Regular Expressions and HTTP

Basic Programming in Python

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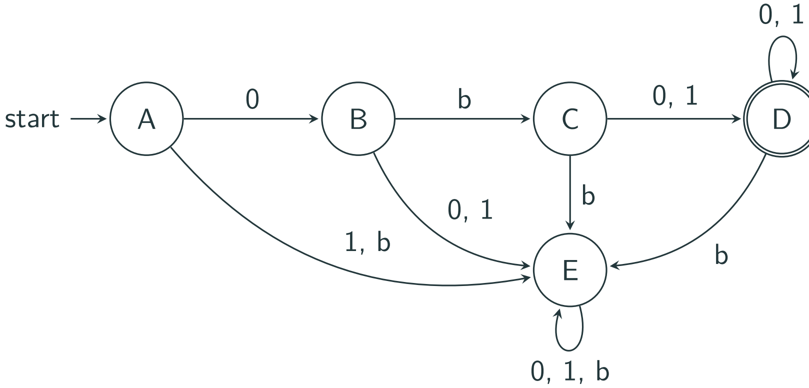
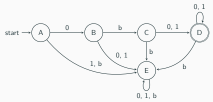
Matching strings: “Python binaries”



Matching strings: “Python binaries”



Last week we discussed the formal language “Python binaries” and how to check strings if they are part of it.

Today we learn a powerful tool to not only check if a string matches a certain grammar (i.e. is part of a formal language), but also to find all matching sequences inside long texts: Regular expressions.

Regular Expressions (regex)

- Regex are often called *patterns*
- Regex were designed to match regular languages[1]
- Regex can also be used to search long texts for patterns
- Regex are built-in into many text editors and programming languages
- Regex are transformed into an FSA just like we implemented last week

[1] Basically those we can represent using the FSA we learned, for more info check https://en.wikipedia.org/wiki/Chomsky_hierarchy or join the theoretical computer science class.

Formal definition of regular languages[2]

Regular languages over Σ are:

- Empty language $\emptyset$, empty string language $\{\epsilon\}$
- Singleton languages ($\{a\}$ if $a \in \Sigma$)
- Union, concatenation and Kleene star of languages A and B

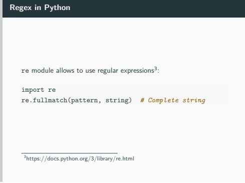
[2]Adapted from Wikipedia contributors (2017)

Regex in Python

`re` module allows to use regular expressions[3]:

```
import re
re.fullmatch(pattern, string)  # Complete string
```

[3] https://docs.python.org/3/library/re.html


Regex in Python

re module allows to use regular expressions[3]:

```
import re
re.fullmatch(pattern, string)  # Complete string
```

[3]https://docs.python.org/3/library/re.html

The `re` module has many more elements to form a regular expression than what we will cover here, if you feel like it, feel free to explore it more for your own projects.

We will only discuss the procedural interface, but there is also an object oriented interface where you *compile* a regex and perform actions on it:

`regex = re.compile(pattern) regex.fullmatch(string)`

The compiled version can also be used like this: `re.fullmatch(regex, string)`. This is faster if you want to reuse the same regex multiple times.

Regex: empty string

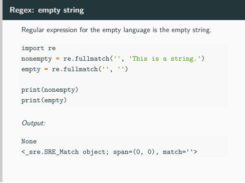
Regular expression for the empty language is the empty string.

```python
import re
nonempty = re.fullmatch('', 'This is a string.')
empty = re.fullmatch('', '')

print(nonempty)
print(empty)
```

Output:

```
None
<_sre.SRE_Match object; span=(0, 0), match=''>
```



Regex: empty string

Regular expression for the empty language is the empty string.

```
import re
nonempty = re.fullmatch('', 'This is a string.')
empty = re.fullmatch('', '')

print(nonempty)
print(empty)
```

Output:

```
None
<_sre.SRE_Match object; span=(0, 0), match=''>
```

The empty string only matches the empty string.

