0.1 in c:\users\rober\appdata\local\programs\python\python311\lib\site-packages (from markdown-it-py>=2.2.0->rich>=10.11.0->typer<1.0.0,>=0.3.0->spacy<3.8.0,>=3.7.2->en-core-web-md==3.7.1) (0.1.2)

[+] Download and installation successful

You can now load the package via `spacy.load('en_core_web_md')`

[notice] A new release of pip is available: 24.0 -> 24.2

[notice] To update, run: `python.exe -m pip install --upgrade pip`

```
In [4]: import spacy
import numpy as np
import pandas as pd
```

```
In [5]: nlp = spacy.load("en_core_web_md")
```

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link: <https://www.seattletimes.com/nation-world/behind-the-deal-spies-a-killer-secret-messages-and-unseen-diplomacy/>

```
In [6]: text = ('WASHINGTON – A turning point came June 25, when a group of CIA officers sat across from
```

```
doc = nlp(text)
doc
```

Out[7]: WASHINGTON – A turning point came June 25, when a group of CIA officers sat across from their Russian counterparts during a secret meeting in a Middle Eastern capital. The Americans floated a proposal: an exchange of two dozen prisoners sitting in jails in Russia, the United States and scattered across Europe, a far bigger and more complex deal than either side had previously contemplated but one that would give both Moscow and Western nations more reasons to say yes. Quiet negotiations between the United States and Russia over a possible prisoner swap had dragged on for more than a year. They were punctuated by only occasional glimpses of hope for the families of the American prisoners – including Evan Gershkovich, a reporter for The Wall Street Journal, and Paul Whelan, an American security contractor – growing increasingly impatient for their ordeal to end. Those hopes were always dashed when one of the two sides balked. But the June meeting changed things, according to accounts from American and Western officials and other people familiar with the long process of bringing the deal to fruition. The Russian spies took the proposal back to Moscow, and only days later the CIA director was on the phone with a Russian spy chief agreeing to the broad parameters of a massive prisoner swap. On Thursday, seven different planes touched down in Turkey and exchanged passengers, bringing to a successful close an intensive diplomatic effort that took place almost entirely out of public view. The deal between longtime adversaries secured the release of Gershkovich, Whelan and 14 other Americans, Russians and Europeans imprisoned in Russia. The deal also freed, among others, a Russian hit man, Vadim Krasikov. He had been jailed in Germany since 2019 for the killing of a Chechen former separatist fighter in a park in Berlin. He was the prize most sought by Russian President Vladimir Putin, who had publicly praised the killing as an act of patriotism and for years had insisted that Krasikov be part of any swap. The deal reached its conclusion even as President Joe Biden, who got personally involved in the negotiations at key points, was slowly losing hope of continuing his reelection bid. On July 21, Biden placed a call from his vacation home in Delaware to Slovenia's prime minister to nail down one of the last pieces of the prisoner agreement. Less than two hours later, he announced he was withdrawing from the presidential race. In December 2022, authorities in Slovenia made two arrests that might, at first, have seemed of little consequence. They brought in a couple posing as Argentine emigres in the country, living under the pseudonyms Ludwig Gisch and Maria Mayer. As it turns out, the couple were deep-cover Russian intelligence officers. The arrests would prove critical for the prisoner exchange. At the time, the United States had been trying to secure the release of Whelan – who had been arrested in Russia four years earlier on espionage charges – but were always unsuccessful because there was nobody in U.S. custody the Russians believed was worthy of a swap. Now, with the arrests in Slovenia, U.S. officials figured they had something to barter. James P. Rubin, a State Department special envoy, and Roger D. Carstens, the department's chief hostage negotiator, came up with a plan that they called "enlarging the problem" – rather than seek a one-for-one or two-for-one exchange, they would broaden any potential swap to include many more people on both sides. They took the idea to Secretary of State Antony Blinken, who got Biden to approve the proposal in March 2023. But the ground in the negotiations shifted later that month when the Russians arrested Gershkovich and falsely accused him of spying for the United States. The day after Gershkovich's arrest, on March 30, 2023, Jake Sullivan, Biden's national security adviser, briefed the president about the case. Biden directed him to lead an effort to make a deal with the Russians to get Gershkovich and Whelan released. It was becoming clearer to the Americans what the Russians really wanted: the release of Krasikov. To Putin, the convicted assassin had become "a symbol" of a faithful soldier carrying out his duty to the Russian state, said a person close to the Kremlin. But including Krasikov in any prisoner deal meant persuading the German government to give him up, a move that posed significant political risk for Chancellor Olaf Scholz. In April 2023, weeks after Gershkovich's arrest, Blinken gauged the German foreign minister's interest in a possible deal that, besides the imprisoned Americans and the Russian assassin, would also include the release of Alexei Navalny, the prominent Russian dissident whom the Germans had been working to get freed from a Russian prison. The German foreign minister, Annalena Baerbock, was cool to any plan that led to the freedom of Krasikov, so White House officials decided to engage the chancellor's office directly. Without Krasikov as part of a deal, there was no deal to be had. In November 2023, CIA officers in Moscow offered another deal – Whelan and Gershkovich for four Russian spies, including the two arrested in Slovenia – but the Russians rejected it. On Jan. 16, Biden spoke by phone to Scholz, who finally relented, agreeing to include Krasikov in a prisoner deal as long as it also included Navalny. "For you, I will try to do this," Scholz told the president. At a meeting on Feb. 9, the two men agreed to pursue the idea, according to a U.S. official. But Navalny died in a Russian penal colony a week later, before the United States had formally broached the possibility of including him in a prisoner deal with the Russians. The White House once again had to work to persuade the German chancellor to include Krasikov in a revised prisoner deal. It took weeks to develop the out

