Data Preparation

Bahy Helmi Hartoyo Putra
1606918124
Tugas 1 - PDIB

In [1]:
```
## Melakukan import libraries
import pandas as pd
import numpy as np
```

1. Load Data

In [2]:
```
## Load data dari CSV
df = pd.read_csv("data-t1.csv")
```

```
---------------------------------------------------------------------------
ParserError                               Traceback (most recent call last)
<ipython-input-2-5f70fca2747d> in <module>
      1 ## Load data dari CSV
----> 2 df = pd.read_csv("data-t1.csv")

c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\pandas\io\parsers.py in parser_
f(filepath_or_buffer, sep, delimiter, header, names, index_col, usecols, squeeze, prefix, mangle_dupe_col
s, dtype, engine, converters, true_values, false_values, skipinitialspace, skiprows, skipfooter, nrows, na
_values, keep_default_na, na_filter, verbose, skip_blank_lines, parse_dates, infer_datetime_format, keep_d
ate_col, date_parser, dayfirst, iterator, chunksize, compression, thousands, decimal, lineterminator, quot
echar, quoting, doublequote, escapechar, comment, encoding, dialect, tupleize_cols, error_bad_lines, warn_
bad_lines, delim_whitespace, low_memory, memory_map, float_precision)
    700                     skip_blank_lines=skip_blank_lines)
    701
--> 702         return _read(filepath_or_buffer, kwds)
    703
    704     parser_f.__name__ = name

c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\pandas\io\parsers.py in _read(f
ilepath_or_buffer, kwds)
    433
    434     try:
--> 435         data = parser.read(nrows)
    436     finally:
    437         parser.close()

c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\pandas\io\parsers.py in read(se
lf, nrows)
   1137     def read(self, nrows=None):
   1138         nrows = _validate_integer('nrows', nrows)
-> 1139         ret = self._engine.read(nrows)
   1140
   1141         # May alter columns / col_dict

c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\pandas\io\parsers.py in read(se
lf, nrows)
   1993     def read(self, nrows=None):
   1994         try:
-> 1995             data = self._reader.read(nrows)
   1996         except StopIteration:
   1997             if self._first_chunk:

pandas\_libs\parsers.pyx in pandas._libs.parsers.TextReader.read()

pandas\_libs\parsers.pyx in pandas._libs.parsers.TextReader._read_low_memory()

pandas\_libs\parsers.pyx in pandas._libs.parsers.TextReader._read_rows()

pandas\_libs\parsers.pyx in pandas._libs.parsers.TextReader._tokenize_rows()

pandas\_libs\parsers.pyx in pandas._libs.parsers.raise_parser_error()

ParserError: Error tokenizing data. C error: Expected 8 fields in line 52431, saw 9
```

Terdapat bad lines pada line 52431 dan 131201, dimana row tersebut memiliki 9 kolom, lebih banyak 1 kolom dibanding row lainnya. Maka kita dapat melakukan *skipping* untuk dua row tersebut.

In [3]:
```
## Load data, skip error/bad lines
df = pd.read_csv("data-t1.csv", error_bad_lines=False)
```

```
b'Skipping line 52431: expected 8 fields, saw 9\n'
b'Skipping line 131201: expected 8 fields, saw 9\n'
```

Line 52431 dan 131201 memiliki lebih dari 8 kolom, kedua line tersebut dapat dilewati (disingkirkan dari tabel).

In [4]:
```
## Melakukan checking terhadap dataset yang dimiliki
df.shape
```

Out[4]: (149997, 8)

In [5]:
```
## Memastikan index yang telah diskip tidak ada dalam dataframe (+-52431)
df.iloc[52429:].head()
```

Out[5]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
52429	Current	8000	13.56	C	2 years	MORTGAGE	80000	36 months
52430	In Grace Period	12000	10.72	B	10+ years	MORTGAGE	140000	36 months
52431	Current	12000	19.92	D	NaN	RENT	0	60 months
52432	Current	8000	7.56	A	10+ years	MORTGAGE	155000	36 months
52433	Current	4600	14.47	C	1 year	RENT	18430	36 months

In [6]:
```
## Memastikan index yang telah diskip tidak ada dalam dataframe (+-131201)
df.iloc[131199:].head()
```