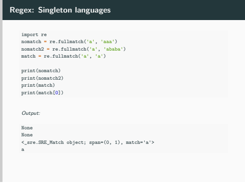
Regex: Singleton languages

```
import re
nomatch = re.fullmatch('a', 'aaa')
nomatch2 = re.fullmatch('a', 'ababa')
match = re.fullmatch('a', 'a')

print(nomatch)
print(nomatch2)
print(match)
print(match[0])
```

Output:

```
None
None
<_sre.SRE_Match object; span=(0, 1), match='a'>
a
```



Regex: Singleton languages

```
import re
nomatch = re.fullmatch('a', 'aaa')
nomatch2 = re.fullmatch('a', 'ababa')
match = re.fullmatch('a', 'a')

print(nomatch)
print(nomatch2)
print(match)
print(match[0])
```

Output:

```
None
None
<_sre.SRE_Match object; span=(0, 1), match='a'>
a
```

A singleton pattern matches single letters which are the same.

Reading the result:

a: `<_sre.SRE_Match object; span=(0, 1), match='a'>`

span:	from where to where (`a.pos`, `a.endpos`)
match:	what was matched (here the input string)

Using the indexing, we can access groups (more later), the first group (0) is the match.

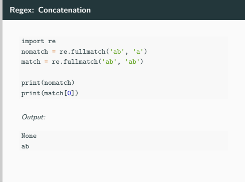
Regex: Concatenation

```
import re
nomatch = re.fullmatch('ab', 'a')
match = re.fullmatch('ab', 'ab')

print(nomatch)
print(match[0])
```

Output:

```
None
ab
```



Regex: Concatenation

```
import re
nomatch = re.fullmatch('ab', 'a')
match = re.fullmatch('ab', 'ab')

print(nomatch)
print(match[0])
```

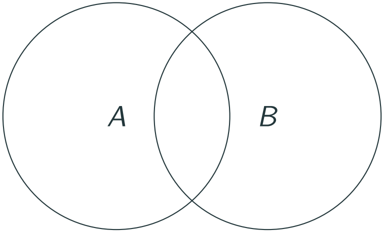
Output:

```
None
ab
```

We can just concatenate (i.e. append to teach other) patterns to match their concatenation. The pattern `a` matches `a`, the pattern `b` matches `b`, but pattern `ab` only matches `ab` and neither `a` nor `b`.

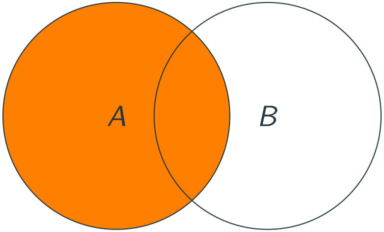
Intermezzo: Set theory meets logic

Two sets, A and B



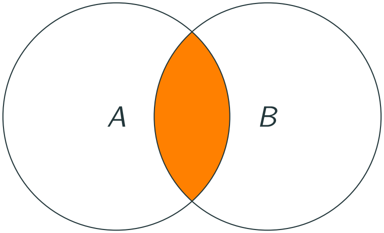
Intermezzo: Set theory meets logic

Only set A

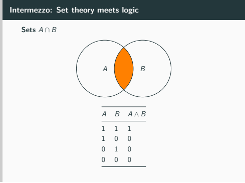


Intermezzo: Set theory meets logic

Sets $A \cap B$



A	B	$A \wedge B$
1	1	1
1	0	0
0	1	0
0	0	0



Intermezzo: Set theory meets logic

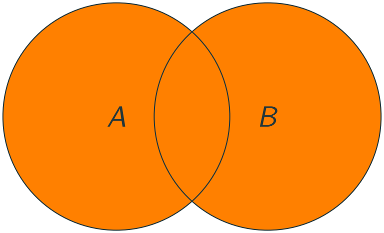
Sets $A \cap B$

A	B	$A \wedge B$
1	1	1
1	0	0
0	1	0
0	0	0

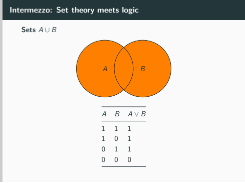
Intersection is like the logical *and*. Notice the similarity between the symbols $\cap$ and $\wedge$!