lines of a proposal shared with the German government, one including numerous people in Russian prisons whom the Germans wanted released. The Americans added Vladimir Kara-Murza, another imprisoned Russian dissident, who was also a permanent U.S. resident, to appeal to Scholz's desire for a moral imperative to justify the release of a Russian assassin. The proposal also needed commitments from Slovenia, Norway and Poland that Russian spies imprisoned in those countries would be released as part of the deal. Scholz approved the deal to include Krasikov on June 7, and on June 25 the CIA officers made the proposal to the Russians in the Middle East. The deal that the Russians agreed to was largely the same as the June 25 proposal, U.S. officials said. Early last month, William Burns, the CIA director, spoke with Alexander Bortnikov, the head of Russia's FSB intelligence service. Days later, CIA officials and Russian intelligence operatives met again in person, this time in Turkey, to work out the final details of the agreement.

1. Show the most common words in the article.

```
In [8]: ##get tokens and token.pos
tokens = []
for token in doc:
    if not token.is_stop and not token.is_punct:
        tokens.append((token.lemma_.lower(), token.pos_))

df = pd.DataFrame(tokens, columns=['word', 'pos'])
```

```
In [9]: df['word'].value_counts().head(10)
```

```
Out[9]: word
russian      17
deal         17
include      11
prisoner     10
russians      9
krasikov      9
arrest        8
release       8
gershkovich   7
proposal      7
Name: count, dtype: int64
```

2. Show the most common words under a part of speech. (i.e. NOUN: {'Bob':12, 'Alice':4,})

Nouns

```
In [10]: df['word'][df['pos'] == 'NOUN'].value_counts().head(10)
```

```
Out[10]: word
deal      17
prisoner  10
proposal  7
official  6
swap      5
arrest    5
release   5
spy       4
officer   4
year      3
Name: count, dtype: int64
```

Verbs

```
In [11]: df['word'][df['pos'] == 'VERB'].value_counts().head(10)
```



```
Out[11]: word
include      11
agree        4
take         4
imprison     4
work         3
arrest       3
release      3
bring        3
come         2
speak        2
Name: count, dtype: int64
```

Adjectives

```
In [12]: df['word'][df['pos'] == 'ADJ'].value_counts().head(10)
```

```
Out[12]: word
russian      17
german       5
american     3
western      2
possible     2
foreign      2
close        1
unsuccessful  1
worthy       1
special      1
Name: count, dtype: int64
```

Adverbs

```
In [13]: df['word'][df['pos'] == 'ADV'].value_counts().head(10)
```

```
Out[13]: word
later        5
early        2
far          1
previously   1
increasingly 1
entirely     1
publicly     1
personally   1
slowly       1
home         1
Name: count, dtype: int64
```

