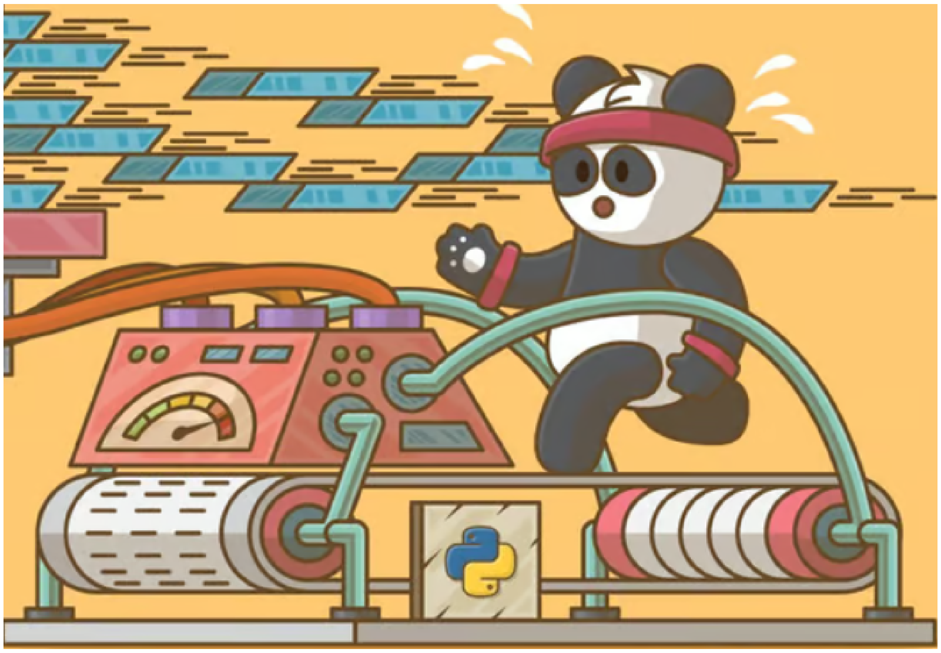
What is MultiIndex in Pandas?

In pandas, a multi-index, also known as a **hierarchical index**, is a way to represent two or more dimensions of data in a single index. This is useful when you have data that can be grouped or categorized by more than one variable.



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

Series is 1D and DataFrames are 2D objects

- But why?
- And what exactly is index?

In [2]:
```
# can we have multiple index? Let's try
index_val = [('cse',2019),('cse',2020),('cse',2021),('cse',2022),('ece',2019),('ece',2020),('ece',2021),('ece',2022)]
data = pd.Series([1,2,3,4,5,6,7,8],index=index_val)
data
```

Out[2]:
```
(cse, 2019)    1
(cse, 2020)    2
(cse, 2021)    3
(cse, 2022)    4
(ece, 2019)    5
(ece, 2020)    6
(ece, 2021)    7
(ece, 2022)    8
dtype: int64
```

In [3]:
```
# The problem?
#data['cse']
```

The solution : multiindex series-2D(also known as Hierarchical Indexing)

multiple index levels within a single index

In [4]:
```
# how to create multiindex object
# 1. pd.MultiIndex.from_tuples()
index_val = [('cse',2019),('cse',2020),('cse',2021),('cse',2022),('ece',2019),('ece',2020),('ece',2021),('ece',2022)]
multiindex = pd.MultiIndex.from_tuples(index_val)
multiindex.levels[0]
```

Out[4]:
```
Index(['cse', 'ece'], dtype='object')
```

In [5]:

```
# 2. pd.MultiIndex.from_product()
pd.MultiIndex.from_product([['cse','ece'],[2019,2020,2021,2022]])
```

Out[5]:

```
MultiIndex([('cse', 2019),
            ('cse', 2020),
            ('cse', 2021),
            ('cse', 2022),
            ('ece', 2019),
            ('ece', 2020),
            ('ece', 2021),
            ('ece', 2022)],
           )
```

In [6]:

```
# creating a series with multiindex object
sample = pd.Series([1,2,3,4,5,6,7,8],index=multiindex)
sample
```

Out[6]:

```
cse  2019    1
     2020    2
     2021    3
     2022    4
ece  2019    5
     2020    6
     2021    7
     2022    8
dtype: int64
```

In [7]:

```
# how to fetch items from such a series
sample[('cse',2022)]
```

Out[7]:

```
4
```

In [8]:

```
sample['cse']
```

Out[8]:

```
2019    1
2020    2
2021    3
2022    4
dtype: int64
```

unstack

reshape the given Pandas DataFrame by transposing specified row level to column level

In [9]:

```
temp = sample.unstack()
temp
```

Out[9]:

	2019	2020	2021	2022
cse	1	2	3	4
ece	5	6	7	8

stack

reshapes the given DataFrame by converting the column label to a row index.

In [10]:

```
temp.stack()
```

Out[10]:

```
cse  2019    1
     2020    2
     2021    3
     2022    4
ece  2019    5
     2020    6
     2021    7
     2022    8
dtype: int64
```

so why we should study Multi Index

because we can convert any dataframe dimension, including 3D, 4D, 10D, and 20D, to 1Dimension (Series) and 2Dimension (Dataframes).

In [11]:

```
# multi index dataframes
branch_df1 = pd.DataFrame(
    [
        [1,2],
        [3,4],
        [5,6],
        [7,8],
        [9,10],
        [11,12],
        [13,14],
        [15,16],
    ],
    index = multiindex,
    columns = ['avg_package','students']
)

branch_df1
```

Out[11]:

		avg_package	students
cse	**2019**	1	2
	2020	3	4
	2021	5	6
	2022	7	8
ece	**2019**	9	10
	2020	11	12
	2021	13	14
	2022	15	16

In [12]:

```
branch_df1.loc['cse']
```

Out[12]:

	avg_package	students
2019	1	2
2020	3	4
2021	5	6
2022	7	8

In [13]:

```
branch_df1['avg_package']
```

Out[13]:

```
cse  2019     1
     2020     3
     2021     5
     2022     7
ece  2019     9
     2020    11
     2021    13
     2022    15
Name: avg_package, dtype: int64
```

In [14]:

```
branch_df1['students']
```

Out[14]:

```
cse  2019     2
     2020     4
     2021     6
     2022     8
ece  2019    10
     2020    12
     2021    14
     2022    16
Name: students, dtype: int64
```

In [15]:
```
branch_df1.loc['ece']
```

Out[15]:

	avg_package	students
2019	9	10
2020	11	12
2021	13	14
2022	15	16

multiindex df from columns perspective

In [16]:
```
branch_df2 = pd.DataFrame(
    [
        [1,2,0,0],
        [3,4,0,0],
        [5,6,0,0],
        [7,8,0,0],
    ],
    index = [2019,2020,2021,2022],
    columns = pd.MultiIndex.from_product([['delhi','mumbai'],['avg_package','students']])
)

branch_df2
```

Out[16]:

	delhi		mumbai	
	avg_package	students	avg_package	students
2019	1	2	0	0
2020	3	4	0	0
2021	5	6	0	0
2022	7	8	0	0

In [17]:
```
branch_df2['delhi']
```

Out[17]:

	avg_package	students
2019	1	2
2020	3	4
2021	5	6
2022	7	8

In [18]:
```
branch_df2.loc[2019]
```

Out[18]:
```
delhi   avg_package    1
        students       2
mumbai  avg_package    0
        students       0
Name: 2019, dtype: int64
```