Intermezzo: Set theory meets logic

Sets $A \cup B$



A	B	$A \vee B$
1	1	1
1	0	1
0	1	1
0	0	0



Intermezzo: Set theory meets logic

Sets $A \cup B$

A	B	$A \vee B$
1	1	1
1	0	1
0	1	1
0	0	0

Union is like the logical *or*. Notice the similarity between the symbols $\cup$ and $\vee$!

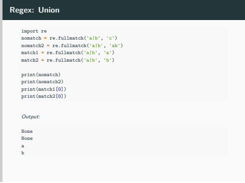
Regex: Union

```python
import re
nomatch = re.fullmatch('a|b', 'c')
nomatch2 = re.fullmatch('a|b', 'ab')
match1 = re.fullmatch('a|b', 'a')
match2 = re.fullmatch('a|b', 'b')

print(nomatch)
print(nomatch2)
print(match1[0])
print(match2[0])
```

Output:

```
None
None
a
b
```



Regex: Union

```
import re
nomatch = re.fullmatch('a|b', 'c')
nomatch2 = re.fullmatch('a|b', 'ab')
match1 = re.fullmatch('a|b', 'a')
match2 = re.fullmatch('a|b', 'b')

print(nomatch)
print(nomatch2)
print(match1[0])
print(match2[0])
```

Output:

```
None
None
a
b
```

We have seen that union is the logical or, hence the regex symbol for *union* is the | - a symbol which for many programmers intuitively maps to *or*.

Regex: Wrap up of simple expressions

- Empty string `''` for empty language and empty string language
- Characters (letters, numbers, etc.) for singleton languages (e.g. `a`, `b`, `1`, . . .)
- Concatenations of characters (e.g. `abcab`, `ab`, `bb`, . . .)
- Union as *or* (e.g. `a|b`, `0|1`, `aa|ab|ba`, . . .)

What about the Kleene star?

Regex: Kleene star

The Kleene star is used to indicate arbitrary repetitions:

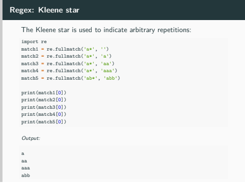
```
import re
match1 = re.fullmatch('a*', '')
match2 = re.fullmatch('a*', 'a')
match3 = re.fullmatch('a*', 'aa')
match4 = re.fullmatch('a*', 'aaa')
match5 = re.fullmatch('ab*', 'abb')

print(match1[0])
print(match2[0])
print(match3[0])
print(match4[0])
print(match5[0])
```

Output:

```

a
aa
aaa
abb
```



Regex: Kleene star

The Kleene star is used to indicate arbitrary repetitions:

```
import re
match1 = re.fullmatch('a*', '')
match2 = re.fullmatch('a*', 'a')
match3 = re.fullmatch('a*', 'aa')
match4 = re.fullmatch('a*', 'aaa')
match5 = re.fullmatch('ab*', 'abb')

print(match1[0])
print(match2[0])
print(match3[0])
print(match4[0])
print(match5[0])
```

Output:

```

a
aa
aaa
abb
```

The Kleene star can match no, one, or many characters of the same expression.

Regex: extension of Kleene

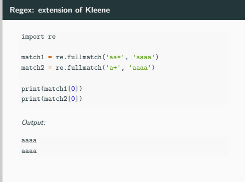
```
import re


match1 = re.fullmatch('aa*', 'aaaa')
match2 = re.fullmatch('a+', 'aaaa')


print(match1[0])
print(match2[0])
```

Output:

```
aaaa
aaaa
```



Regex: extension of Kleene

```
import re

match1 = re.fullmatch('aa*', 'aaaa')
match2 = re.fullmatch('a+', 'aaaa')

print(match1[0])
print(match2[0])
```

Output:

```
aaaa
aaaa
```

+ means: At least one. It is thus equivalent to the concatenation between a singleton language and the Kleene star.

Example: Regex for “Python binaries”

Try to find a regex which matches words of the “Python binaries”.

1. The empty word ($\emptyset$) is not part of $\mathcal{L}_{pb}$.
2. Each word must start with $0b$.
3. After b, a 1 or a 0 must follow.
4. After any 1 or 0 (not the first), there may follow another 1 or 0.