3. Find a subject/object relationship through the dependency parser in any sentence.

```
In [14]: #from video
def pr_tree(word, level):
    if word.is_punct:
        return
    for child in word.lefts:
        pr_tree(child, level+1)
    print('\t'* level + word.text + ' - ' + word.dep_)
    for child in word.rights:
        pr_tree(child, level+1)
```

```
In [15]: for sentence in doc.sents:  
         pr_tree(sentence.root, 0)  
         print('-----')
```

WASHINGTON - dep
 A - det
 turning - compound
 point - nsubj
 came - ROOT
 June - npadvmod
 25 - nummod
 when - advmod
 a - det
 group - nsubj
 of - prep
 CIA - compound
 officers - pobj
 sat - relcl
 across - prt
 from - prep
 their - poss
 Russian - amod
 counterparts - pobj
 during - prep
 a - det
 secret - amod
 meeting - pobj
 in - prep
 a - det
 Middle - amod
 Eastern - amod
 capital - pobj

The - det
 Americans - nsubj
 floated - ROOT
 a - det
 proposal - dobj
 an - det
 exchange - nsubj
 of - prep
 two - compound
 dozen - nummod
 prisoners - pobj
 sitting - acl
 in - prep
 jails - pobj
 in - prep
 Russia - pobj
 the - det
 United - compound
 States - conj
 and - cc
 scattered - conj
 across - prep
 Europe - pobj
 a - det
 far - advmod
 bigger - amod
 and - cc
 more - advmod
 complex - conj
 deal - appos
 than - prep
 either - det
 side - pobj

had - aux
 previously - advmod
 contemplated - acl
 but - cc
 one - appos
 that - nsubj
 would - aux
 give - relcl
 both - preconj
 Moscow - dobj
 and - cc
 Western - amod
 nations - conj
 more - amod
 reasons - dobj
 to - aux
 say - relcl
 yes - intj

 Quiet - amod
 negotiations - nsubj
 between - prep
 the - det
 United - compound
 States - pobj
 and - cc
 Russia - conj
 over - prep
 a - det
 possible - amod
 prisoner - compound
 swap - pobj
 had - aux
 dragged - ROOT
 on - prt
 for - prep
 more - amod
 than - quantmod
 a - nummod
 year - pobj

 They - nsubjpass
 were - auxpass
 punctuated - ROOT
 by - agent
 only - amod
 occasional - amod
 glimpses - pobj
 of - prep
 hope - pobj
 for - mark
 the - det
 families - nsubj
 of - prep
 the - det
 American - amod
 prisoners - pobj
 including - prep
 Evan - compound
 Gershkovich - pobj
 a - det
 reporter - appos

for - prep
 The - det
 Wall - compound
 Street - compound
 Journal - pobj
 and - cc
 Paul - compound
 Whelan - conj
 an - det
 American - amod
 security - compound
 contractor - appos
 growing - advcl
 increasingly - advmod
 impatient - acomp
 for - mark
 their - poss
 ordeal - nsubj
 to - aux
 end - advcl

 Those - det
 hopes - nsubjpass
 were - auxpass
 always - advmod
 dashed - ROOT
 when - advmod
 one - nsubj
 of - prep
 the - det
 two - nummod
 sides - pobj
 balked - advcl

 But - cc
 the - det
 June - compound
 meeting - nsubj
 changed - ROOT
 things - dobj
 according - prep
 to - prep
 accounts - pobj
 from - prep
 American - amod
 and - cc
 Western - conj
 officials - pobj
 and - cc
 other - amod
 people - conj
 familiar - amod
 with - prep
 the - det
 long - amod
 process - pobj
 of - prep
 bringing
 - pcomp
 the - det

eal - dobj

o - prep

fruition - pobj

The - det
 Russian - amod
 spies - nsubj
 took - ROOT
 the - det
 proposal - dobj
 back - advmod
 to - prep
 Moscow - pobj
 and - cc
 only - amod
 days - npadvmod
 later - advmod
 the - det
 CIA - compound
 director - nsubj
 was - conj
 on - prep
 the - det
 phone - pobj
 with - prep
 a - det
 Russian - amod
 spy - compound
 chief - pobj
 agreeing - acl
 to - prep
 the - det
 broad - amod
 parameters - pobj
 of - prep
 a - det
 massive - amod
 prisoner - compound
 swap - pobj

