

05_zero_shot_classific_data

May 21, 2024

1 Analysis on LLM Responses

In this notebook, I will analyze how the BERT model perform in anomaly detection using:

- **zero-shot-classification** modification for the BERT model
- without any fine-tuning
- using as possible labels ["malicious", "benign"] and ["anomalous", "normal"].

The results will be commented.

The data have been limited to 15000 samples, since the running time of the entire model is really high (to have all this data, the model need 3/4 days). For that reson, the input data have been modified to make some sort of statistical representation on what the entire dataset contains.

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1.1 Answers and Conclusions

The data of the first batch (**malicious/benign**) represent clearly that the model represent ad **malicious** with a certain degree of confidence only the logs that represent some sort of **this action is not allowed** message. Beside that, a more in depth analysis should be made in order to understand how the label is correct against an analysis about the log is malicious or not. This phase is not easy, since this is not easily labelled.

Instead, the second batch is more promissing, since it can successfully flag a lot of erorr that hap-pened inside the cluster. These are not only security problems, but every problem the cluster have. This demonstrated that this kind of labelling can be successfully used, but give no representation of the degree of reliability this information provide.

Another things that should be evaluated is the running time: the model *can* give answers, but it takes ages to actually give some responses (15000 samples need around 39H to run). A fine tuning or a more powerful computer here could be beneficial.

1.2 Setup and Data entries for the FIRST Batch

As we can see in the second code block, we will work with 15000 data point.

```
[77]: import polars as pl
import json
import matplotlib.pyplot as plt
```

```
import seaborn as sns
```

```
[78]: data = []

with open("../src/results_transformers_line_by_line.res", "r") as of:
    lines = of.readlines()
    for line in lines:
        oj = json.loads(line)
        oj["sequence"] = json.loads(oj["sequence"])
        data.append(oj)

len(data)
```

[78]: 15000

The structure of the data can be see here. At the table, we added the index (to better represent the graph after that), the **sequence** represent the data input given to BERT. The **labels** represent the labels used, in this case we are analyzing only the first part (**benign/malicious**). The results have been separated from the initial struct, and represent the **scr_benign**, and **scr_malicious**.

```
[79]: df = pl.DataFrame(data)
df = df.with_row_index()
df = df.with_columns(pl.col("scores").list.to_struct()).unnest("scores").
    ↪rename({
        "field_0": "scr_benign",
        "field_1": "scr_malicious"
    })
print(df.head())
```

shape: (5, 5)

index	sequence	labels	
scr_benign	scr_malicious		
---	---	---	---

u32	struct[16]	list[str]	f64
f64			
0	{"Boto3/1.9.201 Python/2.7.12 Li...	["benign", "malicious"]	0.544344
0.455656			
1	{"Boto3/1.9.201 Python/2.7.12 Li...	["benign", "malicious"]	0.540384
0.459616			
2	{"Boto3/1.9.201 Python/2.7.12 Li...	["benign", "malicious"]	0.584245
0.415755			
3	{"Boto3/1.9.201 Python/2.7.12 Li...	["benign", "malicious"]	0.52827
0.47173			

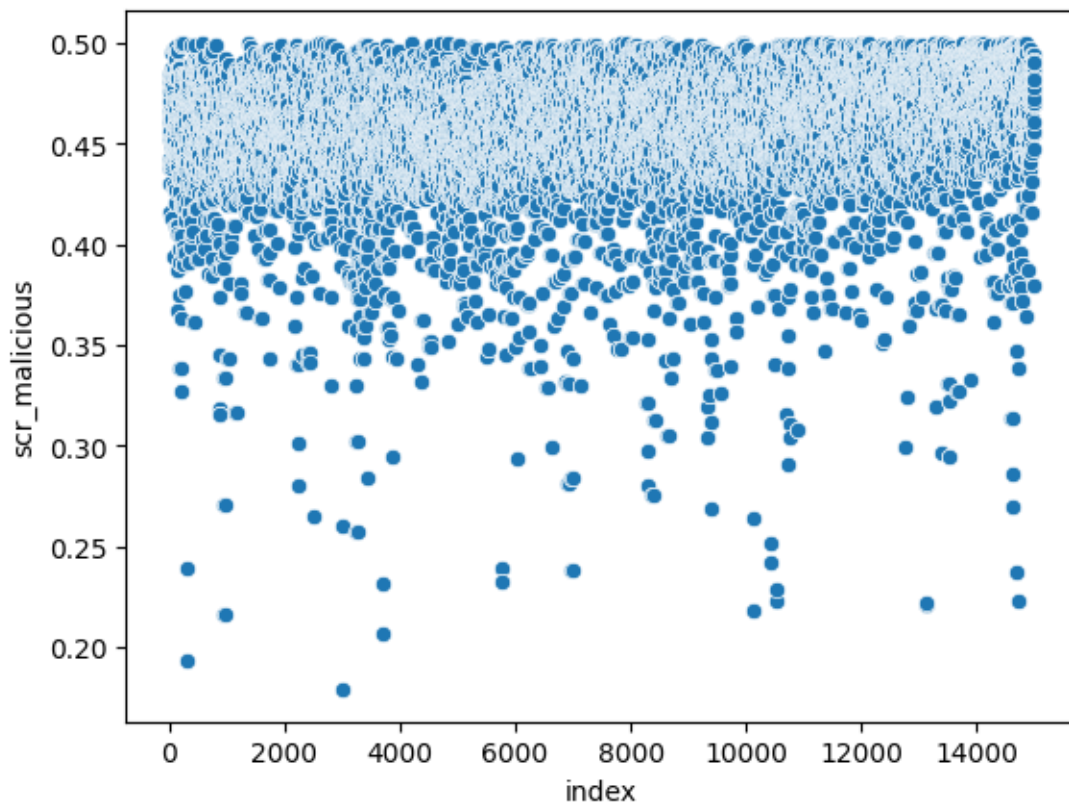
```
4      {"Boto3/1.9.201 Python/2.7.12 Li...  ["benign", "malicious"]  0.537137
0.462863
```

