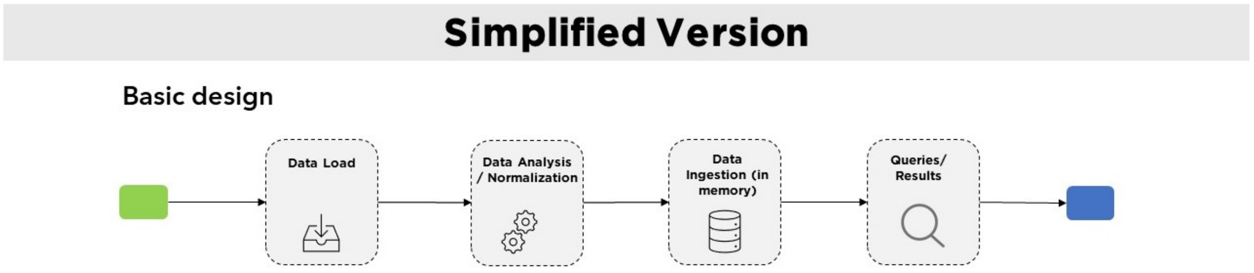
In [1]:
```
import re
import os
import pandas as pd
from sqlalchemy import create_engine
from IPython.display import Image
```

In [2]:
```
root = os.path.abspath(os.curdir).replace('\\docs','') # The main directory of project is kept in the variable root. This may
 have a slice difference in Linux.
```

In [3]:
```
Image(filename=f'{root}/images/simplified_version.jpg')
```

Out[3]:



by Abraão Nascimento

Summary:

1. Data exploration
2. Data ingestion
3. Output 1: Total equipment failures that happened
4. Output 2: Which equipment code had most failures
5. Output 3: Average amount of failures across equipment group, ordered by the number of failures in ascending order
6. Contact

In [4]:
```
root_data = f'{root}\\data\\'
```

1. Data exploration

In [5]:
```
equipment_sensors = pd.read_csv(f'{root_data}equipment_sensors.csv', sep=';') # If you are using Linux, replace \\ to /, pl
ease.
```

1.1 Data equipment_sensors.csv

In [6]:
```
equipment_sensors.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100 entries, 0 to 99
Data columns (total 2 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   equipment_id  100 non-null    int64
 1   sensor_id     100 non-null    int64
dtypes: int64(2)
memory usage: 1.7 KB
```

In [7]:
```
equipment_sensors.duplicated().sum()
```

Out[7]:
```
0
```

It was possible to check that columns are in integer format, with no null values and no duplicate records.

1.2 Data equipment.json

In [8]:
```
equipment = pd.read_json(f'{root_data}equipment.json')
equipment.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14 entries, 0 to 13
Data columns (total 3 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   equipment_id  14 non-null     int64
 1   code          14 non-null     object
 2   group_name    14 non-null     object
dtypes: int64(1), object(2)
memory usage: 464.0+ bytes
```

In [9]:
```
equipment['equipment_id'].duplicated().sum()
```

Out[9]:
```
0
```

It was possible to check that columns are integer and string format, and there are no null values and no duplicates in the equipment_id field.

1.2 Data equipment_failure_sensors.log

In [10]:
```
logs = pd.read_csv(f'{root_data}equipment_failure_sensors.log', sep='\t', header=None)
logs.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 36979 entries, 0 to 36978
Data columns (total 6 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   0       36979 non-null  object
 1   1       36979 non-null  object
 2   2       36979 non-null  object
 3   3       36979 non-null  object
 4   4       36979 non-null  object
 5   5       36979 non-null  object
dtypes: object(6)
memory usage: 1.7+ MB
```

In [11]:
```
logs.head()
```

Out[11]:

	0	1	2	3	4	5
0	[2019-12-10 10:46:09]	ERROR	sensor[5]:	(temperature	365.26, vibration	-6305.32)
1	[2019-12-10 10:46:09]	ERROR	sensor[43]:	(temperature	458.47, vibration	-58.41)
2	[2019-12-10 10:46:09]	ERROR	sensor[44]:	(temperature	57.16, vibration	-999.66)
3	[2019-12-10 10:46:09]	ERROR	sensor[67]:	(temperature	106.69, vibration	-4659.02)
4	[2019-12-02 06:53:29]	ERROR	sensor[5]:	(temperature	26.42, vibration	-3438.67)

Fields are not well structured, because of that they will be normalized and structured into 4 columns: datetime, type, message, sensor_id.