On - prep
 Thursday - pobj
 seven - nummod
 different - amod
 planes - nsubj
 touched - ROOT
 down - prt
 in - prep
 Turkey - pobj
 and - cc
 exchanged - conj
 passengers - dobj
 bringing - advcl
 to - prep
 a - det
 successful - amod
 close - pobj
 an - det
 intensive - amod
 diplomatic - amod

effort - dobj
 that - nsubj
 took - relcl
 place - dobj
 almost - advmod
 entirely - advmod
 out - prep
 of - prep
 public - amod
 view - pobj

The - det
 deal - nsubj
 between - prep
 longtime - amod
 adversaries - pobj
 secured - ROOT
 the - det
 release - dobj
 of - prep
 Gershkovich - pobj
 Whelan - conj
 and - cc
 14 - nummod
 other - amod
 Americans - conj
 Russians - conj
 and - cc
 Europeans - conj
 imprisoned - acl
 in - prep
 Russia - pobj

The - det
 deal - nsubj
 also - advmod
 freed - ROOT
 among - prep
 others - pobj
 a - det
 Russian - amod
 hit - amod
 man - dobj
 Vadim - compound
 Krasikov - appos

He - nsubjpass
 had - aux
 been - auxpass
 jailed - ROOT
 in - prep
 Germany - pobj
 since - prep
 2019 - pobj
 for - prep
 the - det
 killing - pobj
 of - prep
 a - det
 Chechen - nmod
 former - amod
 separatist - amod

```

                                fighter - pobj
                                in - prep
                                a - det
                                park - pobj
                                in - prep
                                Berlin - pobj
-----
He - nsubj
was - ROOT
    the - det
    prize - attr
        most - advmod
        sought - acl
        by - agent
            Russian - amod
            President - compound
            Vladimir - compound
            Putin - pobj
                who - nsubj
                had - aux
                publicly - advmod
                praised - relcl
                    the - det
                    killing - dobj
                    as - prep
                        an - det
                        act - pobj
                        of - prep
                            patriotism - pobj
                    and - cc
                    for - prep
                        years - pobj
                        had - aux
                        insisted - conj
                            that - mark
                            Krasikov - nsubj
                            be - ccomp
                                part - attr
                                    of - prep
                                        any - det
                                        swap - pobj

```

```

-----
The - det
deal - nsubj
reached - ROOT
    its - poss
    conclusion - dobj
    even - advmod
    as - mark
        President - compound
        Joe - compound
        Biden - nsubj
            who - nsubjpass
            got - aux
            personally - advmod
            involved - relcl
                in - prep
                    the - det
                    negotiations - pobj
                    at - prep
                        key - amod
                        points - pobj

```


was - aux
 slowly - advmod
 losing - advcl
 hope - dobj
 of - prep
 continuing - pcomp
 his - poss
 reelection - compound
 bid - dobj

 On - prep
 July - pobj
 21 - nummod
 Biden - nsubj
 placed - ROOT
 a - det
 call - dobj
 from - prep
 his - poss
 vacation - compound
 home - pobj
 in - prep
 Delaware - pobj
 to - prep
 Slovenia - poss
 's - case
 prime - amod
 minister - pobj
 to - aux
 nail - advcl
 down - prt
 one - dobj
 of - prep
 the - det
 last - amod
 pieces - pobj
 of - prep
 the - det
 prisoner - compound
 agreement - pobj

 Less - amod
 than - quantmod
 two - nummod
 hours - npadvmod
 later - advmod
 he - nsubj
 announced - ROOT
 he - nsubj
 was - aux
 withdrawing - ccomp
 from - prep
 the - det
 presidential - amod
 race - pobj