Out[6]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
131199	Current	18000	20.89	D	1 year	OWN	83000	36 months
131200	Current	20000	11.55	B	5 years	MORTGAGE	120000	60 months
131201	Current	10000	16.14	C	1 year	RENT	60000	36 months
131202	Current	30000	12.73	B	4 years	MORTGAGE	100000	60 months
131203	Fully Paid	13000	16.91	C	10+ years	MORTGAGE	55000	36 months

2. Examine Data

Sanity check pada data awal

In [7]:
```
## 5 baris pertama dari data
df.head()
```

Out[7]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
0	Current	2500	13.56	C	10+ years	RENT	55000	36 months
1	Current	30000	18.94	D	10+ years	MORTGAGE	90000	60 months
2	Current	5000	17.97	D	6 years	MORTGAGE	59280	36 months
3	Current	4000	18.94	D	10+ years	MORTGAGE	92000	36 months
4	Current	30000	16.14	C	10+ years	MORTGAGE	57250	60 months

In [8]:
```
## Cek shape dari data
df.shape
```

Out[8]: (149997, 8)

Data memiliki 149997 baris dan 8 kolom.

In [9]:
```
df.head(1)
```

Out[9]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
0	Current	2500	13.56	C	10+ years	RENT	55000	36 months

Berdasarkan referensi berikut (http://wcw.cs.ui.ac.id/teaching/imgs/bahan/pdib/data-t1.txt), baris di atas merupakan contoh dari sebuah baris yang valid/sesuai.

2.1 Check for "Miss-recorded"

Expected values/data types pada setiap kolom yang ada adalah sebagai berikut:

- **loan_status**: (str, categorical) (e.g. Charged off, Current, Default, Fully Paid, etc.)
- **loan_amnt**: (int, discrete) (e.g. 1000, 2000, 3000, etc.)
- **int_rate**: (float, continuous) (e.g. 13.56, 2.5, 12.3, etc.)
- **grade** (str, categorical) (e.g. A, B, C, etc.)
- **emp_length** (str, categorical) (e.g. 4 years, 5 years, etc.)
- **home_ownership** (str, categorical) (e.g. RENT, MORTGAGE, etc.)
- **annual_inc** (float, continuous) (e.g. 111.24, 1231.4, etc.)
- **term** (str, categorical) (e.g. 60 months, 36 months, etc.)

Jika terdapat sebuah baris yang mengandung tipe data/value yang tidak sesuai, maka baris tersebut dapat didrop.

Loan Status

In [10]:
```
## Check value yang sekarang ada pada laon_status
df['loan_status'].unique()
```

Out[10]:
```
array(['Current', 'Fully Paid', 'Dec-2018', 'Late (31-120 days)',
       'In Grace Period', 'Charged Off', 'Verified', 'Late (16-30 days)',
       'Not Verified', 'Source Verified', 'Nov-2018', 'Oct-2018', 'RENT',
       '32000', 'Sep-2018', 'Fulli Paid', 'Full Paid', 'Curren', 'Curent'],
      dtype=object)
```

In [11]:
```
## Check jumlah dari setiap value yang ada pada loan_status
df.groupby(['loan_status']).size()
```

Out[11]:
```
loan_status
32000                    1
Charged Off             73
Curent                   1
Curren                   2
Current             142877
Dec-2018               303
Full Paid                1
Fulli Paid               1
Fully Paid            4272
In Grace Period        592
Late (16-30 days)      232
Late (31-120 days)     704
Not Verified            20
Nov-2018               347
Oct-2018               375
RENT                     1
Sep-2018               181
Source Verified         10
Verified                 4
dtype: int64
```

In [12]:
```
## Status valid yang seharusnya ada pada kolom loan_status
valid_status = ['Charged Off', 'Current', 'Fully Paid', 'In Grace Period', 'Late (16-30 days)', 'Late (31-
120 days)',\
                'Not Verified', 'Source Verified', 'Verified', np.nan]
```

In [13]:
```
## Update data dengan kondisi dimana isi dari loan_status hanya merupakan status yang valid
df = df[df['loan_status'].isin(valid_status)]
```

Status yang tidak valid dapat langsung diremove, karena memang beberapa data yang berupa **miss-recorded** data (e.g. Dec-2018, Nov-2018, dsb.) bukan merupakan data yang bisa diolah. Data-data yang **typo** (e.g. Curent, Fulli Paid) dapat diabaikan karena jumlahnya sangat sedikit.