Regex for “Python binaries”

```
import re

pattern = re.compile('0b(1|0)+')

print(pattern.fullmatch('0b001101')[0])
print(pattern.fullmatch('0b110')[0])
print(pattern.fullmatch('01110011'))
print(pattern.fullmatch('b0b101b'))
print(pattern.fullmatch('0b0000011')[0])
print(pattern.fullmatch('0b'))
```

Output:

```
0b001101
0b110
None
None
0b0000011
None
```

Fullmatch vs. match

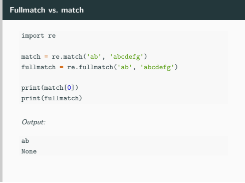
```
import re

match = re.match('ab', 'abcdefg')
fullmatch = re.fullmatch('ab', 'abcdefg')

print(match[0])
print(fullmatch)
```

Output:

```
ab
None
```



Fullmatch vs. match

```
import re

match = re.match('ab', 'abcdefg')
fullmatch = re.fullmatch('ab', 'abcdefg')

print(match[0])
print(fullmatch)
```

Output:

```
ab
None
```

`re.match` matches at the beginning of the string.

`re.fullmatch` matches the full string.

Match vs. search vs. findall

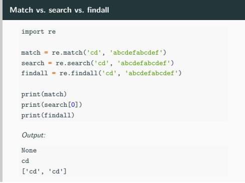
```
import re

match = re.match('cd', 'abcdefabcdef')
search = re.search('cd', 'abcdefabcdef')
findall = re.findall('cd', 'abcdefabcdef')

print(match)
print(search[0])
print(findall)
```

Output:

```
None
cd
['cd', 'cd']
```



Match vs. search vs. findall

```python
import re

match = re.match('cd', 'abcdefabcdef')
search = re.search('cd', 'abcdefabcdef')
findall = re.findall('cd', 'abcdefabcdef')

print(match)
print(search[0])
print(findall)
```

Output:

```
None
cd
['cd', 'cd']
```

`re.search` searches for the first occurrence. `re.findall` searches for all occurrences.

Character sets

Matching a two-digit hexadecimal number is tricky:

```
import re
pattern = re.compile('(0|1|2|3|4|5|6|7|8|9|a|b|c|d|e|f)' +
                     '(0|1|2|3|4|5|6|7|8|9|a|b|c|d|e|f)')
match = pattern.match('4f')
print(match[0])
```

Output:

```
4f
```

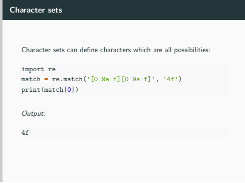
Character sets

Character sets can define characters which are all possibilities:

```
import re
match = re.match('[0-9a-f][0-9a-f]', '4f')
print(match[0])
```

Output:

```
4f
```



Character sets

Character sets can define characters which are all possibilities:

```
import re
match = re.match('[0-9a-f][0-9a-f]', '4f')
print(match[0])
```

Output:

```
4f
```

Note that character sets are case sensitive. Inside character sets, special characters (+, ∗, etc.) have no special meaning.

Very common are the numbers and the alphabets: `[0-9a-zA-Z]`.

Negating a set

It is possible to negate a character set, i.e. “match all but the following”:

```
import re
match = re.match('[^a-c]', 'def')
nomatch = re.match('[^a-c]', 'aef')

print(match[0])
print(nomatch)
```

Output:

```
d
None
```

I don’t care-character

The dot (.) matches all characters but newlines:

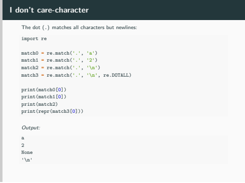
```
import re

match0 = re.match('.', 'a')
match1 = re.match('.', '2')
match2 = re.match('.', '\n')
match3 = re.match('.', '\n', re.DOTALL)

print(match0[0])
print(match1[0])
print(match2)
print(repr(match3[0]))
```

Output:

```
a
2
None
'\n'
```



I don't care-character

The dot (.) matches all characters but newlines:

```
import re

match0 = re.match('.', 'a')
match1 = re.match('.', '2')
match2 = re.match('.', '\n')
match3 = re.match('.', '\n', re.DOTALL)

print(match0[0])
print(match1[0])
print(match2)
print(repr(match3[0]))
```

Output:

```
a
2
None
'\n'
```

Hint: To also match newlines, you can use the `re.DOTALL` flag:

```
re.match('.', '\n', flags=re.DOTALL)
```

Escaping

As in normal strings, we can use \ for escaping, e.g. `\.` would match a literal dot instead of any character.