 In - prep
 December - pobj
 2022 - nummod
 authorities - nsubj
 in - prep
 Slovenia - pobj

```

made - ROOT
    two - nummod
    arrests - dobj
        that - nsubj
        might - aux
        at - prep
            first - pcomp
        have - aux
    seemed - relcl
        of - prep
            little - amod
            consequence - pobj
-----
    They - nsubj
brought - ROOT
    in - prt
        a - det
    couple - dobj
        posing - acl
            as - prep
                Argentine - pobj
    emigres - conj
        in - prep
            the - det
                country - pobj
    living - advcl
        under - prep
            the - det
                pseudonyms - pobj
                    Ludwig - compound
                Gisch - appos
                    and - cc
                        Maria - compound
                    Mayer - conj
-----
        As - mark
        it - nsubj
    turns - advcl
        out - prt
        the - det
    couple - nsubj
were - ROOT
        deep - amod
        cover - nmod
        Russian - amod
        intelligence - compound
    officers - attr
-----
        The - det
    arrests - nsubj
    would - aux
prove - ROOT
    critical - oprd
    for - prep
        the - det
        prisoner - compound
    exchange - pobj
-----
    At - prep
        the - det
        time - pobj
        the - det

```

```

United - compound
States - nsubj
had - aux
been - aux
trying - ROOT
    to - aux
    secure - xcomp
        the - det
        release - dobj
        of - prep
            Whelan - pobj
            who - nsubjpass
            had - aux
            been - auxpass
            arrested - relcl
            in - prep
                Russia - pobj
                four - nummod
                years - npadvmod
                earlier - advmod
                on - prep
                    espionage - compound
                    charges - pobj
but - cc
were - conj
    always - advmod
    unsuccessful - acomp
        because - mark
        there - expl
    was - advcl
        nobody - nsubj
        in - prep
            U.S. - compound
            custody - pobj
            the - det
            Russians - nsubj
            believed - relcl
        was - ccomp
            worthy - acomp
            of - prep
                a - det
                swap - pobj

```

```

Now - advmod
with - prep
    the - det
    arrests - pobj
    in - prep
        Slovenia - pobj
    U.S. - compound
    officials - nsubj
figured - ROOT
    they - nsubj
    had - ccomp
        something - dobj
        to - aux
        barter - relcl

```

```

James - compound
P. - compound
Rubin - nsubj
    a - det

```

```

                                State - nmod
                                Department - nmod
                                special - amod
                                envoy - appos
                                and - cc
                                Roger - compound
                                D. - compound
                                Carstens - conj
                                the - det
                                department - poss
                                's - case
                                chief - amod
                                hostage - compound
                                negotiator - appos
came - ccomp
    up - prt
    with - prep
        a - det
        plan - pobj
            that - dobj
            they - nsubj
            called - relcl
            enlarging - xcomp
                the - det
                problem - dobj
            rather - advmod
        than - cc
        seek - conj
            a - det
            one - nummod
            for - prep
                one - pobj
                or - cc
                two - conj
                for - prep
                one - pobj
            exchange - dobj
        they - nsubj
        would - aux
broaden - ROOT
    any - det
    potential - amod
    swap - dobj
    to - aux
    include - advcl
        many - amod
        more - amod
        people - dobj
        on - prep
            both - det
            sides - pobj
    -----
    They - nsubj
took - ROOT
    the - det
    idea - dobj
    to - prep
        Secretary - nmod
        of - prep
        State - pobj
        Antony - compound
        Blinken - pobj

```

```

                                who - nsubj
                                got - relcl
                                Biden - nsubj
                                to - aux
                                approve - ccomp
                                    the - det
                                proposal - dobj
                                in - prep
                                    March - pobj
                                    2023 - nummod
-----
    But - cc
        the - det
    ground - nsubj
        in - prep
            the - det
            negotiations - pobj
shifted - ROOT
    later - advmod
    that - det
    month - npadvmod
    when - advmod
        the - det
    Russians - nsubj
    arrested - advcl
    Gershkovich - dobj
    and - cc
        falsely - advmod
    accused - conj
        him - dobj
        of - prep
            spying - pobj
            for - prep
                the - det
                United - compound
                States - pobj
-----
    The - det
    day - npadvmod
        after - prep
            Gershkovich - poss
            's - case
            arrest - pobj
    on - prep
        March - pobj
        30 - nummod
        2023 - nummod
        Jake - compound
    Sullivan - nsubj
        Biden - poss
        's - case
        national - amod
        security - compound
    adviser - appos
briefed - ROOT
    the - det
    president - dobj
    about - prep
        the - det
        case - pobj
-----
    Biden - nsubj