In [19]:
```
branch_df2.iloc[1]
```

Out[19]:
```
delhi   avg_package    3
        students       4
mumbai  avg_package    0
        students       0
Name: 2020, dtype: int64
```

Multiindex df in terms of both cols and index

In [20]:

```
branch_df3 = pd.DataFrame(
    [
        [1,2,0,0],
        [3,4,0,0],
        [5,6,0,0],
        [7,8,0,0],
        [9,10,0,0],
        [11,12,0,0],
        [13,14,0,0],
        [15,16,0,0],
    ],
    index = multiindex,
    columns = pd.MultiIndex.from_product([['delhi','mumbai'],['avg_package','students']])
)

branch_df3

#here index= multiindex is a name , already we have stored data of ece and cse in above
```

Out[20]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

Stacking and Unstacking

In [21]:

```
branch_df1
```

Out[21]:

		avg_package	students
cse	2019	1	2
	2020	3	4
	2021	5	6
	2022	7	8
ece	2019	9	10
	2020	11	12
	2021	13	14
	2022	15	16

In [22]:

```
 # After applying Unstack
branch_df1.unstack()
```

Out[22]:

	avg_package				students			
	2019	2020	2021	2022	2019	2020	2021	2022
cse	1	3	5	7	2	4	6	8
ece	9	11	13	15	10	12	14	16

In [23]:
```
branch_df1.unstack().unstack()
```

Out[23]:
```
avg_package  2019  cse     1
                   ece     9
             2020  cse     3
                   ece    11
             2021  cse     5
                   ece    13
             2022  cse     7
                   ece    15
students     2019  cse     2
                   ece    10
             2020  cse     4
                   ece    12
             2021  cse     6
                   ece    14
             2022  cse     8
                   ece    16
dtype: int64
```

The stack() method

It can be used to move the columns to the index. This means that the columns will become the rows, and the rows will become the columns.
The stack method can be used to move the columns to the index

In [24]:
```
# After applying Unstack + stack
branch_df1.unstack().stack()
```

Out[24]:

		avg_package	students
cse	**2019**	1	2
	2020	3	4
	2021	5	6
	2022	7	8
ece	**2019**	9	10
	2020	11	12
	2021	13	14
	2022	15	16

In [25]:
```
# applying multiple stack

branch_df1.unstack().stack().stack()
```

Out[25]:
```
cse  2019  avg_package     1
           students        2
     2020  avg_package     3
           students        4
     2021  avg_package     5
           students        6
     2022  avg_package     7
           students        8
ece  2019  avg_package     9
           students       10
     2020  avg_package    11
           students       12
     2021  avg_package    13
           students       14
     2022  avg_package    15
           students       16
dtype: int64
```

In [26]:
```
# Example : 2
branch_df2
```

Out[26]:

	delhi		mumbai	
	avg_package	students	avg_package	students
2019	1	2	0	0
2020	3	4	0	0
2021	5	6	0	0
2022	7	8	0	0

The Unstack()

It is method can be used to move the index to the columns. This means that the index will become the rows, and the rows will become the columns.
The unstack method can be used to move the index to the columns

In [27]:
```
branch_df2.unstack()
```

Out[27]:
```
delhi   avg_package  2019    1
                     2020    3
                     2021    5
                     2022    7
        students     2019    2
                     2020    4
                     2021    6
                     2022    8
mumbai  avg_package  2019    0
                     2020    0
                     2021    0
                     2022    0
        students     2019    0
                     2020    0
                     2021    0
                     2022    0
dtype: int64
```

In [28]:
```
branch_df2.stack()
```

Out[28]:

		delhi	mumbai
2019	avg_package	1	0
	students	2	0
2020	avg_package	3	0
	students	4	0
2021	avg_package	5	0
	students	6	0
2022	avg_package	7	0
	students	8	0

In [29]:
```
branch_df2.stack().stack()
```

Out[29]:
```
2019  avg_package  delhi     1
                   mumbai    0
      students     delhi     2
                   mumbai    0
2020  avg_package  delhi     3
                   mumbai    0
      students     delhi     4
                   mumbai    0
2021  avg_package  delhi     5
                   mumbai    0
      students     delhi     6
                   mumbai    0
2022  avg_package  delhi     7
                   mumbai    0
      students     delhi     8
                   mumbai    0
dtype: int64
```

In [30]:
```
# Working on 4D data
branch_df3
```

Out[30]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
cse	**2019**	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	**2019**	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

In [31]:
```
branch_df3.stack()
```

Out[31]:

			delhi	mumbai
cse	**2019**	**avg_package**	1	0
		students	2	0
	2020	**avg_package**	3	0
		students	4	0
	2021	**avg_package**	5	0
		students	6	0
	2022	**avg_package**	7	0
		students	8	0
ece	**2019**	**avg_package**	9	0
		students	10	0
	2020	**avg_package**	11	0
		students	12	0
	2021	**avg_package**	13	0
		students	14	0
	2022	**avg_package**	15	0
		students	16	0

In [32]:
```
branch_df3.stack().stack()
```

Out[32]:
```
cse  2019  avg_package  delhi      1
                        mumbai     0
           students     delhi      2
                        mumbai     0
     2020  avg_package  delhi      3
                        mumbai     0
           students     delhi      4
                        mumbai     0
     2021  avg_package  delhi      5
                        mumbai     0
           students     delhi      6
                        mumbai     0
     2022  avg_package  delhi      7
                        mumbai     0
           students     delhi      8
                        mumbai     0
ece  2019  avg_package  delhi      9
                        mumbai     0
           students     delhi     10
                        mumbai     0
     2020  avg_package  delhi     11
                        mumbai     0
           students     delhi     12
                        mumbai     0
     2021  avg_package  delhi     13
                        mumbai     0
           students     delhi     14
                        mumbai     0
     2022  avg_package  delhi     15
                        mumbai     0
           students     delhi     16
                        mumbai     0
dtype: int64
```

In [33]:
```
# Unstacking on 4D data
branch_df3.unstack()
```

Out[33]:

	delhi								mumbai							
	avg_package				students				avg_package				students			
	2019	2020	2021	2022	2019	2020	2021	2022	2019	2020	2021	2022	2019	2020	2021	2022
cse	1	3	5	7	2	4	6	8	0	0	0	0	0	0	0	0
ece	9	11	13	15	10	12	14	16	0	0	0	0	0	0	0	0

In [34]:
```
branch_df3.unstack().unstack()
```

Out[34]:
```
delhi   avg_package  2019  cse     1
                           ece     9
                     2020  cse     3
                           ece    11
                     2021  cse     5
                           ece    13
                     2022  cse     7
                           ece    15
        students     2019  cse     2
                           ece    10
                     2020  cse     4
                           ece    12
                     2021  cse     6
                           ece    14
                     2022  cse     8
                           ece    16
mumbai  avg_package  2019  cse     0
                           ece     0
                     2020  cse     0
                           ece     0
                     2021  cse     0
                           ece     0
                     2022  cse     0
                           ece     0
        students     2019  cse     0
                           ece     0
                     2020  cse     0
                           ece     0
                     2021  cse     0
                           ece     0
                     2022  cse     0
                           ece     0
dtype: int64
```