To match a literal backslash we run into trouble:

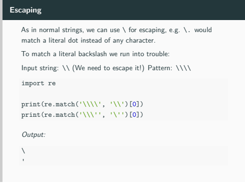
Input string: \\ (We need to escape it!) Pattern: \\\\

```
import re


print(re.match('\\\\', '\\')[0])
print(re.match('\\\'', '\'')[0])
```

Output:

```
\
'
```



Escaping

As in normal strings, we can use \ for escaping, e.g. `\.` would match a literal dot instead of any character.

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Input string: \\ (We need to escape it!) Pattern: \\\\

```
import re


print(re.match('\\\\', '\\')[0])
print(re.match('\\\'', '\'')[0])
```

Output:

```
\
'
```

For the \\\\ pattern, we are escaping the escape character and the character to be escaped.

Avoid some escaping

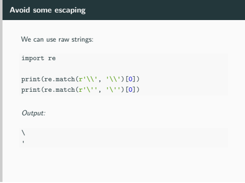
We can use raw strings:

```
import re


print(re.match(r'\\', '\\')[0])
print(re.match(r'\'', '\'')[0])
```

Output:

```
\
'
```



Avoid some escaping

We can use raw strings:

```
import re

print(re.match(r'\\', '\\')[0])
print(re.match(r'\'', '\'')[0])
```

Output:

```
\
'
```

Raw strings use \ as literals, they usually ignore the escaping capabilities. But since a regex is compiled, it has a deeper level and the escaping still applies for it.

An edge case are quotes: They are still escaped by backslashes but also remain in there. You can find more about this in the documentation https://docs.python.org/3/reference/lexical_analysis.html#string-and-bytes-literals

.

Groups

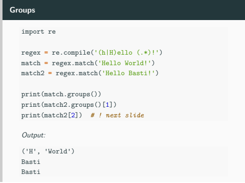
```
import re

regex = re.compile('(h|H)ello (.*)!')
match = regex.match('Hello World!')
match2 = regex.match('Hello Basti!')

print(match.groups())
print(match2.groups()[1])
print(match2[2])  # ! next slide
```

Output:

```
('H', 'World')
Basti
Basti
```



Groups

```
import re

regex = re.compile('(h|H)ello (.*)!')
match = regex.match('Hello World!')
match2 = regex.match('Hello Basti!')

print(match.groups())
print(match2.groups()[1])
print(match2[2])  # ! next slide
```

Output:

```
('H', 'World')
Basti
Basti
```

Groups are denoted by `()`. They can be extracted from the results using the `groups()` function.

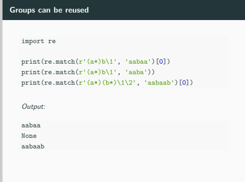
Groups can be reused

```
import re

print(re.match(r'(a*)b\1', 'aabaa')[0])
print(re.match(r'(a*)b\1', 'aaba'))
print(re.match(r'(a*)(b*)\1\2', 'aabaab')[0])
```

Output:

```
aabaa
None
aabaab
```



Groups can be reused

```
import re

print(re.match(r'(a*)b\1', 'aabaa')[0])
print(re.match(r'(a*)b\1', 'aaba'))
print(re.match(r'(a*)(b*)\1\2', 'aabaab')[0])
```

Output:

```
aabaa
None
aabaab
```

Groups can be accessed using `\1`, where 1 can be replaced by the group numbers. This is 1-indexed, i.e. the first is not 0 but 1 – this is because the full match is considered a group as well, group 0! When we used the `[...]` notation, we in fact already accessed groups!