With the data formatted as this, we can easily represent the entire statistical space of every response, using `seaborn`.

The graph represent on the y-axis the probability of the classification of the input. This graph allow us to easily see the probabilistic space of the responses, and it give us a dregree of understanding how much this method could be useful. (Easy answer: very little).

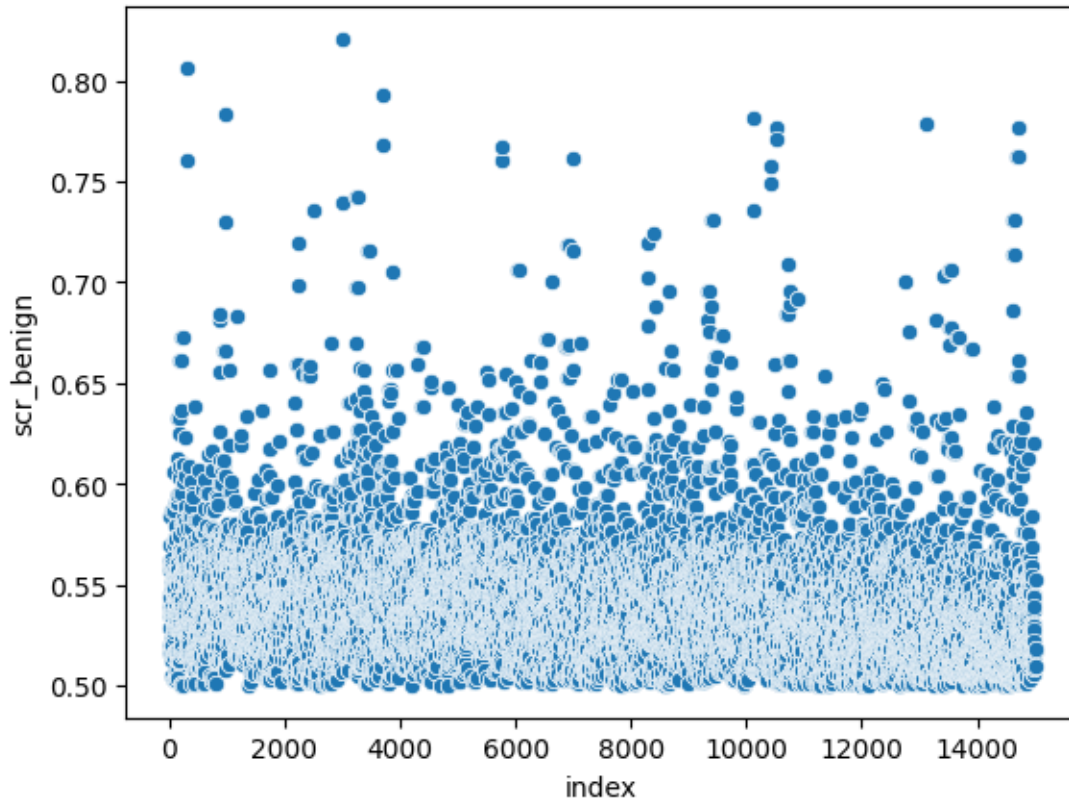
```
[80]: sns.scatterplot(data=df.to_pandas(), x="index", y="scr_malicious")
```

```
[80]: <Axes: xlabel='index', ylabel='scr_malicious'>
```



```
[81]: sns.scatterplot(data=df.to_pandas(), x="index", y="scr_benign")
```

```
[81]: <Axes: xlabel='index', ylabel='scr_benign'>
```



Since the entire view is useful only at the start of such as analysis, we can start focusing at the problem. We can start in the space from 40 to 65, that are the useless answer, since they do not represent enough certainty to define the correct label to the log.