Working with multiindex dataframes

In [35]:
```
# Multi index dataframes works same as normal dataframes
branch_df3
```

Out[35]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

In [36]:
```
# head and tail
branch_df3.head()
```

Out[36]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0

In [37]:
```
# shape
branch_df3.shape
```

Out[37]:
```
(8, 4)
```

In [38]:
```
# info
branch_df3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 8 entries, ('cse', 2019) to ('ece', 2022)
Data columns (total 4 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   (delhi, avg_package)   8 non-null      int64
 1   (delhi, students)      8 non-null      int64
 2   (mumbai, avg_package)  8 non-null      int64
 3   (mumbai, students)     8 non-null      int64
dtypes: int64(4)
memory usage: 932.0+ bytes
```

In [39]:
```
# duplicated -> isnull
branch_df3.duplicated()
```

Out[39]:
```
cse  2019    False
     2020    False
     2021    False
     2022    False
ece  2019    False
     2020    False
     2021    False
     2022    False
dtype: bool
```

In [40]:
```
branch_df3.isnull()
```

Out[40]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
cse	**2019**	False	False	False	False
	2020	False	False	False	False
	2021	False	False	False	False
	2022	False	False	False	False
ece	**2019**	False	False	False	False
	2020	False	False	False	False
	2021	False	False	False	False
	2022	False	False	False	False

In [41]:
```
# Extracting rows single

branch_df3.loc[('cse',2022)]
```

Out[41]:
```
delhi   avg_package    7
        students       8
mumbai  avg_package    0
        students       0
Name: (cse, 2022), dtype: int64
```

In [42]:
```
# Extracting multiple rows

branch_df3.loc[('cse',2019):('ece',2020):2]
```

Out[42]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
cse	**2019**	1	2	0	0
	2021	5	6	0	0
ece	**2019**	9	10	0	0

In [43]:

```
# Using iloc
branch_df3.iloc[0:5:2]
```

Out[43]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2021	5	6	0	0
ece	2019	9	10	0	0

In [44]:

```
# Extracting single columns
branch_df3['delhi']['students']
```

Out[44]:

```
cse  2019     2
     2020     4
     2021     6
     2022     8
ece  2019    10
     2020    12
     2021    14
     2022    16
Name: students, dtype: int64
```

In [45]:

```
# we want to extract delhi - students , mumbai - avg_package
branch_df3
```

Out[45]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

In [46]:

```
#here [:] all rows ,
#columns : delhi=avg_package[0],students[1],mumbai=avg_package[2],students[3]

branch_df3.iloc[:,1:3]
```

Out[46]:

		delhi	mumbai
		students	avg_package
cse	2019	2	0
	2020	4	0
	2021	6	0
	2022	8	0
ece	2019	10	0
	2020	12	0
	2021	14	0
	2022	16	0

In [47]:

```
# Extracting both rows and columns
branch_df3.iloc[[0,4],[1,2]]
```

Out[47]:

		delhi	mumbai
		students	avg_package
cse	2019	2	0
ece	2019	10	0

In [48]:
```
# sort index
# both -> descending -> diff order
# based on one level

branch_df3
```

Out[48]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
cse	**2019**	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	**2019**	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

In [49]:
```
branch_df3.sort_index(ascending=False)
```

Out[49]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
ece	**2022**	15	16	0	0
	2021	13	14	0	0
	2020	11	12	0	0
	2019	9	10	0	0
cse	**2022**	7	8	0	0
	2021	5	6	0	0
	2020	3	4	0	0
	2019	1	2	0	0

In [50]:
```
# if we want year in descending order
branch_df3.sort_index(ascending=[False ,True])
```

Out[50]:

		delhi		mumbai	
		avg_package	**students**	**avg_package**	**students**
ece	**2019**	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0
cse	**2019**	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0

In [51]:
```
# multiindex dataframe(col) -> transpose
branch_df3.transpose()
```

Out[51]:

		cse				ece			
		2019	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
delhi	**avg_package**	1	3	5	7	9	11	13	15
	students	2	4	6	8	10	12	14	16
mumbai	**avg_package**	0	0	0	0	0	0	0	0
	students	0	0	0	0	0	0	0	0

In [52]:
```
# swaplevel
branch_df3
```

Out[52]:

		delhi		mumbai	
		avg_package	students	avg_package	students
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

In [53]:
```
# On rows
branch_df3.swaplevel()
```

Out[53]:

		delhi		mumbai	
		avg_package	students	avg_package	students
2019	cse	1	2	0	0
2020	cse	3	4	0	0
2021	cse	5	6	0	0
2022	cse	7	8	0	0
2019	ece	9	10	0	0
2020	ece	11	12	0	0
2021	ece	13	14	0	0
2022	ece	15	16	0	0

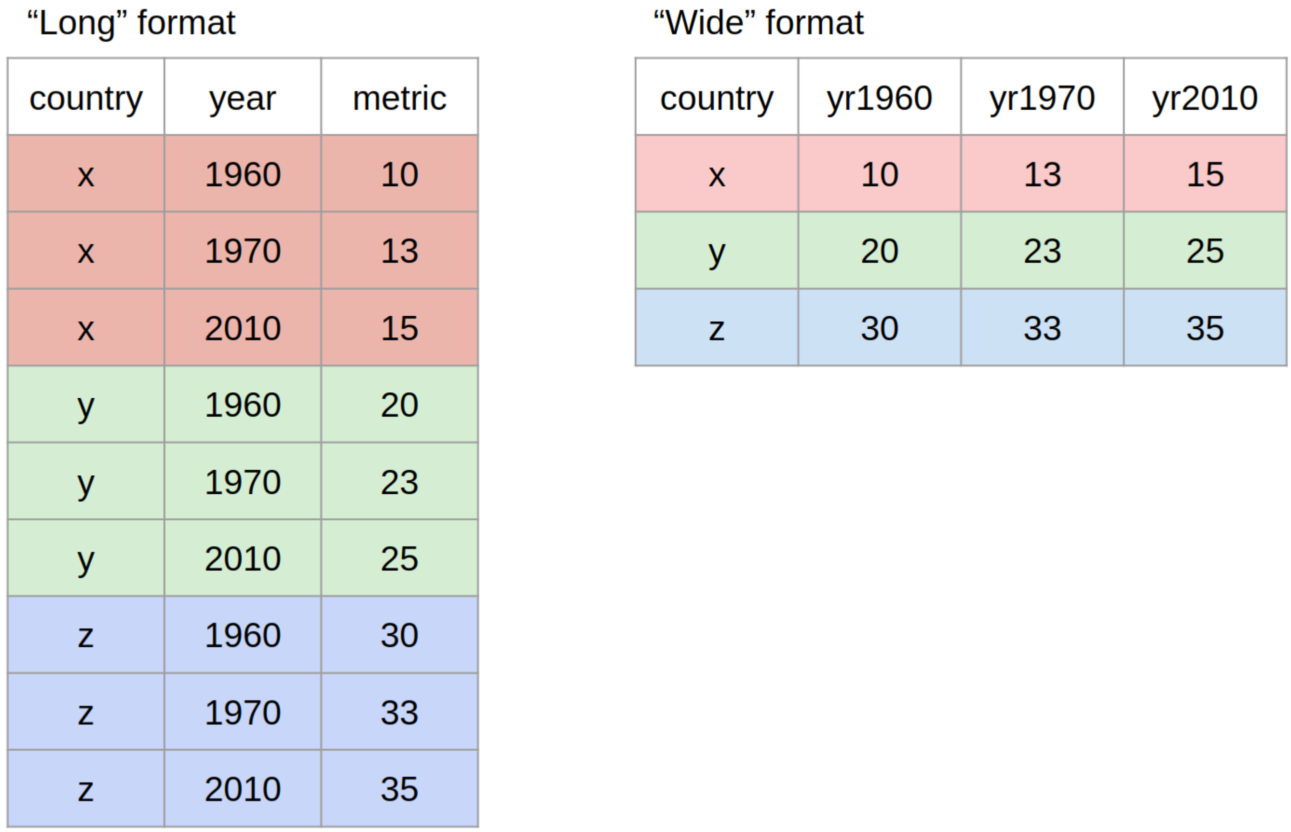
In [54]:
```
# on columns

branch_df3.swaplevel(axis=1)
```