```

directed - ROOT
 him - dobj
 to - aux
 lead - xcomp
 an - det
 effort - dobj
 to - aux
 make - acl
 a - det
 deal - dobj
 with - prep
 the - det
 Russians - pobj
 to - aux
 get - advcl
 Gershkovich - nsubj
 and - cc
 Whelan - conj
 released - ccomp

 It - nsubj
 was - aux
 becoming - ROOT
 clearer - acomp
 to - prep
 the - det
 Americans - pobj
 what - dobj
 the - det
 Russians - nsubj
 really - advmod
 wanted - ccomp
 the - det
 release - attr
 of - prep
 Krasikov - pobj

 To - prep
 Putin - pobj
 the - det
 convicted - amod
 assassin - nsubj
 had - aux
 become - ccomp
 a - det
 symbol - attr
 of - prep
 a - det
 faithful - amod
 soldier - pobj
 carrying - acl
 out - prt
 his - poss
 duty - dobj
 to - prep
 the - det
 Russian - amod
 state - pobj
 said - ROOT
 a - det
 person - nsubj
 close - amod

```

to - prep
the - det
Kremlin - pobj
-----
But - cc
including - prep
Krasikov - pobj
in - prep
any - det
prisoner - compound
deal - pobj
meant - ROOT
persuading - xcomp
the - det
German - amod
government - dobj
to - aux
give - xcomp
him - dobj
up - prt
a - det
move - npadvmod
that - nsubj
posed - relcl
significant - amod
political - amod
risk - dobj
for - prep
Chancellor - compound
Olaf - compound
Scholz - pobj
-----
In - prep
April - pobj
2023 - nummod
weeks - npadvmod
after - prep
Gershkovich - poss
's - case
arrest - pobj
Blinken - nsubj
gauged - ROOT
the - det
German - amod
foreign - amod
minister - poss
's - case
interest - dobj
in - prep
a - det
possible - amod
deal - pobj
that - nsubj
besides - prep
the - det
imprisoned - amod
Americans - pobj
and - cc
the - det
Russian - amod
assassin - conj
would - aux

```

```

also - advmod
include - ccomp
    the - det
    release - dobj
        of - prep
            Alexei - compound
            Navalny - pobj
                the - det
                prominent - amod
                Russian - amod
            dissident - appos
                the - det
                Germans - nsubj
                had - aux
                been - aux
                working - relcl
                    to - aux
                    get - auxpass
                    freed - xcomp
                        whom - pobj
                        from - prep
                            a - det
                            Russian - amod
                            prison - pobj
-----
    The - det
    German - amod
    foreign - amod
    minister - nsubj
        Annalena - compound
        Baerbock - appos
was - ccomp
    cool - acomp
        to - prep
            any - det
            plan - pobj
                that - nsubj
                led - relcl
                    to - prep
                        the - det
                        freedom - pobj
                        of - prep
                            Krasikov - pobj
so - mark
    White - compound
    House - compound
    officials - nsubj
decided - ROOT
    to - aux
    engage - xcomp
        the - det
        chancellor - poss
        's - case
    office - dobj
    directly - advmod
-----
    Without - prep
    Krasikov - pobj
    as - prep
        part - pobj
        of - prep
            a - det

```



```

                                deal - pobj
                                there - expl
was - ROOT
                                no - det
                                deal - attr
                                to - aux
                                be - auxpass
                                had - relcl
-----
In - prep
    November - pobj
        2023 - nummod
    CIA - compound
officers - nsubj
    in - prep
        Moscow - pobj
offered - ROOT
    another - det
    deal - dobj
        Whelan - appos
            and - cc
            Gershkovich - conj
    for - prep
        four - nummod
        Russian - amod
    spies - pobj
        including - prep
            the - det
            two - pobj
            arrested - acl
                in - prep
                    Slovenia - pobj
    but - cc
        the - det
        Russians - nsubj
    rejected - conj
        it - dobj
-----
On - prep
    Jan. - pobj
        16 - nummod
    Biden - nsubj
spoke - ROOT
    by - prep
        phone - pobj
    to - prep
        Scholz - pobj
            who - nsubj
            finally - advmod
        relented - relcl
            agreeing - advcl
                to - aux
                include - xcomp
                    Krasikov - dobj
                    in - prep
                        a - det
                        prisoner - compound
                    deal - pobj
                    as - advmod
                long - advmod
                    as - mark
                    it - nsubj