The code-block here represent 14782 is contained in this range. This value of entities represent the 98.54 of the entire dataset.

```
[82]: df.filter(pl.col("scr_benign") < 0.65).count()["sequence"].item() # How many
      ↪ items are below 65% certainly
```

```
[82]: 14782
```

```
[83]: df.filter(pl.col("scr_benign") < 0.65).count()["sequence"].item() / df.shape[0]
      ↪ * 100 # Percentage of items in this probabilistic space
```

```
[83]: 98.54666666666667
```

1.2.1 Probabilistic space higher of 65%

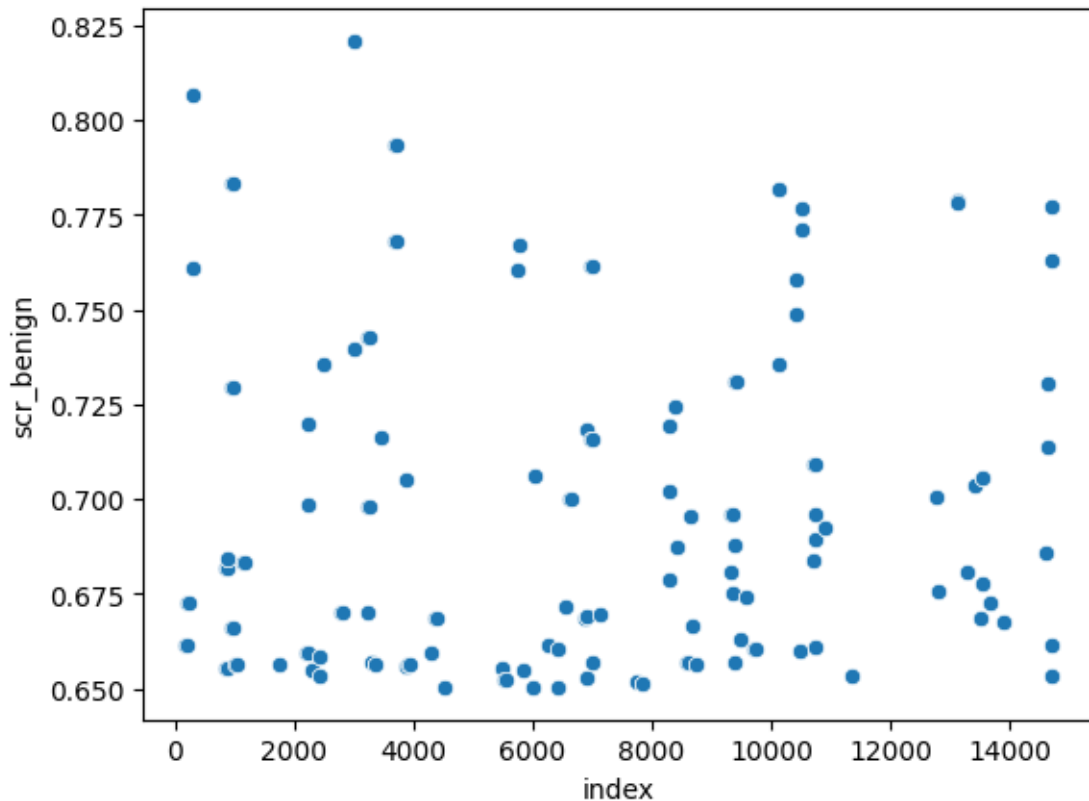
This section of data is more useful, since it start giving some sort of answer to the labelling question. We have to remember that the data are really few (the 1.45 of the entire dataset).

```
[84]: df.filter(pl.col("scr_benign") >= .65).count()["scr_benign"].item() / df.  
      ↪shape[0] * 100
```

```
[84]: 1.4533333333333334
```

```
[85]: sns.scatterplot(data=df.filter(pl.col("scr_benign") >= 0.65).to_pandas(),  
      ↪x="index", y="scr_benign")
```

```
[85]: <Axes: xlabel='index', ylabel='scr_benign'>
```