Out[54]:

		avg_package	students	avg_package	students
		delhi	delhi	mumbai	mumbai
cse	2019	1	2	0	0
	2020	3	4	0	0
	2021	5	6	0	0
	2022	7	8	0	0
ece	2019	9	10	0	0
	2020	11	12	0	0
	2021	13	14	0	0
	2022	15	16	0	0

Long(Tall) Vs Wide data



"Long" format

country	year	metric
x	1960	10
x	1970	13
x	2010	15
y	1960	20
y	1970	23
y	2010	25
z	1960	30
z	1970	33
z	2010	35

"Wide" format

country	yr1960	yr1970	yr2010
x	10	13	15
y	20	23	25
z	30	33	35

Wide format is where we have a single row for every data point with multiple columns to hold the values of various attributes.

Long format is where, for each data point we have as many rows as the number of attributes and each row contains the value of a particular attribute for a given data point.

Melt -- Converting wide data to long Data.

In [55]:

```
# melt -> simple example branch
# wide to long
pd.DataFrame({'cse':[120]})
```

Out[55]:

```
   cse
0  120
```

In [56]:

```
pd.DataFrame({'cse':[120]}).melt()
```

Out[56]:

```
   variable  value
0       cse    120
```

In [57]:

```
# melt -> branch with year
pd.DataFrame({'cse':[120],'ece':[100],'mech':[50]}).melt()
```

Out[57]:

```
   variable  value
0       cse    120
1       ece    100
2      mech     50
```

In [58]:

```
# we can name the varibale and value
pd.DataFrame({'cse':[120],'ece':[100],'mech':[50]}).melt(var_name='branch',value_name='num_students')
```

Out[58]:

	branch	num_students
0	cse	120
1	ece	100
2	mech	50

In [59]:

```
pd.DataFrame(
    {
        'branch':['cse','ece','mech'],
        '2020':[100,150,60],
        '2021':[120,130,80],
        '2022':[150,140,70]
    }
)
```

Out[59]:

	branch	2020	2021	2022
0	cse	100	120	150
1	ece	150	130	140
2	mech	60	80	70

In [60]:

```
pd.DataFrame(
    {
        'branch':['cse','ece','mech'],
        '2020':[100,150,60],
        '2021':[120,130,80],
        '2022':[150,140,70]
    }
).melt()
```

Out[60]:

	variable	value
0	branch	cse
1	branch	ece
2	branch	mech
3	2020	100
4	2020	150
5	2020	60
6	2021	120
7	2021	130
8	2021	80
9	2022	150
10	2022	140
11	2022	70

In [61]:

```
# dont include 'branch' to rows
pd.DataFrame(
    {
        'branch':['cse','ece','mech'],
        '2020':[100,150,60],
        '2021':[120,130,80],
        '2022':[150,140,70]
    }
).melt(id_vars=['branch'])
```

Out[61]:

	branch	variable	value
0	cse	2020	100
1	ece	2020	150
2	mech	2020	60
3	cse	2021	120
4	ece	2021	130
5	mech	2021	80
6	cse	2022	150
7	ece	2022	140
8	mech	2022	70

the **melt()** method is used to reshape a DataFrame from wide to long format. This means that the columns of the DataFrame are converted into rows, and the values in the columns are converted into columns.

In [62]:

```
# adding variable and value names.
pd.DataFrame(
    {
        'branch':['cse','ece','mech'],
        '2020':[100,150,60],
        '2021':[120,130,80],
        '2022':[150,140,70]
    }
).melt(id_vars=['branch'],var_name='year',value_name='students')
```

Out[62]:

	branch	year	students
0	cse	2020	100
1	ece	2020	150
2	mech	2020	60
3	cse	2021	120
4	ece	2021	130
5	mech	2021	80
6	cse	2022	150
7	ece	2022	140
8	mech	2022	70

In [63]:

```
# melt ---> Real world examples.

deaths =pd.read_csv("time_series_covid19_deaths_global.csv")
confirm = pd.read_csv("time_series_covid19_confirmed_global.csv")
```

In [64]:

```
deaths.head(2)
```

Out[64]:

	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	...	12/24/22	12/25/22	12/26/22	12/27/22
0	NaN	Afghanistan	33.93911	67.709953	0	0	0	0	0	0	...	7845	7846	7846	7846
1	NaN	Albania	41.15330	20.168300	0	0	0	0	0	0	...	3595	3595	3595	3595

2 rows × 1081 columns

In [65]:
```
deaths.shape
```

Out[65]:
```
(289, 1081)
```

In [66]:
```
deaths =deaths.melt(id_vars=['Province/State','Country/Region','Lat','Long'],var_name='date',value_name='no. of deaths'
```

In [67]:
```
# After converting columns into rows,
# which is converting wide format to long format using 'melt'
deaths.shape
```

Out[67]:
```
(311253, 6)
```

In [75]:
```
deaths.head()
```

Out[75]:

	Province/State	Country/Region	Lat	Long	date	no. of deaths
0	NaN	Afghanistan	33.93911	67.709953	1/22/20	0
1	NaN	Albania	41.15330	20.168300	1/22/20	0
2	NaN	Algeria	28.03390	1.659600	1/22/20	0
3	NaN	Andorra	42.50630	1.521800	1/22/20	0
4	NaN	Angola	-11.20270	17.873900	1/22/20	0

In [68]:
```
confirm.head(2)
```

Out[68]:

	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	...	12/24/22	12/25/22	12/26/22	12/27/22
0	NaN	Afghanistan	33.93911	67.709953	0	0	0	0	0	0	...	207310	207399	207438	207460
1	NaN	Albania	41.15330	20.168300	0	0	0	0	0	0	...	333749	333749	333751	333751

2 rows × 1081 columns

In [69]:
```
confirm.shape
```

Out[69]:
```
(289, 1081)
```

In [73]:
```
confirm =confirm.melt(id_vars=['Province/State','Country/Region','Lat','Long'],var_name='date',value_name='no. of confi
```

In [76]:
```
confirm.head()
```

Out[76]:

	Province/State	Country/Region	Lat	Long	date	no. of confirmed
0	NaN	Afghanistan	33.93911	67.709953	1/22/20	0
1	NaN	Albania	41.15330	20.168300	1/22/20	0
2	NaN	Algeria	28.03390	1.659600	1/22/20	0
3	NaN	Andorra	42.50630	1.521800	1/22/20	0
4	NaN	Angola	-11.20270	17.873900	1/22/20	0