To be more precise: `group()` returns all groups, while `groups()` only returns *subgroups*, i.e. all but the full match.

Note the `r` for the single backslashes, otherwise we'd need to escape them again.

More specialties of

- `\b`: word boundary (empty string at beginning or end of word)
- `\B` is opposite of `\b`: No empty string at beginning or end of word
- `\d`: Digits (analogue: `\D` non-digits)
- `\s`: Whitespace (`\S` no whitespace)

Example: Finding rhymes

Try to find a regex which matches some rhymes:

Matches

- `house mouse`
- `blue true`
- `bake brake`
- `mock sock`

No matches

- `hippo horse`
- `dog cat`
- `home castle`
- `legend hero`

Finding rhymes

```python
import re
matches = ['house mouse', 'blue true',
           'bake brake', 'mock sock']
nomatches = ['hippo horse', 'dog cat',
             'home keep', 'legend hero']
regex = re.compile(r'(.+?)(..+) (.+)\2')

for i in matches:
    print(regex.match(i)[2])
for i in nomatches:
    if regex.match(i):
        print('{} matched!'.format(i))
```

Output:

```
ouse
ue
ake
ock
```

Other useful things

`^` means: "This has to be the start of a string".

`$` is the opposite, the end of a string.

`ab?` is equivalent to `a|ab`, `?` matches "zero or one" occurrence.

`*?` makes the `*` non-greedy, same goes for `+` and `?` itself (i.e. `??`).

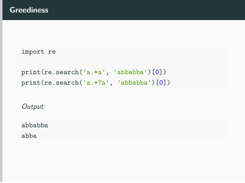
Greediness

```
import re

print(re.search('a.*a', 'abbabba')[0])
print(re.search('a.*?a', 'abbabba')[0])
```

Output:

```
abbabba
abba
```



Greediness

```
import re

print(re.search('a.*a', 'abbabba')[0])
print(re.search('a.*?a', 'abbabba')[0])
```

Output:

```
abbabba
abba
```

Regex special characters try to match as much as possible by default. But sometimes we want minimal matches, we don't want to be *greedy* and take everything. We can then modify the expression and use `?` to allow this.

Example: Romeo and Juliet

Find out which characters appear in this excerpt of Romeo and Juliet (Shakespeare 1623).

> *But with a rearward following Tybalt's death,*
> *'Romeo is banished'- to speak that word*
> *Is father, mother, Tybalt, Romeo, Juliet,*
> *All slain, all dead. 'Romeo is banished'-*
> *There is no end, no limit, measure, bound,*
> *In that word's death; no words can that woe sound.*
> *Where is my father and my mother, nurse?*

The characters to look for are: Escalus, Paris, Capulet, Tybalt, Romeo, Juliet, Balthasar, Abram.

Example: Romeo and Juliet

```
import re
with open('julietspeakwell.txt') as f:
    text = f.read()

characters = ['Escalus', 'Paris', 'Capulet', 'Tybalt',
              'Romeo', 'Juliet', 'Balthasar', 'Abram']

for character in characters:
    m = re.search('.*({}).*'.format(character), text)
    if m:
        print('{}: {}'.format(m[1], m[0]))
```

Output:

```
Tybalt: But with a rearward following Tybalt's death,
Romeo: 'Romeo is banished'- to speak that word
Juliet: Is father, mother, Tybalt, Romeo, Juliet,
```

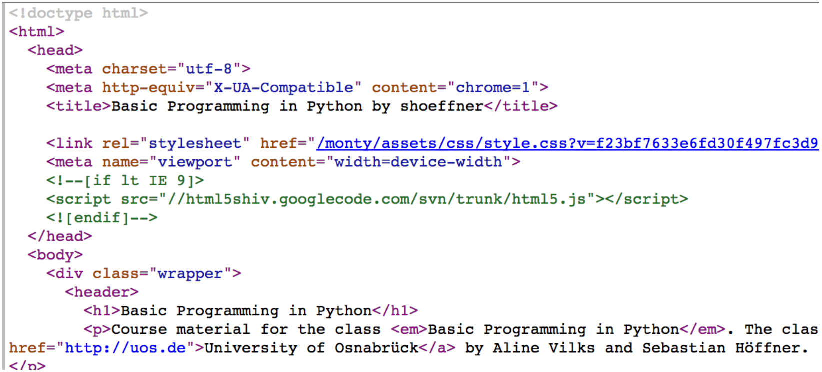
Ctrl + C

Now take a deep breath and relax, we finish regular expressions and move on to a new topic!