```

also - advmod
included - advcl
Navalny - dobj

For - prep
 you - pobj
I - nsubj
will - aux
try - ccomp
 to - aux
do - xcomp
 this - dobj
Scholz - nsubj
told - ROOT
 the - det
president - dobj

At - prep
 a - det
meeting - pobj
 on - prep
 Feb. - pobj
 9 - nummod
 the - det
two - nummod
men - nsubj
agreed - ROOT
 to - aux
pursue - xcomp
 the - det
idea - dobj
according - prep
 to - prep
 a - det
 U.S. - compound
official - pobj

But - cc
Navalny - nsubj
died - ROOT
in - prep
 a - det
 Russian - amod
 penal - amod
colony - pobj
 a - det
week - npadvmod
later - advmod
before - mark
 the - det
 United - compound
States - nsubj
had - aux
formally - advmod
broached - advcl
 the - det
possibility - dobj
 of - prep
 including - pcomp
 him - dobj
 in - prep
a - det

```

prisoner - compound
deal - pobj
with - prep
the - det
Russians - pobj
-----
The - det
White - compound
House - nsubj
once - advmod
again - advmod
had - ROOT
to - aux
work - xcomp
to - aux
persuade - advcl
the - det
German - amod
chancellor - dobj
to - aux
include - xcomp
Krasikov - dobj
in - prep
a - det
revised - amod
prisoner - compound
deal - pobj
-----
It - nsubj
took - ROOT
weeks - dobj
to - aux
develop - xcomp
the - det
outlines - dobj
of - prep
a - det
proposal - pobj
shared - acl
with - prep
the - det
German - amod
government - pobj
one - appos
including - prep
numerous
- amod
people - pobj
in - prep
Russian - amod
risons - pobj
the - det
ermans - nsubj
wanted -
relcl
whom - dobj

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released - xcomp

The - det
Americans - nsubj
added - ROOT
Vladimir - compound
Kara - compound
Murza - dobj
another - det
imprisoned - amod
Russian - amod
dissident - appos
who - nsubj
was - relcl
also - advmod
a - det
permanent - amod
U.S. - compound
resident - attr
to - aux
appeal - advcl
to - prep
Scholz - poss
's - case
desire - pobj
for - prep
a - det
moral - amod
imperative - pobj
to - aux
justify - acl
the - det
release - dobj
of - prep
a - det
Russian - amod
assassin - pobj

The - det
proposal - nsubj
also - advmod
needed - ROOT
commitments - dobj
from - prep
Slovenia - pobj
Norway - conj
and - cc
Poland - conj
that - mark
Russian - amod
spies - nsubjpass
imprisoned - acl
in - prep
those - det
countries - pobj
would - aux
be - auxpass
released - acl
as - prep
part - pobj
of - prep
the - det

deal - pobj

Scholz - nsubj
approved - ROOT
the - det
deal - dobj
to - aux
include - advcl
Krasikov - dobj
on - prep
June - pobj
7 - nummod
and - cc
on - prep
June - pobj
25 - nummod
the - det
CIA - compound
officers - nsubj
made - conj
the - det
proposal - dobj
to - prep
the - det
Russians - pobj
in - prep
the - det
Middle - compound
East - pobj

The - det
deal - dep
the - det
Russians - nsubj
agreed - relcl
that - dobj
to - aux
was - xcomp
largely - advmod
the - det
same - attr
as - prep
the - det
June - nmod
25 - nummod
proposal - pobj
U.S. - compound
officials - nsubj
said - ROOT

Early - advmod
last - amod
month - npadvmod
William - compound
Burns - nsubj
the - det
CIA - compound
director - appos
spoke - ROOT
with - prep
Alexander - compound
Bortnikov - pobj