1.2.1 Merging and renaming fields

In [12]:
```
logs.head()
```

Out[12]:

	0	1	2	3	4	5
0	[2019-12-10 10:46:09]	ERROR	sensor[5]:	(temperature	365.26, vibration	-6305.32)
1	[2019-12-10 10:46:09]	ERROR	sensor[43]:	(temperature	458.47, vibration	-58.41)
2	[2019-12-10 10:46:09]	ERROR	sensor[44]:	(temperature	57.16, vibration	-999.66)
3	[2019-12-10 10:46:09]	ERROR	sensor[67]:	(temperature	106.69, vibration	-4659.02)
4	[2019-12-02 06:53:29]	ERROR	sensor[5]:	(temperature	26.42, vibration	-3438.67)

In [13]:
```
logs['message'] = ''
```

In [14]:
```
logs.loc[:]
```

Out[14]:

	0	1	2	3	4	5	message
0	[2019-12-10 10:46:09]	ERROR	sensor[5]:	(temperature	365.26, vibration	-6305.32)	
1	[2019-12-10 10:46:09]	ERROR	sensor[43]:	(temperature	458.47, vibration	-58.41)	
2	[2019-12-10 10:46:09]	ERROR	sensor[44]:	(temperature	57.16, vibration	-999.66)	
3	[2019-12-10 10:46:09]	ERROR	sensor[67]:	(temperature	106.69, vibration	-4659.02)	
4	[2019-12-02 06:53:29]	ERROR	sensor[5]:	(temperature	26.42, vibration	-3438.67)	
...	...	...	...	...	...	...	...
36974	[2019-12-09 09:26:38]	ERROR	sensor[27]:	(temperature	472.36, vibration	9660.13)	
36975	[2019-12-09 09:26:38]	ERROR	sensor[51]:	(temperature	134.64, vibration	-736.71)	
36976	[2019-12-09 09:26:38]	ERROR	sensor[56]:	(temperature	388.94, vibration	1237.49)	
36977	[2019-12-09 09:26:38]	ERROR	sensor[81]:	(temperature	82.97, vibration	-1871.2)	
36978	[2019-12-09 09:26:38]	ERROR	sensor[89]:	(temperature	204.79, vibration	-6460.27)	

36979 rows × 7 columns

In [15]:
```
logs['message'] = logs[2] + ' ' + logs[3] + ' ' + logs[4] + ' ' +  logs[5]
logs.rename(columns = {0:"datetime", 1:"type"}, inplace = True)
logs = logs[["datetime","type","message"]]
```

1.2.2 Creating a new field for sensor_id

In [16]:
```
messages = logs.message.tolist()
messages[0:3]
```

Out[16]:
```
['sensor[5]: (temperature 365.26, vibration -6305.32)',
 'sensor[43]: (temperature 458.47, vibration -58.41)',
 'sensor[44]: (temperature 57.16, vibration -999.66)']
```

In [17]:
```
sensor_ids = [re.search('\[(\d+)\]', record).group(0) for record in messages] # Regex and list comprehension are used to fi
nd sensor IDs
sensor_ids[0:10]
```

Out[17]:
```
['[5]', '[43]', '[44]', '[67]', '[5]', '[43]', '[44]', '[67]', '[11]', '[15]']
```

In [18]:
```
sensor_ids = [re.search('\d+',ID).group(0) for ID in sensor_ids]
sensor_ids[0:10]
```

Out[18]:
```
['5', '43', '44', '67', '5', '43', '44', '67', '11', '15']
```

In [19]:
```
logs['sensor_id'] = sensor_ids
logs.head()
```

Out[19]:

	datetime	type	message	sensor_id
0	[2019-12-10 10:46:09]	ERROR	sensor[5]: (temperature 365.26, vibration -630...	5
1	[2019-12-10 10:46:09]	ERROR	sensor[43]: (temperature 458.47, vibration -58...	43
2	[2019-12-10 10:46:09]	ERROR	sensor[44]: (temperature 57.16, vibration -999...	44
3	[2019-12-10 10:46:09]	ERROR	sensor[67]: (temperature 106.69, vibration -46...	67
4	[2019-12-02 06:53:29]	ERROR	sensor[5]: (temperature 26.42, vibration -3438...	5