Loan Amount

In [14]:
```
## Check jumlah data pada kolom loan_amnt yang merupakan integer
df['loan_amnt'].astype(str).str.isdigit().sum()
```

Out[14]: 148784

In [15]:
```
## Check data pada kolom loan_amnt yang bukan merupakan integer
df[~df['loan_amnt'].astype(str).str.isdigit()]
```

Out[15]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term

In [16]:
```
df['loan_amnt'].describe()
```

Out[16]:
```
count    148784.000000
mean      15979.620288
std       10117.444912
min        1000.000000
25%        8000.000000
50%       14000.000000
75%       21600.000000
max       40000.000000
Name: loan_amnt, dtype: float64
```

Semua data pada kolom loan_amnt telah berisikan **integer** dengan nilai minimum 1000 dan maksimum 40000.

Interest Rate

In [17]:
```
## Check tipe data yang terdapat pada kolom int_rate
df['int_rate'].dtype
```

Out[17]: dtype('float64')

In [18]:
```
df['int_rate'].describe()
```

Out[18]:
```
count    148784.000000
mean         12.913209
std           5.127769
min           6.000000
25%           8.460000
50%          11.800000
75%          16.140000
max          30.990000
Name: int_rate, dtype: float64
```

Semua data pada kolom int_rate telah berisikan **float** dengan nilai minimum 6 dan maksimum 30.99.

Grade

In [19]:
```
## Check tipe data yang terdapat pada kolom grade
df['grade'].unique()
```

Out[19]: array(['C', 'D', 'B', 'A', 'E', 'F', 'G'], dtype=object)

Semua data pada kolom grade telah sesuai, berisikan category A-G.

Employment Length

In [20]:
```
## Check values yang terdapat pada kolom emp_length
df['emp_length'].unique()
```

Out[20]:
```
array(['10+ years', '6 years', '4 years', '< 1 year', '2 years',
       '9 years', nan, '5 years', '3 years', '7 years', '1 year',
       '8 years', ' Policy', ' Office of Conferences', ' Team Leader',
       ' Windows', ' CSO', ' Governance', 'mason', ' Finance',
       'Purchasing Manager', ' GA', 'M', ' Assistant', ' Marketing',
       ' Cosmetic', ' equipment operator', ' NV', 'Hostess', ' Artist',
       ' Media Director', ' LVN', ' maintenance', 'bellman',
       ' Volunteer ; HR', ' Head Tech', ' 230 Appleton Pl', ' bartender',
       ' Physician', ' Bus driver', ' Benefits',
       ' Health Management Nurse', 'Cashier', ' hostess', ' operator',
       ' machinest'], dtype=object)
```

In [21]:
```
## Check jumlah dari setiap value yang ada pada kolom emp_length
df.groupby(['emp_length']).size()
```

Out[21]:
```
emp_length
 230 Appleton Pl                1
 Artist                         1
 Assistant                      1
 Benefits                       1
 Bus driver                     1
 CSO                            1
 Cosmetic                       1
 Finance                        1
 GA                             1
 Governance                     1
 Head Tech                      1
 Health Management Nurse        1
 LVN                            1
 Marketing                      1
 Media Director                 1
 NV                             1
 Office of Conferences          1
 Physician                      1
 Policy                         1
 Team Leader                    1
 Volunteer ; HR                 1
 Windows                        1
 bartender                      1
 equipment operator             1
 hostess                        1
 machinest                      1
 maintenance                    1
 operator                       1
1 year                      10395
10+ years                   45066
2 years                     12574
3 years                     11699
4 years                      8718
5 years                      8984
6 years                      6287
7 years                      5065
8 years                      4742
9 years                      3226
< 1 year                    18326
Cashier                         1
Hostess                         1
M                               1
Purchasing Manager              1
bellman                         1
mason                           1
dtype: int64
```

In [22]:
```
## Length valid yang seharusnya ada pada kolom emp_length
valid_length = ['10+ years', '6 years', '4 years', '< 1 year', '2 years','9 years', \
                np.nan, '5 years', '3 years', '7 years', '1 year', '8 years']
```

Null values masih di-*include*, baru akan diremove pada bab berikutnya (**Imputation**).