Python and the internet

Open up your browser and go to a website,
e.g. https://shoeffner.github.io/monty/

Most browser have an option to show the source code:



```
<!doctype html>
<html>
  <head>
    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="chrome=1">
    <title>Basic Programming in Python by shoeffner</title>

    <link rel="stylesheet" href="/monty/assets/css/style.css?v=f23bf7633e6fd30f497fc3d9
    <meta name="viewport" content="width=device-width">
    <!--[if lt IE 9]>
    <script src="//html5shiv.googlecode.com/svn/trunk/html5.js"></script>
    <![endif]-->
  </head>
  <body>
    <div class="wrapper">
      <header>
        <h1>Basic Programming in Python</h1>
        <p>Course material for the class <em>Basic Programming in Python</em>. The clas
href="http://uos.de">University of Osnabrück</a> by Aline Vilks and Sebastian Höffner.
</p>
```

Figure 1: Source code excerpt of https://shoeffner.github.io/monty/

Source code

Source code for websites is not written in Python, but usually in HTML (or derivatives).

We will not discuss HTML today, but how browsers can download it.

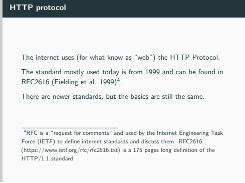
HTTP protocol

The internet uses (for what know as “web”) the HTTP Protocol.

The standard mostly used today is from 1999 and can be found in RFC2616 (Fielding et al. 1999)[4].

There are newer standards, but the basics are still the same.

[4] RFC is a “request for comments” and used by the Internet Engineering Task Force (IETF) to define internet standards and discuss them. RFC2616 (https://www.ietf.org/rfc/rfc2616.txt) is a 175 pages long definition of the HTTP/1.1 standard.



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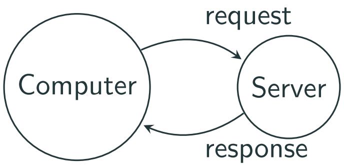
There are classes focusing only on computer communication, so I will only scratch the very very surface.

HTTP requests

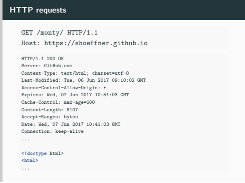


HTTP requests

```
GET /monty/ HTTP/1.1
Host: https://shoeffner.github.io
```

```
HTTP/1.1 200 OK
Server: GitHub.com
Content-Type: text/html; charset=utf-8
Last-Modified: Tue, 06 Jun 2017 09:10:02 GMT
Access-Control-Allow-Origin: *
Expires: Wed, 07 Jun 2017 10:51:03 GMT
Cache-Control: max-age=600
Content-Length: 8107
Accept-Ranges: bytes
Date: Wed, 07 Jun 2017 10:41:03 GMT
Connection: keep-alive
...

<!doctype html>
<html>
...
```



HTTP requests

```
GET /monty/ HTTP/1.1
Host: https://shoeffner.github.io
```

```
HTTP/1.1 200 OK
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Content-Type: text/html; charset=utf-8
Last-Modified: Tue, 06 Jun 2017 09:10:02 GMT
Access-Control-Allow-Origin: *
Expires: Wed, 07 Jun 2017 10:51:03 GMT
Cache-Control: max-age=600
Content-Length: 8107
Accept-Ranges: bytes
Date: Wed, 07 Jun 2017 10:41:03 GMT
Connection: keep-alive
...

<!doctype html>
<html>
...
```

For this request you need a connection, which is a whole topic on how computers can communicate with each other. We assume that connection can be magically made.