After that, we can start from the higher probability (above 80), and read some logs.

```
[86]: df.filter(pl.col("scr_benign") > 0.80)["sequence"]
```

```
[86]: shape: (4,)
      Series: 'sequence' [struct[16]]
      [
        {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
        Botocore/1.12.201", "57896c6-5b02-449f-ae22-4834d58f238e", "You are not authorized
        to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::811
        596193553:user/Level6", "811596193553", "ASIAZ6XVDR2PA984G89L", "Level6", {{null}}, {n
```

```

ull},{ "false", "2019-08-
21T07:41:19Z"}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
ateKeyPair", "ec2.amazonaws.com", "811596193553", {{null}, null, null, {null}, {null}, n
ull, {null}}, "us-west-1", "378dd1b1-13ae-46c3-b398-
5c956a6753fb", {null, null, null}, "1.05", "2019-08-21T11:32:11Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201", "57896c6-5b02-449f-ae22-4834d58f238e", "You are not authorized
to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::811
596193553:user/Level6", "811596193553", "ASIAZ6XVDR2PA984G89L", "Level6", {{null}, {n
ull}}, {"false", "2019-08-
21T07:41:19Z"}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
ateKeyPair", "ec2.amazonaws.com", "811596193553", {{null}, null, null, {null}, {null}, n
ull, {null}}, "us-west-1", "378dd1b1-13ae-46c3-b398-
5c956a6753fb", {null, null, null}, "1.05", "2019-08-21T11:32:11Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201", "34ac112c-12c0-4083-99fb-7cbc8bf11216", "You are not
authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:a
ws:iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"
, {{null}, {null}}, {"false", "2019-08-
21T07:41:25Z"}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
ateKeyPair", "ec2.amazonaws.com", "811596193553", {{null}, null, null, {null}, {null}, n
ull, {null}}, "ap-southeast-1", "0cff1b41-8c17-492e-8e93-
caafd69080e1", {null, null, null}, "1.05", "2019-08-21T11:36:28Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201", "34ac112c-12c0-4083-99fb-7cbc8bf11216", "You are not
authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:a
ws:iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"
, {{null}, {null}}, {"false", "2019-08-
21T07:41:25Z"}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
ateKeyPair", "ec2.amazonaws.com", "811596193553", {{null}, null, null, {null}, {null}, n
ull, {null}}, "ap-southeast-1", "0cff1b41-8c17-492e-8e93-
caafd69080e1", {null, null, null}, "1.05", "2019-08-21T11:36:28Z"}
]

```

After this, we clearly see that the logs represent a error code that "You are not authorized to perform this operation".

Going on, we can clearly see that every time a malicious logs is highlighted, we have some sort of not permitted in the phrase, that is probably the reason the log has been flagged.

Here are represented the other probabilistic space of the labelled logs.

```

[87]: # btw 0,75 < X < 0,80

df.filter( (pl.col("scr_benign") > 0.75) & (pl.col("scr_benign") < 0.8) )
      ↪ ["sequence"]

```

```

[87]: shape: (30,)
Series: 'sequence' [struct[16]]
[
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
    Botocore/1.12.201", "f8e8f082-edc8-4726-a323-2ba48929bb", "You are not authorized
    to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::811
    596193553:user/Level6", "811596193553", "ASIAZ6XVDR2PA984G89L", "Level6", {"null"}, {"n
    ull"}, {"false", "2019-08-
    21T07:41:19Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
    ateDefaultVpc", "ec2.amazonaws.com", "811596193553", {"null"}, null, null, {"null"}, {"null
    }, null, {"null"}, {"us-west-1", "36166-cafe-44f6-affd-
    88bf5190f9c6", {"null", null, null}, "1.05", "2019-08-21T11:32:12Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
    Botocore/1.12.201", "f8e8f082-edc8-4726-a323-2ba48929bb", "You are not authorized
    to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::811
    596193553:user/Level6", "811596193553", "ASIAZ6XVDR2PA984G89L", "Level6", {"null"}, {"n
    ull"}, {"false", "2019-08-
    21T07:41:19Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
    ateDefaultVpc", "ec2.amazonaws.com", "811596193553", {"null"}, null, null, {"null"}, {"null
    }, null, {"null"}, {"us-west-1", "36166-cafe-44f6-affd-
    88bf5190f9c6", {"null", null, null}, "1.05", "2019-08-21T11:32:12Z"}
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    Botocore/1.12.201", "6b6305b8-191f-4194-a9f6-cc7ac2fe9b25", "You are not
    authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:a
    ws:iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"
    }, {"null"}, {"null"}, {"false", "2019-08-
    21T07:41:25Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
    ateKeyPair", "ec2.amazonaws.com", "811596193553", {"null"}, null, null, {"null"}, {"null"}, n
    ull, {"null"}, {"ap-northeast-1", "e72df559-f4f3-489f-a671-
    6cd3a6e973e4", {"null", null, null}, "1.05", "2019-08-21T11:33:09Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
    Botocore/1.12.201", "6b6305b8-191f-4194-a9f6-cc7ac2fe9b25", "You are not
    authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:a
    ws:iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"
    }, {"null"}, {"null"}, {"false", "2019-08-
    21T07:41:25Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
    ateKeyPair", "ec2.amazonaws.com", "811596193553", {"null"}, null, null, {"null"}, {"null"}, n
    ull, {"null"}, {"ap-northeast-1", "e72df559-f4f3-489f-a671-
    6cd3a6e973e4", {"null", null, null}, "1.05", "2019-08-21T11:33:09Z"}
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
    Botocore/1.12.201", "f397510e3-5d90-4a91-b185-cc79b6b05e37", "You are not
    authorized to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:a
    ws:iam::811596193553:user/Level6", "811596193553", "ASIAZ6XVDR2PA984G89L", "Level6"
    }, {"null"}, {"null"}, {"false", "2019-08-
    21T07:41:19Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre
    ateKeyPair", "ec2.amazonaws.com", "811596193553", {"null"}, null, null, {"null"}, {"null"}, n
    ull, {"null"}, {"ap-southeast-1", "202a01c8-f21b-4c3d-a449-