In [23]:
```
## Update data dengan kondisi dimana isi dari emp_length hanya merupakan length yang valid
df = df[df['emp_length'].isin(valid_length)]
```

In [24]:
```
## Check jumlah dari setiap value yang ada pada kolom emp_length
df['emp_length'].unique()
```

Out[24]:
```
array(['10+ years', '6 years', '4 years', '< 1 year', '2 years',
       '9 years', nan, '5 years', '3 years', '7 years', '1 year',
       '8 years'], dtype=object)
```

Semua data pada kolom emp_length telah sesuai, berisikan category < 1 year - 10+ years.

Home Ownership

In [25]:
```
## Check values yang terdapat pada kolom home_ownership
df['home_ownership'].unique()
```

Out[25]:
```
array(['RENT', 'MORTGAGE', 'OWN', 'ANY', 'MOTGAGE', 'MORGAGE'],
      dtype=object)
```

In [26]:
```
## Check jumlah dari setiap value yang ada pada kolom home_ownership
df.groupby(['home_ownership']).size()
```

Out[26]:
```
home_ownership
ANY           363
MORGAGE         2
MORTGAGE    73413
MOTGAGE         3
OWN         16388
RENT        58581
dtype: int64
```

In [27]:
```
## Ownership valid yang seharusnya ada pada kolom home_ownership
valid_ownership = ['RENT', 'MORTGAGE', 'OWN', 'ANY', np.nan]
```

In [28]:
```
## Update data dengan kondisi dimana isi dari home_ownership hanya merupakan length yang valid
df = df[df['home_ownership'].isin(valid_ownership)]
```

Semua data pada kolom home_ownership telah sesuai, berisikan category RENT, MORGAGE, OWN, ANY.

Annual Income

In [29]:
```
## Check jumlah data pada kolom annual_inc yang merupakan integer
df['annual_inc'].str.isdigit().sum()
```

Out[29]:
```
148109
```

In [30]:
```
## Check data pada kolom annual_inc yang bukan merupakan integer
df[~df['annual_inc'].str.isdigit()][['annual_inc']].head()
```

Out[30]:

	annual_inc
1115	70775.28
1924	19110.59
2450	82492.8
2572	63659.88
2631	33865.68

In [31]:
```
## Memastikan data selain integer hanya merupakan data float
df[~df['annual_inc'].str.isdigit()]['annual_inc'].astype(float).head()
```

Out[31]:
```
1115    70775.28
1924    19110.59
2450    82492.80
2572    63659.88
2631    33865.68
Name: annual_inc, dtype: float64
```

Semua data pada kolom annual_inc berisikan float & integer, untuk saat ini cukup melakukan checking bahwa kolom tersebut mengandung data numerical. Data yang masih berbentuk float dapat ditangani dengan melakukan **smoothing** pada step berikutnya.

Term

In [32]:
```
## Check values yang ada pada kolom term
df['term'].unique()
```

Out[32]:
```
array([' 36 months', ' 60 months'], dtype=object)
```

Semua data pada kolom term telah sesuai, berisikan dua category term yaitu 36 months dan 60 months.