```

                                the - det
                                head - appos
                                of - prep
                                Russia - poss
                                's - case
                                FSB - compound
                                intelligence - compound
                                service - pobj
-----
                                Days - npadvmod
                                later - advmod
                                CIA - compound
                                officials - nsubj
                                and - cc
                                Russian - amod
                                intelligence - compound
                                operatives - conj
met - ROOT
                                again - advmod
                                in - prep
                                person - pobj
                                this - det
                                time - npadvmod
                                in - prep
                                Turkey - pobj
                                to - aux
                                work - advcl
                                out - prt
                                the - det
                                final - amod
                                details - dobj
                                of - prep
                                the - det
                                agreement - pobj
-----

```

4. Show the most common Entities and their types. & 5. Find Entities and their dependency (hint: entity.root.head)

```

In [16]: entities = []
for entity in doc.ents:
    entities.append((entity.text.lower(), entity.label_, entity.root.text, entity.root.head))

df_ent = pd.DataFrame(entities, columns=['entity', 'type', 'root', 'head'])

df_ent['ent_type'] = df_ent['entity'] + '(' + df_ent['type'] + ')'

```

Common Entities and types

```

In [17]: df_ent['ent_type'].value_counts().head(10)

```

```
Out[17]: ent_type
russian(NORP)      17
russians(NORP)     9
cia(ORG)           6
one(CARDINAL)      5
two(CARDINAL)      5
biden(PERSON)      5
americans(NORP)    5
gershkovich(PERSON) 5
russia(GPE)        5
the united states(GPE) 5
Name: count, dtype: int64
```

Dependencies

```
In [18]: df_ent.rename(columns={'head': 'dependency'}).groupby(['entity', 'root', 'dependency']).size().n
```

Out[18]:

	entity	root	dependency	count
0	14	14	Americans	1
1	2019	2019	since	1
2	a week later	later	died	1
3	alexander bortnikov	Bortnikov	with	1
4	alexei navalny	Navalny	of	1
5	american	American	prisoners	1
6	american	American	contractor	1
7	american	American	officials	1
12	americans	Americans	added	1
11	americans	Americans	besides	1
9	americans	Americans	Whelan	1
8	americans	Americans	floated	1
10	americans	Americans	to	1
13	annalena baerbock	Baerbock	minister	1
14	antony blinken	Blinken	to	1
15	april 2023, weeks	weeks	gauged	1
16	argentine	Argentina	as	1
17	berlin	Berlin	in	1
21	biden	Biden	directed	1
20	biden	Biden	adviser	1

6. Find the most similar words in the article

```
In [19]: df_freq = df['word'].value_counts().reset_index()
df_freq.columns = ['word', 'frequency']
top = df_freq.head(15)['word'].tolist()
```

```
In [20]: ##Used ChatGPT to assist with the enumeration formula.
similarities = []
token_doc = {token: nlp(token) for token in top}
for i, token_1 in enumerate(top):
    for token_2 in top[i+1:]:
        if token_1 != token_2:
            doc1 = token_doc[token_1]
            doc2 = token_doc[token_2]
            similarity = doc1.similarity(doc2)
            similarities.append((token_1, token_2, similarity))
##Citation: OpenAI. (2024). ChatGPT. Retrieved from: openai.chatgpt.com
```

```
In [21]: df_sim = pd.DataFrame(similarities, columns = ['Word 1', 'Word 2', 'Similarity'])
df_sim.sort_values(by='Similarity', ascending = False).head(20)
```

Out[21]:

	Word 1	Word 2	Similarity
3	russian	russians	0.745630
41	prisoner	arrest	0.536314
11	russian	official	0.482444
92	proposal	official	0.451758
39	prisoner	russians	0.445172
81	release	official	0.430754
21	deal	proposal	0.420921
57	russians	official	0.375246
45	prisoner	cia	0.349065
69	arrest	release	0.340447
36	include	official	0.338986
78	release	proposal	0.336700
55	russians	cia	0.334286
54	russians	proposal	0.328909
72	arrest	cia	0.328618
19	deal	release	0.310008
74	arrest	official	0.295469
56	russians	biden	0.293366
9	russian	cia	0.292091
2	russian	prisoner	0.290614