```



```

ce14888e999",{null,null,null},"1.05","2019-08-21T11:37:20Z"}
...
{"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201","598bf528-6a37-495e-b089-8ef8bb04546","You are not authorized
to perform this operation.",{"IAMUser","AIDADO2GQDOK8TEF7KW1V","arn:aws:iam::811
596193553:user/Level6","811596193553","ASIAZ6XVDR2PA984G89L","Level6",{{null}},{n
ull}},{"false","2019-08-
21T07:41:19Z"}}},"AwsApiCall","Client.UnauthorizedOperation","5.205.62.253","Cre
ateDefaultVpc","ec2.amazonaws.com","811596193553",{{null}},null,null,{null},{null
},null,{null}},"ap-south-1","151490c3a-6a99-4d74-8c02-
5c97b33e9ac1",{null,null,null},"1.05","2019-08-21T11:49:52Z"}
{"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201","cfd5efdf-7a7d-4ecf-9fd8-c908fd4c3efc","You are not
authorized to perform this operation.",{"IAMUser","AIDADO2GQDOK8TEF7KW1V","arn:a
ws:iam::811596193553:user/Level6","811596193553","ASIAZ6XVDR2PA984G89L","Level6"
,{{null}},{null}},{"false","2019-08-
21T07:41:19Z"}}},"AwsApiCall","Client.UnauthorizedOperation","5.205.62.253","Cre
ateKeyPair","ec2.amazonaws.com","811596193553",{{null}},null,null,{null},{null},n
ull,{null}},"ap-southeast-2","8c396233-8ef3-4d4e-b6e1-
893167324224",{null,null,null},"1.05","2019-08-21T11:52:26Z"}
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,{{null}},{null}},{"false","2019-08-
21T07:41:19Z"}}},"AwsApiCall","Client.UnauthorizedOperation","5.205.62.253","Cre
ateKeyPair","ec2.amazonaws.com","811596193553",{{null}},null,null,{null},{null},n
ull,{null}},"ap-southeast-2","8c396233-8ef3-4d4e-b6e1-
893167324224",{null,null,null},"1.05","2019-08-21T11:52:26Z"}
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Botocore/1.12.201","4fb481de-91a3-4e60-a1d8-c27efd79e9f8","You are not
authorized to perform this operation.",{"IAMUser","AIDADO2GQDOK8TEF7KW1V","arn:a
ws:iam::811596193553:user/Level6","811596193553","ASIAZ6XVDR2PA984G89L","Level6"
,{{null}},{null}},{"false","2019-08-
21T07:41:19Z"}}},"AwsApiCall","Client.UnauthorizedOperation","5.205.62.253","Cre
ateDefaultVpc","ec2.amazonaws.com","811596193553",{{null}},null,null,{null},{null
},null,{null}},"ap-southeast-2","2f2520d3-7251-4bb8-9a28-
46c94f1e1f79",{null,null,null},"1.05","2019-08-21T11:52:27Z"}
{"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201","4fb481de-91a3-4e60-a1d8-c27efd79e9f8","You are not
authorized to perform this operation.",{"IAMUser","AIDADO2GQDOK8TEF7KW1V","arn:a
ws:iam::811596193553:user/Level6","811596193553","ASIAZ6XVDR2PA984G89L","Level6"
,{{null}},{null}},{"false","2019-08-
21T07:41:19Z"}}},"AwsApiCall","Client.UnauthorizedOperation","5.205.62.253","Cre
ateDefaultVpc","ec2.amazonaws.com","811596193553",{{null}},null,null,{null},{null
},null,{null}},"ap-southeast-2","2f2520d3-7251-4bb8-9a28-
46c94f1e1f79",{null,null,null},"1.05","2019-08-21T11:52:27Z"}