2.2 Check for "Null Values"

In [33]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 148745 entries, 0 to 149996
Data columns (total 8 columns):
loan_status       148745 non-null object
loan_amnt         148745 non-null int64
int_rate          148745 non-null float64
grade             148745 non-null object
emp_length        135077 non-null object
home_ownership    148745 non-null object
annual_inc        148745 non-null object
term              148745 non-null object
dtypes: float64(1), int64(1), object(6)
memory usage: 6.8+ MB
```

Hanya terdapat 1 kolom yang memiliki null values, yaitu **emp_length**.

In [34]:
```
## Jumlah null values pada kolom emp_length (%)
df['emp_length'].isnull().sum()/df.shape[0]*100
```

Out[34]:
```
9.188880298497429
```

In [35]:
```
## Jumlah null values pada kolom emp_length (row)
df['emp_length'].isnull().sum()
```

Out[35]:
```
13668
```

Ada 9% (13668 rows) pada kolom emp_length yang memiliki null values.

3. Smoothing, Imputation, Transformation, and Outlier Treatment

In [36]:
```
df.head()
```

Out[36]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
0	Current	2500	13.56	C	10+ years	RENT	55000	36 months
1	Current	30000	18.94	D	10+ years	MORTGAGE	90000	60 months
2	Current	5000	17.97	D	6 years	MORTGAGE	59280	36 months
3	Current	4000	18.94	D	10+ years	MORTGAGE	92000	36 months
4	Current	30000	16.14	C	10+ years	MORTGAGE	57250	60 months

3.1 Smoothing

- Sebagian data annual income masih berupa decimal (float), dapat dilakukan data smoothing untuk menghilangkan perbedaan yang tidak signifikan.
- Interest rate tidak perlu dilakukan *smoothing* karena 2 angka di belakang koma pada bunga dapat berperan penting dalam pengali suatu value.

In [37]:
```
## DataFrame dengan annual_inc yang memiliki tipe data selain integer (float)
df[~df['annual_inc'].astype(str).str.isdigit()].head()
```

Out[37]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
1115	Current	40000	16.14	C	10+ years	RENT	70775.28	60 months
1924	Fully Paid	1000	23.40	E	NaN	OWN	19110.59	36 months
2450	Current	20000	8.81	A	10+ years	MORTGAGE	82492.8	36 months
2572	Current	18000	6.46	A	10+ years	RENT	63659.88	36 months
2631	Current	3500	19.92	D	NaN	OWN	33865.68	36 months

In [38]:
```
## Simpan ke sebuah variable baru, untuk memisahkan annual income float & integer
df_ann_income_float = df[~df['annual_inc'].astype(str).str.isdigit()]
df_ann_income_int = df[df['annual_inc'].astype(str).str.isdigit()]
## Rounding float pada annual_inc ke integer
ann_income_float = df_ann_income_float['annual_inc'].apply(lambda x: round(float(x)))
## Assign annual income yang sudah berbentuk integer ke dataframe
df_ann_income_float['annual_inc'] = ann_income_float
```

```
c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\ipykernel_launcher.py:7: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#indexing-v
iew-versus-copy
  import sys
```

In [39]:
```
## Float telah diround ke nearest integer
df_ann_income_float.head()
```

Out[39]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
1115	Current	40000	16.14	C	10+ years	RENT	70775	60 months
1924	Fully Paid	1000	23.40	E	NaN	OWN	19111	36 months
2450	Current	20000	8.81	A	10+ years	MORTGAGE	82493	36 months
2572	Current	18000	6.46	A	10+ years	RENT	63660	36 months
2631	Current	3500	19.92	D	NaN	OWN	33866	36 months

In [40]:
```
## Update tabel dengan data yang telah di smoothing
df = pd.concat([df_ann_income_float, df_ann_income_int]).sort_index()
df['annual_inc'] = df['annual_inc'].astype(int)
```

3.2 Imputation

Karena data pada kolom **emp_length** merupakan qualitative data, maka yang akan digunakan adalah *mode imputation*.

In [41]:
```
df.groupby(['emp_length']).size().sort_values(ascending=False)
```

Out[41]:
```
emp_length
10+ years    45065
< 1 year     18324
2 years      12574
3 years      11699
1 year       10395
5 years       8984
4 years       8717
6 years       6286
7 years       5065
8 years       4742
9 years       3226
dtype: int64
```

In [42]:
```
## DataFrame yang mengandung null values pada kolom emp_length
df[df['emp_length'].isnull()].head()
```

Out[42]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
25	Current	15000	14.47	C	NaN	MORTGAGE	30000	60 months
34	Current	20000	11.80	B	NaN	MORTGAGE	47590	60 months
41	Current	2200	15.02	C	NaN	RENT	70000	36 months
43	Current	4000	11.80	B	NaN	RENT	20000	36 months
46	Current	7500	11.80	B	NaN	MORTGAGE	32700	36 months

In [43]:
```
## Simpan ke sebuah variable baru, untuk memisahkan employement length null dan yang tidak null
df_emp_length_null = df[df['emp_length'].isnull()]
df_emp_length_not_null = df[~df['emp_length'].isnull()]
## Assign 10+ years ke value-value yang tadinya null
df_emp_length_null['emp_length'] = '10+ years'
```