In [74]:
```
# After converting columns into rows,
# which is converting wide format to long format using 'melt'
confirm.shape
```

Out[74]:
```
(311253, 6)
```

In [77]:
```
# Now merge both data frames as per desire
confirm.merge(deaths, on =['Province/State','Country/Region','Lat','Long','date'])
```

Out[77]:

	Province/State	Country/Region	Lat	Long	date	no. of confirmed	no. of deaths
0	NaN	Afghanistan	33.939110	67.709953	1/22/20	0	0
1	NaN	Albania	41.153300	20.168300	1/22/20	0	0
2	NaN	Algeria	28.033900	1.659600	1/22/20	0	0
3	NaN	Andorra	42.506300	1.521800	1/22/20	0	0
4	NaN	Angola	-11.202700	17.873900	1/22/20	0	0
...	...	...	...	...	...	...	...
311248	NaN	West Bank and Gaza	31.952200	35.233200	1/2/23	703228	5708
311249	NaN	Winter Olympics 2022	39.904200	116.407400	1/2/23	535	0
311250	NaN	Yemen	15.552727	48.516388	1/2/23	11945	2159
311251	NaN	Zambia	-13.133897	27.849332	1/2/23	334661	4024
311252	NaN	Zimbabwe	-19.015438	29.154857	1/2/23	259981	5637

311253 rows × 7 columns

In [80]:
```
esired columns
eaths, on =['Province/State','Country/Region','Lat','Long','date'])[['Country/Region','date','no. of confirmed','no. of
```

Out[80]:

	Country/Region	date	no. of confirmed	no. of deaths
0	Afghanistan	1/22/20	0	0
1	Albania	1/22/20	0	0
2	Algeria	1/22/20	0	0
3	Andorra	1/22/20	0	0
4	Angola	1/22/20	0	0
...	...	...	...	...
311248	West Bank and Gaza	1/2/23	703228	5708
311249	Winter Olympics 2022	1/2/23	535	0
311250	Yemen	1/2/23	11945	2159
311251	Zambia	1/2/23	334661	4024
311252	Zimbabwe	1/2/23	259981	5637

311253 rows × 4 columns

Pivot table -- Converting Long data to wide data.

the **Pivot table** takes simple column wise data as input, and groups as the entire Into 2 dimensional table that provides a multi dimensional summarization of the data.

Pivot table generally used on categorical data

In [81]:
```
import seaborn as sns
```

In [83]:
```
df = sns.load_dataset('tips')
df.head()
```

Out[83]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4

In [85]:
```
# On gender basis average total bill
df.groupby('sex')['total_bill'].mean()
```

Out[85]:
```
sex
Male      20.744076
Female    18.056897
Name: total_bill, dtype: float64
```

In [88]:
```
# On gender basis. Who smokes more? On average.
df.groupby(['sex','smoker'])['total_bill'].mean().unstack()
```

Out[88]:

smoker	Yes	No
sex		
Male	22.284500	19.791237
Female	17.977879	18.105185

In [89]:
```
# Using Pivot table method

df.pivot_table(index ='sex',columns='smoker',values = 'total_bill')
```

Out[89]:

smoker	Yes	No
sex		
Male	22.284500	19.791237
Female	17.977879	18.105185

In [90]:
```
# Aggregate function.
# Print, the total amount smokers of the bill, Not mean Or average,
df.pivot_table(index ='sex',columns='smoker',values = 'total_bill',aggfunc='sum')
```

Out[90]:

smoker	Yes	No
sex		
Male	1337.07	1919.75
Female	593.27	977.68

In [91]:
```
# count of people
df.pivot_table(index ='sex',columns='smoker',values = 'total_bill',aggfunc='count')
```

Out[91]:

smoker	Yes	No
sex		
Male	60	97
Female	33	54

In [92]:
```
# standard deviation

df.pivot_table(index ='sex',columns='smoker',values = 'total_bill',aggfunc='std')
```

Out[92]:

smoker	Yes	No
sex		
Male	9.911845	8.726566
Female	9.189751	7.286455

In [93]:

```
# All columns together --- gives average

df.pivot_table(index='sex',columns='smoker')
```

Out[93]:

	size		tip		total_bill	
smoker	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
sex						
Male	2.500000	2.711340	3.051167	3.113402	22.284500	19.791237
Female	2.242424	2.592593	2.931515	2.773519	17.977879	18.105185

In [95]:

```
# single column
df.pivot_table(index='sex',columns='smoker')['tip']
```

Out[95]:

smoker	Yes	No
sex		
Male	3.051167	3.113402
Female	2.931515	2.773519

In [96]:

```
df.pivot_table(index='sex',columns='smoker')['size']
```

Out[96]:

smoker	Yes	No
sex		
Male	2.500000	2.711340
Female	2.242424	2.592593

In [98]:

```
# Multi dimensional -5D
df.head(2)
```

Out[98]:

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3

In [100]:

```
# 5D - 5 Dimensional data
df.pivot_table(index=['sex','smoker'],columns=['day','time'],values='total_bill')
```

Out[100]:

	day	Thur		Fri		Sat	Sun
	time	**Lunch**	**Dinner**	**Lunch**	**Dinner**	**Dinner**	**Dinner**
sex	**smoker**						
Male	**Yes**	19.171000	NaN	11.386667	25.892	21.837778	26.141333
	No	18.486500	NaN	NaN	17.475	19.929063	20.403256
Female	**Yes**	19.218571	NaN	13.260000	12.200	20.266667	16.540000
	No	15.899167	18.78	15.980000	22.750	19.003846	20.824286

In [102]:

```
df.pivot_table(index=['sex','smoker'],columns=['day','time'])
```

Out[102]:

					tip						total_bill				
	Fri		**Sat**	**Sun**	**Thur**		**Fri**		**Sat**	**Sun**	**Thur**		**Fri**		**Sat**
Dinner	**Lunch**	**Dinner**	**Dinner**	**Dinner**	**Lunch**	**Dinner**	**Lunch**	**Dinner**	**Dinner**	**Dinner**	**Lunch**	**Dinner**	**Lunch**	**Dinner**	**Dinner**
NaN	1.666667	2.4	2.629630	2.600000	3.058000	NaN	1.90	3.246	2.879259	3.521333	19.171000	NaN	11.386667	25.892	21.837778
NaN	NaN	2.0	2.656250	2.883721	2.941500	NaN	NaN	2.500	3.256563	3.115349	18.486500	NaN	NaN	17.475	19.929063
NaN	2.000000	2.0	2.200000	2.500000	2.990000	NaN	2.66	2.700	2.868667	3.500000	19.218571	NaN	13.260000	12.200	20.266667
2.0	3.000000	2.0	2.307692	3.071429	2.437083	3.0	3.00	3.250	2.724615	3.329286	15.899167	18.78	15.980000	22.750	19.003846

In [103]:
```
df.pivot_table(index=['sex','smoker'],columns=['day','time'],aggfunc={'size':'mean','tip':'max','total_bill':'sum'})
```