```


]

```
[88]: # btw 0,70 < X < 0,75
```

```
df.filter( (pl.col("scr_benign") > 0.70) & (pl.col("scr_benign") < 0.75) )  
↳ ["sequence"]
```

```
[88]: shape: (46,)
```

```
Series: 'sequence' [struct[16]]
```

```
[  
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic  
Botocore/1.12.201", "1982eaa4-75ab-42f9-9862-f5ca8fda8b1a", "You are not  
authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:aws:  
iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"  
, {{null}}, {null}}, {"false", "2019-08-  
21T07:41:25Z"}}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "Cre  
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, null, {null}}, "ap-northeast-1", "d367439a-acb0-4476-a950-  
efe89222bd", {null, null, null}, "1.05", "2019-08-21T11:33:09Z"}  
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authorized to perform this operation.", {"IAMUser", "AIDA9B036HFBHKGJA09C1", "arn:aws:  
iam::811596193553:user/backup", "811596193553", "ASIARF55FBMFZBXLKDFW", "backup"  
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, null, {null}}, "ap-northeast-1", "d367439a-acb0-4476-a950-  
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ull}}, {null, null}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "C  
reateDefaultVpc", "ec2.amazonaws.com", "811596193553", {{null}}, null, null, {null}}, {nu  
ll}, null, {null}}, "ca-central-1", "75cb5963-4431-4237-8944-  
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to perform this operation.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::811  
596193553:user/Level6", "811596193553", "AKIA3Z2XBVUDFQ9TU4MD", "Level6", {{null}}, {n  
ull}}, {null, null}}, {"AwsApiCall", "Client.UnauthorizedOperation", "5.205.62.253", "C  
reateDefaultVpc", "ec2.amazonaws.com", "811596193553", {{null}}, null, null, {null}}, {nu  
ll}, null, {null}}, "ca-central-1", "75cb5963-4431-4237-8944-  
68a5656b8770", {null, null, null}, "1.05", "2019-08-21T11:35:09Z"}  
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic  
Botocore/1.12.201", "73ea7e81-9eff-44a9-ab20-a41308becb6", "You are not authorized  
to perform this operation. Encoded authorization failure message: nlKc0-
```

iaf4w4KiutDvcNFYn0QWeBL_4F-DFIvAdSnIKA4V1G3y1gVRpPPNEut-29FZB3nqGP6-
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[89]: # btw 0,65 < X < 0,70

```

df.filter( (pl.col("scr_benign") > 0.65) & (pl.col("scr_benign") < 0.70) )
↳ ["sequence"]

```

[89]: shape: (138,)

Series: 'sequence' [struct[16]]

```

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Evzomnj_z_7lpGyj1NBGoX3Vs1FprgNSJjjp-
Pw-_8yybFj4q3cny2J6t39bW8b54w8YA7imzBeQFJn0qty-
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qBOScqWLWXscnzPjQL-8hLO-ptaR_uqhdo_m7vREkoe3etalQiZij4DKhqXSjDacfw3wKdmkCp-
cEFQOKhFqnjlVMCZXKNuk_Vk1qRtnwQVf6IN9g6LuS9w4JixDEB7Yrdxtb3WHiSS-pGZJoXvhohCAtVd
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nauthorizedOperation", "5.205.62.253", "RunInstances", "ec2.amazonaws.com", "8115961
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8536e71c936f036cc", 1, 10}], "<sensitiveDataRemoved>", "m5d.24xlarge", {"null"}, {"false"
, true, [{"{"instance", [{"my_ec2_key", "my_a_val"}]}]}], "us-east-2", "895ed63f-ac8c-
4789-983c-69a00bfa98d2", {"null", null, null}, "1.05", "2019-08-21T11:52:27Z"}
```

```
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
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perform this operation. Encoded authorization failure message:
1dMWhfdALrewr1tfBCmcSF0Q95GmlyuounSt2ayBehnM-
beAWhqPiGastnfSaWAXdWcFcCFr8I_R8DZ_5FcMcyCAk-BFN2KXENM-
Evzomnj_z_7lpGyj1NBGoX3Vs1FprgNSJjjp-
Pw-_8yybFj4q3cny2J6t39bW8b54w8YA7imzBeQFJn0qty-
jlRoxyJl1c9LtNcLfEQ5SsvklEd0TlKsMLSfHnrYY7pFsa2bnp4w6bc5NFseJ431oNh-Zh5iqwCqbvAP
```

```
gZuhNl0v_6fj60RRtweU9DccXaQM7_oagi6Ai1IEz3-EBnz8AgwtXjzAy40yWI9w-
pgFC4HiXV5jdFpkj0tYd7DLK05GwiJxGkIOZzhCxyOxYeWJOHd01738iQOBpEj1U2wkGGGH6UiTvX_Oe
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nauthorizedOperation","5.205.62.253","RunInstances","ec2.amazonaws.com","8115961
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},true,{{{"instance",[{"my_ec2_key","my_a_val"}]}}},"us-east-2","895ed63f-ac8c-
4789-983c-69a00bfa98d2",{null,null,null},"1.05","2019-08-21T11:52:27Z"}
]
```

1.3 Analysis on the secon batch

This part of the notebook is for the second dataset. The data are being evaluated in this time, so the probabilitis space will probably run of fewer sample.