```
c:\users\bahyh\appdata\local\programs\python\python37-32\lib\site-packages\ipykernel_launcher.py:5: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html#indexing-v
iew-versus-copy
  """
```

In [44]:
```
## Null values pada emp_length telah diisikan dengan mode dari kolom tersebut (10+ years)
df_emp_length_null.head()
```

Out[44]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
25	Current	15000	14.47	C	10+ years	MORTGAGE	30000	60 months
34	Current	20000	11.80	B	10+ years	MORTGAGE	47590	60 months
41	Current	2200	15.02	C	10+ years	RENT	70000	36 months
43	Current	4000	11.80	B	10+ years	RENT	20000	36 months
46	Current	7500	11.80	B	10+ years	MORTGAGE	32700	36 months

In [45]:
```
## Update tabel dengan data yang telah di-impute
df = pd.concat([df_emp_length_null, df_emp_length_not_null]).sort_index()
```

3.3 Transformation

Merubah data menjadi numerical untuk pengolahan lebih lanjut.

- **Ordinal data**: grade & emp_length dapat diubah menjadi numerical.
- **Nominal data**: loan_status, home_ownership, term dapat diubah menjadi boolean numerical (1,0).

In [46]:
```
## Grade A-G -> 1-7, Employement Length 1-10 -> 1-10
replacing_dict = {
"emp_length": {
"10+ years": 10,
"9 years": 9,
"8 years": 8,
"7 years": 7,
"6 years": 6,
"5 years": 5,
"4 years": 4,
"3 years": 3,
"2 years": 2,
"1 year": 1,
"< 1 year": 0,
},
"grade":{
"A": 1,
"B": 2,
"C": 3,
"D": 4,
"E": 5,
"F": 6,
"G": 7
}
}
```

In [47]:
```
## Operasi replace ordinal -> numerical
df = df.replace(replacing_dict)
```

In [48]:
```
## Data dengan tipe ordinal telah diubah menjadi numerical
df.head()
```

Out[48]:

	loan_status	loan_amnt	int_rate	grade	emp_length	home_ownership	annual_inc	term
0	Current	2500	13.56	3	10	RENT	55000	36 months
1	Current	30000	18.94	4	10	MORTGAGE	90000	60 months
2	Current	5000	17.97	4	6	MORTGAGE	59280	36 months
3	Current	4000	18.94	4	10	MORTGAGE	92000	36 months
4	Current	30000	16.14	3	10	MORTGAGE	57250	60 months

In [49]:
```
## Nominal columns -> numerical columns
nominal_columns = ["home_ownership", "loan_status", "term"]
## Membuat dummy df untuk nominal columns
dummy_df = pd.get_dummies(df[nominal_columns])
```

In [50]:
```
## Data nominal telah diubah menjadi numerical
dummy_df.head()
```

Out[50]:

	home_ownership_ANY	home_ownership_MORTGAGE	home_ownership_OWN	home_ownership_RENT	loan_status_Charged Off	loan_
0	0	0	0	1	0	
1	0	1	0	0	0	
2	0	1	0	0	0	
3	0	1	0	0	0	
4	0	1	0	0	0	

In [51]:
```
## Update df dengan data terbaru, yaitu data yang hanya mengandung numerical features
df = pd.concat([df.drop(nominal_columns, axis=1), dummy_df], axis=1)
```

3.4 Outlier Treatment

Aturan *outlier treatment* yang digunakan adalah membuat threshold menggunakan:

- Q1 - 1.5 IQR, Q3 + 1.5 IQR
- Mean +- 2 SD

In [52]:
```
## Import library untuk visualisasi
import seaborn as sns
```

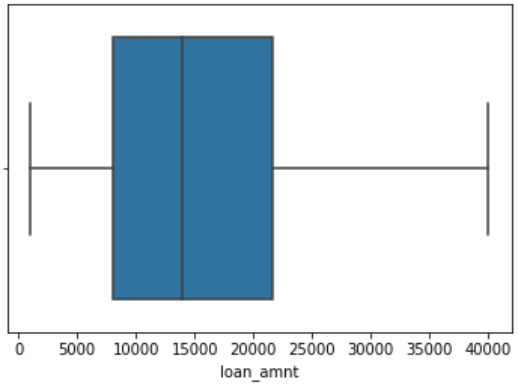
In [53]:
```
## Hasil tabel yang telah di lakukan transformation
df.head()
```

Out[53]:

	loan_amnt	int_rate	grade	emp_length	annual_inc	home_ownership_ANY	home_ownership_MORTGAGE	home_ownership_OWN
0	2500	13.56	3	10	55000	0	0	0
1	30000	18.94	4	10	90000	0	1	0
2	5000	17.97	4	6	59280	0	1	0
3	4000	18.94	4	10	92000	0	1	0
4	30000	16.14	3	10	57250	0	1	0

In [54]:
```
## Check outlier loan_amnt
sns.boxplot(df['loan_amnt'])
```

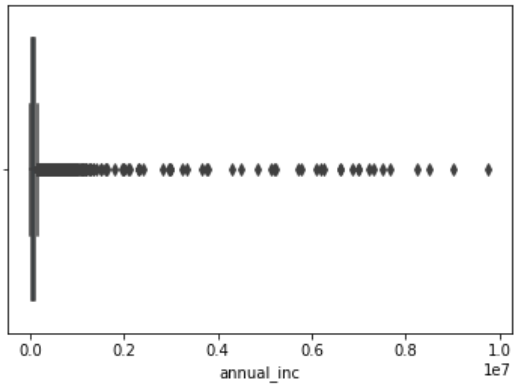
Out[54]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x10349330>
```