1.2.3 Filtering Data by January, 2020

In [20]:
```
logs_01_2020 = logs[logs['datetime'].str.contains('2020-01')==True]
```

2 - Data ingestion (In Memory)

Note: The production code ('source code' folder) reads the data on-demand by using a chunk size of 100.000 records each to improve the efficiency of the code when it is dealing with gigabytes-size data.

2.1 Creating a in memory database

In [21]:
```
in_memory_db = create_engine('sqlite://', echo=False)
```

2.2 Loading the data to the database created

In [22]:
```
logs.to_sql('logs', con=in_memory_db)
equipment.to_sql('equipment', con=in_memory_db)
equipment_sensors.to_sql('equipment_sensors', con=in_memory_db)
```

3 - Output 1: Total equipment failures that happened

In [23]:
```
sql = '''
SELECT COUNT(*)
FROM (SELECT DISTINCT equipment_id
    FROM logs
    LEFT JOIN equipment_sensors
    ON logs.sensor_id = equipment_sensors.sensor_id
    WHERE logs.type = 'ERROR')
'''
```

In [24]:
```
output = {'Total equipment failures': [in_memory_db.execute(sql).fetchall()[0][0]]}
output = pd.DataFrame(data=output)
output
```

Out[24]:

	Total equipment failures
0	13

4 - Output 2: Which equipment code had most failures

In [25]:
```
sql2 = '''
SELECT code, COUNT(code) AS total FROM (SELECT equipment_id
          FROM logs
          LEFT JOIN equipment_sensors
          ON logs.sensor_id = equipment_sensors.sensor_id
          WHERE logs.type = 'ERROR') AS query1
LEFT JOIN equipment
ON query1.equipment_id = equipment.equipment_id
GROUP BY code
ORDER BY total DESC
'''
data = in_memory_db.execute(sql2).fetchall()
```

In [26]:
```
output2 = {'Equipment code with most failures': [data[0][0]], 'Total of failures': [data[0][1]]}
output2 = pd.DataFrame(data=output2)
output2
```

Out[26]:

	Equipment code with most failures	Total of failures
0	E1AD07D4	3753

5 - Output 3: Average amount of failures across equipment group, ordered by the number of failures in ascending order

In [27]:
```
sql3 = '''
SELECT group_name, CAST(ROUND(AVG(total)) AS INTEGER)
FROM  (SELECT code, COUNT(code) AS total
      FROM (SELECT equipment_id
      FROM logs
      LEFT JOIN equipment_sensors
      ON logs.sensor_id = equipment_sensors.sensor_id
      WHERE logs.type = 'ERROR') AS query1
   LEFT JOIN equipment
   ON query1.equipment_id = equipment.equipment_id
   GROUP BY code) AS query2
LEFT JOIN equipment
ON query2.code = equipment.code
GROUP BY group_name
ORDER BY total ASC
'''
data = in_memory_db.execute(sql3).fetchall()
```

In [28]:
```
output3 = {'Group_name': [line[0] for line in data ], 'Average': [line[1] for line in data]}
output3 = pd.DataFrame(data=output3)
output3
```

Out[28]:

	Group_name	Average
0	FGHQWR2Q	2704
1	VAPQY59S	2592
2	PA92NCXZ	2727
3	NQWPA8D3	2881
4	9N127Z5P	3034
5	Z9K1SAP4	3699