The start of the analysis is really similar to the one done before, so the code block will be not heavily commented.

```
[90]: data = []

with open("../src/results_transformers2.res", "r") as of:
    lines = of.readlines()
    for line in lines:
        oj = json.loads(line)
        oj["sequence"] = json.loads(oj["sequence"])
        data.append(oj)

len(data)
```

[90]: 5458

```
[91]: df = pl.DataFrame(data)
df = df.with_row_index()
df = df.with_columns(pl.col("scores").list.to_struct()).unnest("scores").
    ↪rename({
        "field_0": "scr_normal",
        "field_1": "scr_anomaluos"
    })
print(df.head())
```

shape: (5, 5)

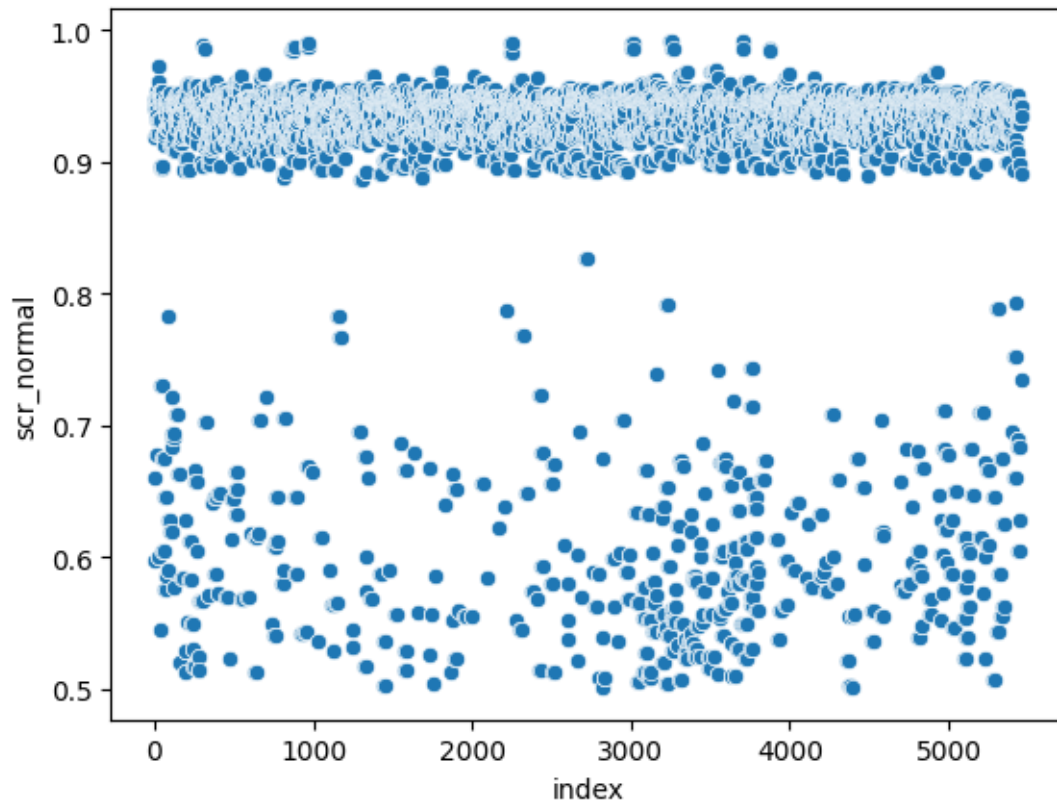
index	sequence	labels	
scr_normal	scr_anomaluos		
---	---	---	---

u32	struct[16]	list[str]	f64
f64			
0	{"Boto3/1.9.201 Python/2.7.12 Li...	["anomalous", "normal"]	0.941086
0.058914			
1	{"Boto3/1.9.201 Python/2.7.12 Li...	["anomalous", "normal"]	0.943774
0.056226			
2	{"Boto3/1.9.201 Python/2.7.12 Li...	["anomalous", "normal"]	0.597761
0.402239			
3	{"Boto3/1.9.201 Python/2.7.12 Li...	["anomalous", "normal"]	0.94017
0.05983			
4	{"Boto3/1.9.201 Python/2.7.12 Li...	["anomalous", "normal"]	0.659942
0.340058			

As we can see in the following graph, we have a really more defined labelling in this case. The samples that are above 70 certainly are around 87.