Out[103]:

		size						tip						total_bill			
	day	Thur		Fri		Sat	Sun	Thur		Fri		Sat	Sun	Thur		Fri	
	time	Lunch	Dinner	Lunch	Dinner	Dinner	Dinner	Lunch	Dinner	Lunch	Dinner	Dinner	Dinner	Lunch	Dinner	Lunch	Di
sex	smoker																
Male	Yes	2.300000	NaN	1.666667	2.4	2.629630	2.600000	5.00	NaN	2.20	4.73	10.00	6.5	191.71	0.00	34.16	12
	No	2.500000	NaN	NaN	2.0	2.656250	2.883721	6.70	NaN	NaN	3.50	9.00	6.0	369.73	0.00	0.00	3
Female	Yes	2.428571	NaN	2.000000	2.0	2.200000	2.500000	5.00	NaN	3.48	4.30	6.50	4.0	134.53	0.00	39.78	4
	No	2.500000	2.0	3.000000	2.0	2.307692	3.071429	5.17	3.0	3.00	3.25	4.67	5.2	381.58	18.78	15.98	2

In [106]:
```
# Margins.
df.pivot_table(index='sex',columns= 'smoker',values ='total_bill',aggfunc='sum',margins=True)
```

Out[106]:

smoker	Yes	No	All
sex			
Male	1337.07	1919.75	3256.82
Female	593.27	977.68	1570.95
All	1930.34	2897.43	4827.77

In [108]:
```
# Plotting Graphs.
expense= pd.read_csv("expense_data.csv")
```

In [110]:
```
expense.head(2)
```

Out[110]:

	Date	Account	Category	Subcategory	Note	INR	Income/Expense	Note.1	Amount	Currency	Account.1
0	3/2/2022 10:11	CUB - online payment	Food	NaN	Brownie	50.0	Expense	NaN	50.0	INR	50.0
1	3/2/2022 10:11	CUB - online payment	Other	NaN	To lended people	300.0	Expense	NaN	300.0	INR	300.0

In [115]:
```
# Categories
expense['Category'].value_counts()
```

Out[115]:
```
Food                156
Other                60
Transportation       31
Apparel               7
Household             6
Allowance             6
Social Life           5
Education             1
Salary                1
Self-development      1
Beauty                1
Gift                  1
Petty cash            1
Name: Category, dtype: int64
```

In [117]:
```
expense.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 277 entries, 0 to 276
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   Date            277 non-null    object 
 1   Account         277 non-null    object 
 2   Category        277 non-null    object 
 3   Subcategory     0 non-null      float64
 4   Note            273 non-null    object 
 5   INR             277 non-null    float64
 6   Income/Expense  277 non-null    object 
 7   Note.1          0 non-null      float64
 8   Amount          277 non-null    float64
 9   Currency        277 non-null    object 
 10  Account.1       277 non-null    float64
dtypes: float64(5), object(6)
memory usage: 23.9+ KB
```

In [119]:
```
# Converting integer to daytime format
expense['Date'] = pd.to_datetime(expense['Date'])
```

In [121]:
```
expense.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 277 entries, 0 to 276
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype         
---  ------          --------------  -----         
 0   Date            277 non-null    datetime64[ns]
 1   Account         277 non-null    object        
 2   Category        277 non-null    object        
 3   Subcategory     0 non-null      float64       
 4   Note            273 non-null    object        
 5   INR             277 non-null    float64       
 6   Income/Expense  277 non-null    object        
 7   Note.1          0 non-null      float64       
 8   Amount          277 non-null    float64       
 9   Currency        277 non-null    object        
 10  Account.1       277 non-null    float64       
dtypes: datetime64[ns](1), float64(5), object(5)
memory usage: 23.9+ KB
```

In [123]:
```
# Extracting month from the date column

expense['Date'].dt.month_name()
```

Out[123]:
```
0         March
1         March
2         March
3         March
4         March
         ...   
272    November
273    November
274    November
275    November
276    November
Name: Date, Length: 277, dtype: object
```

In [124]:
```
expense['month']= expense['Date'].dt.month_name()
```

In [125]:
```
expense.head(2)
```

Out[125]:

	Date	Account	Category	Subcategory	Note	INR	Income/Expense	Note.1	Amount	Currency	Account.1	month
0	2022-03-02 10:11:00	CUB - online payment	Food	NaN	Brownie	50.0	Expense	NaN	50.0	INR	50.0	March
1	2022-03-02 10:11:00	CUB - online payment	Other	NaN	To lended people	300.0	Expense	NaN	300.0	INR	300.0	March

In [126]:
```
# Using pivot table
expense.pivot_table(index ='month', columns='Category', values ='INR', aggfunc='sum')
```

Out[126]:

Category	Allowance	Apparel	Beauty	Education	Food	Gift	Household	Other	Petty cash	Salary	Self-development	Social Life	Transportation
month													
December	11000.0	2590.0	196.0	NaN	6440.72	NaN	4800.0	1790.0	NaN	NaN	400.0	513.72	914.0
February	NaN	798.0	NaN	NaN	5579.85	NaN	2808.0	20000.0	NaN	NaN	NaN	1800.00	5078.8
January	1000.0	NaN	NaN	1400.0	9112.51	NaN	4580.0	13178.0	NaN	8000.0	NaN	200.00	2850.0
March	NaN	NaN	NaN	NaN	195.00	NaN	NaN	900.0	NaN	NaN	NaN	NaN	30.0
November	2000.0	NaN	NaN	NaN	3174.40	115.0	NaN	2000.0	3.0	NaN	NaN	NaN	331.0

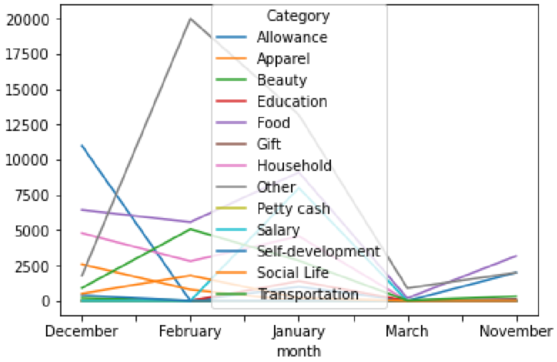
In [128]:
```
# fill values of NAN
expense.pivot_table(index ='month', columns='Category', values ='INR', aggfunc='sum',fill_value =0)
```

Out[128]:

Category	Allowance	Apparel	Beauty	Education	Food	Gift	Household	Other	Petty cash	Salary	Self-development	Social Life	Transportation
month													
December	11000	2590	196	0	6440.72	0	4800	1790	0	0	400	513.72	914.0
February	0	798	0	0	5579.85	0	2808	20000	0	0	0	1800.00	5078.8
January	1000	0	0	1400	9112.51	0	4580	13178	0	8000	0	200.00	2850.0
March	0	0	0	0	195.00	0	0	900	0	0	0	0.00	30.0
November	2000	0	0	0	3174.40	115	0	2000	3	0	0	0.00	331.0

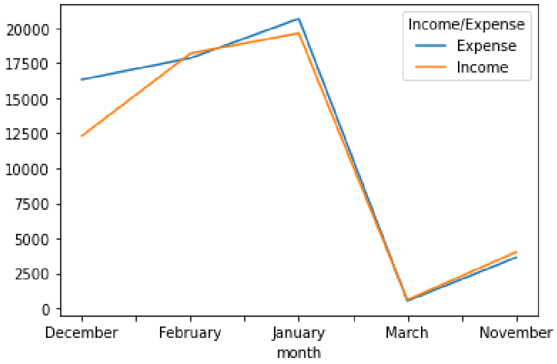
In [131]:
```
# plot
expense.pivot_table(index ='month', columns='Category', values ='INR', aggfunc='sum',fill_value =0).plot()
```