Kolom loan_amnt tidak memiliki outlier, tidak perlu dilakukan treatment

In [55]:
```
## Check outlier annual_inc
sns.boxplot(df['annual_inc'])
```

Out[55]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x113bb230>
```



Kolom annual_inc memiliki banyak sekali outliers, outliers treatment perlu dilakukan.

In [56]:
```
## Mengambil Q1, Q3, dan IQR kolom annual_inc
q1_annual_inc = df['annual_inc'].quantile(0.25)
q3_annual_inc = df['annual_inc'].quantile(0.75)
iqr_annual_inc = q3_annual_inc - q1_annual_inc
```

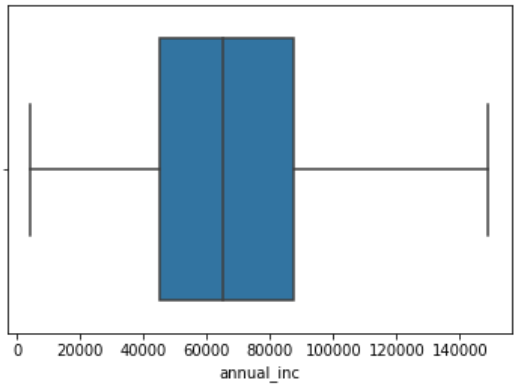
In [57]:
```
lower_bound_annual_inc = iqr_annual_inc - q1_annual_inc
upper_bound_annual_inc = iqr_annual_inc + q3_annual_inc
```

In [58]:
```
## Check shape sebelum diremove outliers
df.shape
```

Out[58]: (148745, 17)

In [59]:
```
## Remove outliers menggunakan > 0.95 & < 0.05 karena banyaknya outliers yang terdeteksi
df = df[(df['annual_inc'] > lower_bound_annual_inc) & (df['annual_inc'] < upper_bound_annual_inc)]
sns.boxplot(df['annual_inc'])
```

Out[59]: <matplotlib.axes._subplots.AxesSubplot at 0x114b6390>



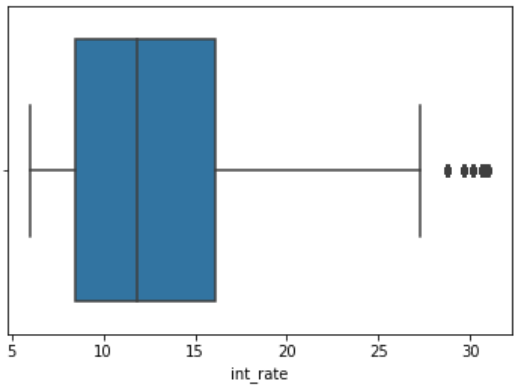
In [60]:
```
## Check shape setelah diremove outliers
df.shape
```

Out[60]: (135433, 17)

Outlers pada kolom annual_inc telah dihilangkan, dapat dilihat distribusi boxplot di atas.

In [61]:
```
## Check outlier int_rate
sns.boxplot(df['int_rate'])
```

Out[61]: <matplotlib.axes._subplots.AxesSubplot at 0xb88a7b0>



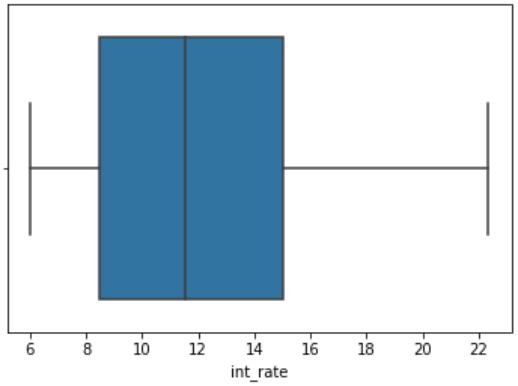
In [62]:
```
## Check shape sebelum diremove outliers
df.shape
```

Out[62]: (135433, 17)

In [63]:
```
## Remove outliers pada kolom int_rate
mean_interest_rate = df['int_rate'].mean()
std_interest_rate = df['int_rate'].std()
upper_interest_rate = mean_interest_rate + (2*std_interest_rate)