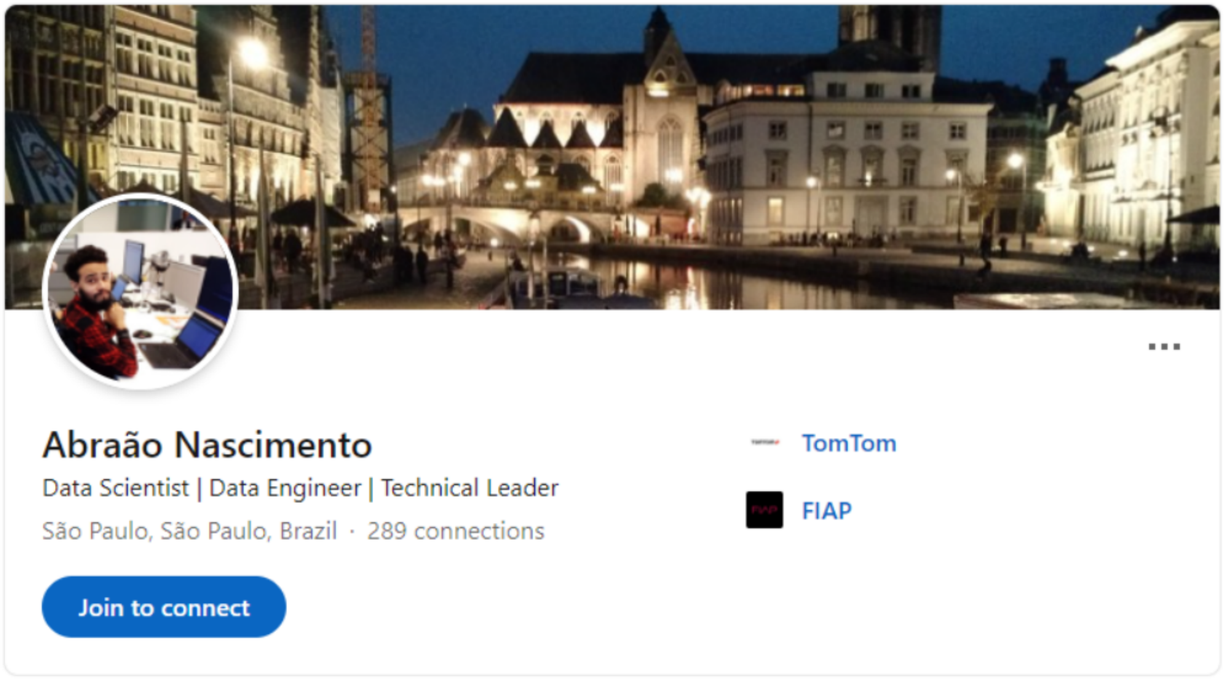
Average has been formatted to integer, but it also can be decimal if needed

6. Contact

Hi. You can find more information about me by searching on my LinkedIn profile https://www.linkedin.com/in/abra%C3%A3o-nascimento-39915162/ (https://www.linkedin.com/in/abra%C3%A3o-nascimento-39915162/).
This and other projects can be found on my Github page: https://github.com/abraaonascimento (https://github.com/abraaonascimento).

In [29]:
```
Image(filename=f'{root}/images/contact.jpg')
```

Out[29]:



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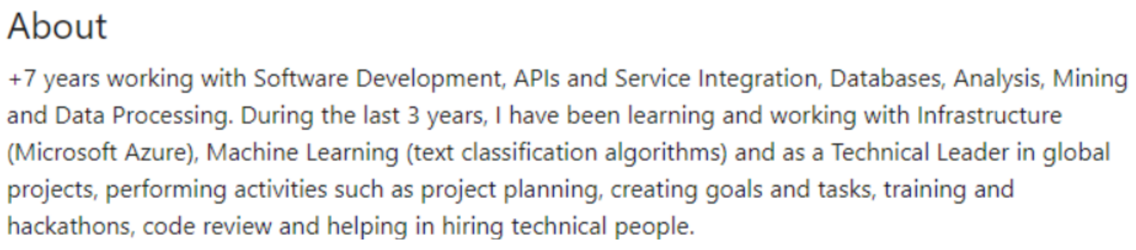
In [30]:
```
Image(filename=f'{root}/images/about.jpg')
```

Out[30]:



About

+7 years working with Software Development, APIs and Service Integration, Databases, Analysis, Mining and Data Processing. During the last 3 years, I have been learning and working with Infrastructure (Microsoft Azure), Machine Learning (text classification algorithms) and as a Technical Leader in global projects, performing activities such as project planning, creating goals and tasks, training and hackathons, code review and helping in hiring technical people.

Thank you!