Out[131]:
```
<AxesSubplot:xlabel='month'>
```



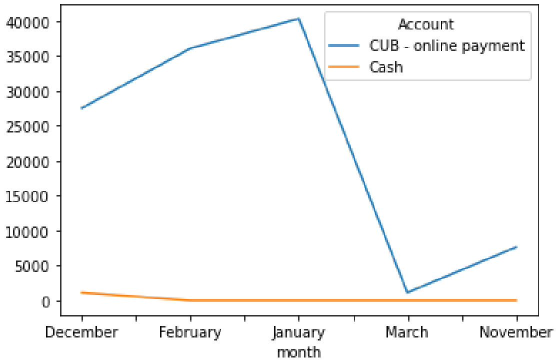
In [132]:
```
expense.pivot_table(index ='month', columns='Income/Expense', values ='INR', aggfunc='sum',fill_value =0).plot()
```

Out[132]:
```
<AxesSubplot:xlabel='month'>
```



```
In [133]: expense.pivot_table(index ='month', columns='Account', values ='INR', aggfunc='sum',fill_value =0).plot()
```

```
Out[133]: <AxesSubplot:xlabel='month'>
```



```
In [ ]:
```

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

What are vectorized operations

vectorized operations are a way to perform operations on entire arrays of data at once, which is faster than doing them one at a time.

In [2]:
```
a = np.array([1,2,3,4])
a * 4
```

Out[2]:
```
array([ 4,  8, 12, 16])
```

In [3]:
```
# problem in vectorized opertions in vanilla python
s = ['cat','mat',None,'rat']
[i.startswith('c') for i in s]
## Throws an error , because Startswith only works on strings
```

In [4]:
```
# How pandas solves this issue?

s = pd.Series(['cat','mat',None,'rat'])
s
```

Out[4]:
```
0     cat
1     mat
2    None
3     rat
dtype: object
```

here , **str = string accesor**

In [5]:
```
s.str.startswith('c') # Fast and optimized for larger datasets.
```

Out[5]:
```
0     True
1    False
2     None
3    False
dtype: object
```

In [6]:
```
# import titanic dataset
df =pd.read_csv("titanic.csv")
```

In [7]:
```
df.head(1)
```

Out[7]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Emba
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.25	NaN	

In [8]:
```
df['Name']
```

Out[8]:
```
0                                Braund, Mr. Owen Harris
1      Cumings, Mrs. John Bradley (Florence Briggs Th...
2                                 Heikkinen, Miss. Laina
3           Futrelle, Mrs. Jacques Heath (Lily May Peel)
4                               Allen, Mr. William Henry
                             ...
886                                Montvila, Rev. Juozas
887                         Graham, Miss. Margaret Edith
888             Johnston, Miss. Catherine Helen "Carrie"
889                                Behr, Mr. Karl Howell
890                                  Dooley, Mr. Patrick
Name: Name, Length: 891, dtype: object
```

Common Functions

lower/upper/capitalize/title

In [9]:
```
# Upper
df['Name'].str.upper() # converts into Capital Words
```

Out[9]:
```
0                                BRAUND, MR. OWEN HARRIS
1      CUMINGS, MRS. JOHN BRADLEY (FLORENCE BRIGGS TH...
2                                 HEIKKINEN, MISS. LAINA
3           FUTRELLE, MRS. JACQUES HEATH (LILY MAY PEEL)
4                               ALLEN, MR. WILLIAM HENRY
                             ...
886                                MONTVILA, REV. JUOZAS
887                         GRAHAM, MISS. MARGARET EDITH
888             JOHNSTON, MISS. CATHERINE HELEN "CARRIE"
889                                BEHR, MR. KARL HOWELL
890                                  DOOLEY, MR. PATRICK
Name: Name, Length: 891, dtype: object
```

In [10]:
```
# lower
df['Name'].str.lower() # converts into small Words
```

Out[10]:
```
0                                braund, mr. owen harris
1      cumings, mrs. john bradley (florence briggs th...
2                                 heikkinen, miss. laina
3           futrelle, mrs. jacques heath (lily may peel)
4                               allen, mr. william henry
                             ...                        
886                                montvila, rev. juozas
887                         graham, miss. margaret edith
888             johnston, miss. catherine helen "carrie"
889                                behr, mr. karl howell
890                                  dooley, mr. patrick
Name: Name, Length: 891, dtype: object
```

In [11]:
```
# title
df['Name'].str.title() # converts into starting Letter of Word to Capital
```

Out[11]:
```
0                                Braund, Mr. Owen Harris
1      Cumings, Mrs. John Bradley (Florence Briggs Th...
2                                 Heikkinen, Miss. Laina
3           Futrelle, Mrs. Jacques Heath (Lily May Peel)
4                               Allen, Mr. William Henry
                             ...                        
886                                Montvila, Rev. Juozas
887                         Graham, Miss. Margaret Edith
888             Johnston, Miss. Catherine Helen "Carrie"
889                                Behr, Mr. Karl Howell
890                                  Dooley, Mr. Patrick
Name: Name, Length: 891, dtype: object
```

In [12]:
```
# lets try to find the longest name In the passengers
df['Name'].str.len().max()
```

Out[12]:
```
82
```

In [13]:
```
df['Name'][df['Name'].str.len()== 82]
```

Out[13]:
```
307    Penasco y Castellana, Mrs. Victor de Satode (M...
Name: Name, dtype: object
```

In [14]:
```
df['Name'][df['Name'].str.len()== 82].values[0]
```

Out[14]:
```
'Penasco y Castellana, Mrs. Victor de Satode (Maria Josefa Perez de Soto y Va
llejo)'
```

strip

In [16]:
```
'           jack  '.strip()
```

Out[16]:
```
'jack'
```

In [17]:
```
df['Name'].str.strip() # removes spaces
```

Out[17]:
```
0                                Braund, Mr. Owen Harris
1      Cumings, Mrs. John Bradley (Florence Briggs Th...
2                                 Heikkinen, Miss. Laina
3           Futrelle, Mrs. Jacques Heath (Lily May Peel)
4                               Allen, Mr. William Henry
                             ...                        
886                                Montvila, Rev. Juozas
887                         Graham, Miss. Margaret Edith
888             Johnston, Miss. Catherine Helen "Carrie"
889                                Behr, Mr. Karl Howell
890                                  Dooley, Mr. Patrick
Name: Name, Length: 891, dtype: object
```

split

In [19]:
```
# split
df['Name'].str.split(',')
```

Out[19]:
```
0                             [Braund,  Mr. Owen Harris]
1      [Cumings,  Mrs. John Bradley (Florence Briggs ...
2                              [Heikkinen,  Miss. Laina]
3        [Futrelle,  Mrs. Jacques Heath (Lily May Peel)]
4                            [Allen,  Mr. William Henry]
                             ...                        
886                             [Montvila,  Rev. Juozas]
887                      [Graham,  Miss. Margaret Edith]
888          [Johnston,  Miss. Catherine Helen "Carrie"]
889                             [Behr,  Mr. Karl Howell]
890                               [Dooley,  Mr. Patrick]
Name: Name, Length: 891, dtype: object
```