lower_interest_rate = mean_interest_rate - (2*std_interest_rate)
```

In [64]:
```
## Outliers telah diremove
df = df[(df['int_rate'] < upper_interest_rate) & (df['int_rate'] > lower_interest_rate)]
sns.boxplot(df['int_rate'])
```

Out[64]:
```
<matplotlib.axes._subplots.AxesSubplot at 0xb7e7030>
```



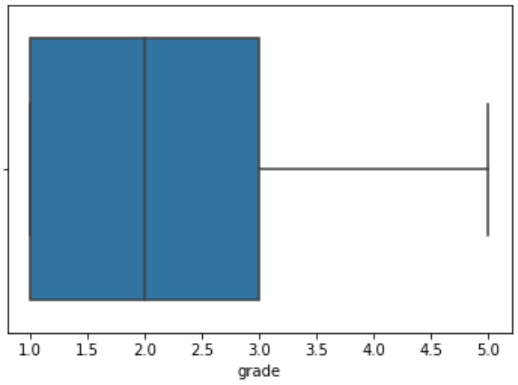
In [65]:
```
## Check shape setelah diremove outliers
df.shape
```

Out[65]:
```
(128548, 17)
```

Outlers pada kolom int_rate telah dihilangkan, dapat dilihat distribusi boxplot di atas.

In [66]:
```
## Check outlier grade
sns.boxplot(df['grade'])
```

Out[66]:
```
<matplotlib.axes._subplots.AxesSubplot at 0xb820590>
```

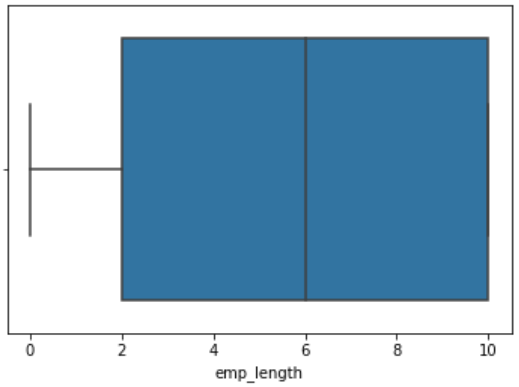


In [67]:
```
df['grade'].describe()
```

Out[67]:
```
count    128548.000000
mean          2.240012
std           1.040200
min           1.000000
25%           1.000000
50%           2.000000
75%           3.000000
max           5.000000
Name: grade, dtype: float64
```

In [68]:
```
## Check outlier emp_length
sns.boxplot(df['emp_length'])
```

Out[68]:
```
<matplotlib.axes._subplots.AxesSubplot at 0xb7db4b0>
```



In [69]:
```
df['emp_length'].describe()
```

Out[69]:
```
count    128548.000000
mean          5.933029
std           3.883395
min           0.000000
25%           2.000000
50%           6.000000
75%          10.000000
max          10.000000
Name: emp_length, dtype: float64
```

Kolom **grade** dan **emp_length** tidak memiliki outliers, hanya saja distribusinya *skewed* karena banyaknya data yang terdapat pada salah satu bagian (negatif/positif) dari distribusi.

4. Export Result

In [70]:
```
## Check final shape
df.shape
```

Out[70]:
```
(128548, 17)
```

In [71]:
```
df.to_csv("data-t1-result.csv", index=False)
```