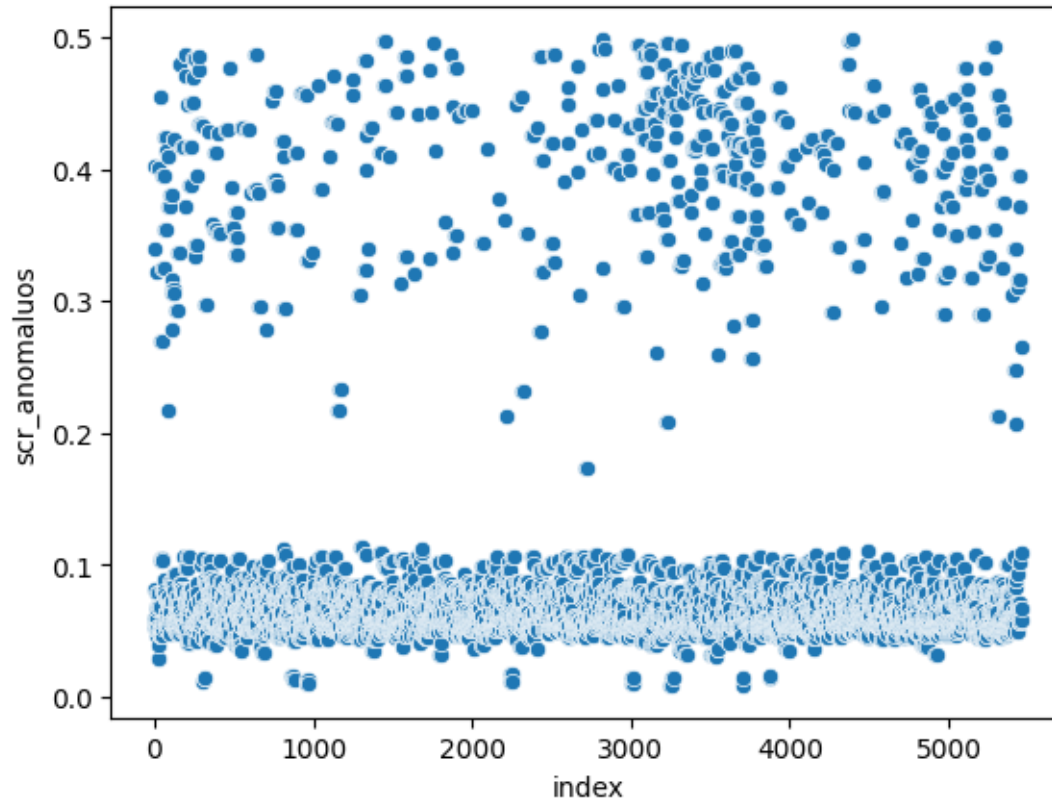
```
[92]: sns.scatterplot(data=df.to_pandas(), x="index", y="scr_normal")
```

```
[92]: <Axes: xlabel='index', ylabel='scr_normal'>
```



```
[93]: sns.scatterplot(data=df.to_pandas(), x="index", y="scr_anomaluos")
```

```
[93]: <Axes: xlabel='index', ylabel='scr_anomaluos'>
```



```
[94]: df.filter(pl.col("scr_normal") >= .70).count()["scr_normal"].item() / df.  
      ↪shape[0] * 100
```

```
[94]: 87.04653719311104
```

Since these are the normal ones, we can start analysing the more abnormal. As we can see they all represent some sort of problem in the request, but more in general. If we compare to the other dataset in which they are labelled certain logs as malicious, we clearly see in this dataset that every problem is being flagged as malicious.

```
[95]: df.filter(pl.col("scr_normal") >= .80)["sequence"]
```

```
[95]: shape: (4_694,)
      Series: 'sequence' [struct[16]]
      [
        {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
        Botocore/1.12.201", "40422e90-d6ec-4c33-9ed3-e206107", "Request limit exceeded.", {
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```

```
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ac52b5731ffd", {null, null, null}, "1.05", "2019-08-21T11:31:47Z"}
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21T07:41:19Z"}]}, "AwsApiCall", "Server.InsufficientInstanceCapacity", "5.205.62.25
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], "us-west-1", "4e1ff722-81d8-431d-aa0f-
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```

```

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configuration is currently not supported. Please check the documentation for
supported configurations.", {"IAMUser", "AIDADO2GQDOK8TEF7KW1V", "arn:aws:iam::8115
96193553:user/Level6", "811596193553", "AKIA3Z2XBVUDFQ9TU4MD", "Level6", {[null], {nu
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5e09-4db4-8078-fe0f8a9744bc", {null, null, null}, "1.05", "2019-08-21T11:39:35Z"}
]

```

```

[96]: df.filter( (pl.col("scr_normal") >= .70) & (pl.col("scr_normal") < .80)
↳ ["sequence"]

```

```
[96]: shape: (57,)
Series: 'sequence' [struct[16]]
[
    {"Boto3/1.9.201 Python/2.7.12 Linux/4.4.0-157-generic
Botocore/1.12.201","ab259edc-05d5-43b6-86ff-094291ccca9c","You are not
authorized to perform this operation. Encoded authorization failure message: nyQ
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811596193553","AKIA01U43UX3RBRDXF4Q","backup",{{null},{null},{null,null}}},"AwsA
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26d6-447e-872b-9af9dfc1b5f9",{null,null,null},"1.05","2019-08-21T11:31:51Z"}
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Botocore/1.12.201","ab259edc-05d5-43b6-86ff-094291ccca9c","You are not
authorized to perform this operation. Encoded authorization failure message: nyQ
9tRpudX_jmlBa4v9GuqZ1At3FyZVzUjyu2MWz4hfxlq6sv0k0EhaqD20nuKNLj7mTbPkJbzviYyEMFVz
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vha43iC2NRcieZtl-yTzG2Bpq7ToTlRPD5dQUE0ckis-
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```

authorized to perform this operation. Encoded authorization failure message:
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