A request contains a VERB, a resource, and the protocol, followed by the host name, which is the server address.

A response contains the protocol, the status code and message (`200 OK`), some meta data in `key: value` pairs, and the content. (Here I abbreviated everything a little bit.)

HTTP verbs

```
GET /monty/ HTTP/1.1
Host: https://shoeffner.github.io
```

The GET is one of a few HTTP *verbs*. There are others, e.g. POST. These two are the most important ones.

HTTP verb meanings

The verbs have special meanings[5] (here are just some):

Verb	Meaning
GET	Request a resource
POST	Create a resource
PUT	Update a resource
DELETE	Delete a resource
HEAD	Requests the meta data

[5] Even though they do have semantics, they are often used slightly different than their original meanings. E.g. POST is very often used for complicated GET requests, it also allows for a more secure way of transferring passwords and similar things, . . .

HTTP via requests in Python

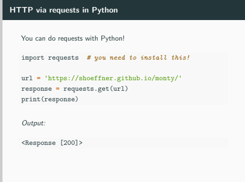
You can do requests with Python!

```
import requests  # you need to install this!

url = 'https://shoeffner.github.io/monty/'
response = requests.get(url)
print(response)
```

Output:

```
<Response [200]>
```



HTTP via requests in Python

You can do requests with Python!

```
import requests  # you need to install this!

url = 'https://shoeffner.github.io/monty/'
response = requests.get(url)
print(response)
```

Output:

```
<Response [200]>
```

Install `requests`, which is a much easier to use python package than Python's own urllib (it is even recommended in the documentation!). To install, just run `pip3 install requests`.

You can find the awesome documentation here:
http://docs.python-requests.org

Retrieving the content

```python
import requests


url = 'https://shoeffner.github.io/monty/'
response = requests.get(url)
print(response.text[:120])
```

Output:

```
<!doctype html>
<html>
  <head>
    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="chrome=1">
```

Downloading images

The internet does not only have websites, but e.g. images!

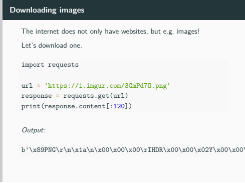
Let's download one.

```
import requests

url = 'https://i.imgur.com/3GmPd7O.png'
response = requests.get(url)
print(response.content[:120])
```

Output:

```
b'\x89PNG\r\n\x1a\n\x00\x00\x00\rIHDR\x00\x00\x02Y\x00\x00\
```



Downloading images

The internet does not only have websites, but e.g. images!

Let's download one.

```
import requests

url = 'https://i.imgur.com/3GmPd7O.png'
response = requests.get(url)
print(response.content[:120])
```

Output:

```
b'\x89PNG\r\n\x1a\n\x00\x00\x00\rIHDR\x00\x00\x02Y\x00\x00
```

Images are **binary data** (not simple text).

Thus we have to use the *raw* content, not the text, as text already performs some conversions (all data sent over the internet is at first "binary").

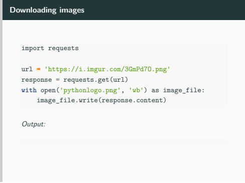
Downloading images

```
import requests

url = 'https://i.imgur.com/3GmPd7O.png'
response = requests.get(url)
with open('pythonlogo.png', 'wb') as image_file:
    image_file.write(response.content)
```

Output:

```
```



Downloading images

```
import requests

url = 'https://i.imgur.com/3GmPd70.png'
response = requests.get(url)
with open('pythonlogo.png', 'wb') as image_file:
    image_file.write(response.content)
```

Output:

Finally we can use the `b` in `open`!

Download images

Figure 2: Result: pythonlogo.png

Your tenth homework

- Download a book and find some sentences containing specific words.

References

Fielding, R., J. Gettys, J. Mogul, H. Frystyk, L. Masinter, P. Leach, and T. Berners-Lee. 1999. “Hypertext Transfer Protocol – Http/1.1.” *Request for Comments*, June.

Shakespeare, William. 1623. *Romeo and Juliet*.

Wikipedia contributors. 2017. “Regular Language.” *Wikipedia, the Free Encyclopedia*, May.