In [21]:
```
# Split -> get
df['Name'].str.split(',').str.get(0)
```

Out[21]:
```
0         Braund
1        Cumings
2      Heikkinen
3       Futrelle
4          Allen
         ...    
886     Montvila
887       Graham
888     Johnston
889         Behr
890       Dooley
Name: Name, Length: 891, dtype: object
```

In [22]:
```
df['Name'].str.split(',').str.get(1)
```

Out[22]:
```
0                                   Mr. Owen Harris
1               Mrs. John Bradley (Florence Briggs Thayer)
2                                       Miss. Laina
3                   Mrs. Jacques Heath (Lily May Peel)
4                                 Mr. William Henry
                           ...
886                                     Rev. Juozas
887                            Miss. Margaret Edith
888                    Miss. Catherine Helen "Carrie"
889                                  Mr. Karl Howell
890                                      Mr. Patrick
Name: Name, Length: 891, dtype: object
```

In [23]:
```
df['last_name'] = df['Name'].str.split(',').str.get(0)
```

In [25]:
```
df.head(1)
```

Out[25]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Emba
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.25	NaN	

In [29]:
```
# it is used to split the Name column of the DataFrame df into two columns
# FirstName and LastName.

df['Name'].str.split(',').str.get(1).str.strip().str.split(' ',n=1, expand=Tru
```

Out[29]:

	0	1
0	Mr.	Owen Harris
1	Mrs.	John Bradley (Florence Briggs Thayer)
2	Miss.	Laina
3	Mrs.	Jacques Heath (Lily May Peel)
4	Mr.	William Henry
...	...	...
886	Rev.	Juozas
887	Miss.	Margaret Edith
888	Miss.	Catherine Helen "Carrie"
889	Mr.	Karl Howell
890	Mr.	Patrick

891 rows × 2 columns

In [30]:
```
df[['title','firstname']]= df['Name'].str.split(',').str.get(1).str.strip().st
```

In [31]:
```
df.head(1)
```

Out[31]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Emba
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.25	NaN	

In [33]:
```
# Number of titles
df['title'].value_counts()
```

Out[33]:
```
Mr.          517
Miss.        182
Mrs.         125
Master.       40
Dr.            7
Rev.           6
Mlle.          2
Major.         2
Col.           2
the            1
Capt.          1
Ms.            1
Sir.           1
Lady.          1
Mme.           1
Don.           1
Jonkheer.      1
Name: title, dtype: int64
```

replace

In [36]:
```
df['title'] = df['title'].str.replace('Ms.','Miss.')
df['title'] = df['title'].str.replace('Mlle.','Miss.')
```

```
C:\Users\user\AppData\Local\Temp/ipykernel_15952/1805277261.py:1: FutureWarni
ng: The default value of regex will change from True to False in a future ver
sion.
  df['title'] = df['title'].str.replace('Ms.','Miss.')
C:\Users\user\AppData\Local\Temp/ipykernel_15952/1805277261.py:2: FutureWarni
ng: The default value of regex will change from True to False in a future ver
sion.
  df['title'] = df['title'].str.replace('Mlle.','Miss.')
```

In [37]:

```
df['title'].value_counts()
```

Out[37]:

```
Mr.          517
Miss.        185
Mrs.         125
Master.       40
Dr.            7
Rev.           6
Major.         2
Col.           2
Don.           1
Mme.           1
Lady.          1
Sir.           1
Capt.          1
the            1
Jonkheer.      1
Name: title, dtype: int64
```

Filtering

In [38]:

```
# startswith/endswith
df[df['firstname'].str.startswith('A')]
```

Out[38]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare
13	14	0	3	Andersson, Mr. Anders Johan	male	39.0	1	5	347082	31.2750
22	23	1	3	McGowan, Miss. Anna "Annie"	female	15.0	0	0	330923	8.0292
35	36	0	1	Holverson, Mr. Alexander Oskar	male	42.0	1	0	113789	52.0000
38	39	0	3	Vander Planke, Miss. Augusta Maria	female	18.0	2	0	345764	18.0000
61	62	1	1	Icard, Miss. Amelie	female	38.0	0	0	113572	80.0000
...	...	...	...	...	...	...	...	...	...	...
842	843	1	1	Serepeca, Miss. Augusta	female	30.0	0	0	113798	31.0000
845	846	0	3	Abbing, Mr. Anthony	male	42.0	0	0	C.A. 5547	7.5500
866	867	1	2	Duran y More, Miss. Asuncion	female	27.0	1	0	SC/PARIS 2149	13.8583
875	876	1	3	Najib, Miss. Adele Kiamie "Jane"	female	15.0	0	0	2667	7.2250
876	877	0	3	Gustafsson, Mr. Alfred Ossian	male	20.0	0	0	7534	9.8458

95 rows × 15 columns

In [40]:
```
# endswith
df[df['firstname'].str.endswith('z')]
```

Out[40]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabi
69	70	0	3	Kink, Mr. Vincenz	male	26.0	2	0	315151	8.6625	Na
679	680	1	1	Cardeza, Mr. Thomas Drake Martinez	male	36.0	0	1	PC 17755	512.3292	B5 B5 B5
721	722	0	3	Jensen, Mr. Svend Lauritz	male	17.0	1	0	350048	7.0542	Na

In [41]:
```
# isdigit/isalpha...
df[df['firstname'].str.isdigit()]
```

Out[41]:

PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarke

regex

In [42]:
```
# applying regex
# contains
# search john -> both case
df[df['firstname'].str.contains('john',case=False)]
```

Out[42]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	7
41	42	0	2	Turpin, Mrs. William John Robert (Dorothy Ann ...	female	27.0	1	0	11668	2
45	46	0	3	Rogers, Mr. William John	male	NaN	0	0	S.C./A.4. 23567	
98	99	1	2	Doling, Mrs. John T (Ada Julia Bone)	female	34.0	0	1	231919	2

In [44]:

```
# find lastnames with start and end char vowel ( aeiou)
df[df['last_name'].str.contains('^[^aeiouAEIOU].+[^aeiouAEIOU]$')]
```

Out[44]:

	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250
5	6	0	3	Moran, Mr. James	male	NaN	0	0	330877	8.4583
6	7	0	1	McCarthy, Mr. Timothy J	male	54.0	0	0	17463	51.8625
...	...	...	...	...	...	...	...	...	...	...
884	885	0	3	Sutehall, Mr. Henry Jr	male	25.0	0	0	SOTON/OQ 392076	7.0500
887	888	1	1	Graham, Miss. Margaret Edith	female	19.0	0	0	112053	30.0000
888	889	0	3	Johnston, Miss. Catherine Helen "Carrie"	female	NaN	1	2	W./C. 6607	23.4500
889	890	1	1	Behr, Mr. Karl Howell	male	26.0	0	0	111369	30.0000
890	891	0	3	Dooley, Mr. Patrick	male	32.0	0	0	370376	7.7500

671 rows × 15 columns

slicing

In [45]:
```
df['Name'].str[:4] # first 4 characters
```

Out[45]:
```
0      Brau
1      Cumi
2      Heik
3      Futr
4      Alle
       ...
886    Mont
887    Grah
888    John
889    Behr
890    Dool
Name: Name, Length: 891, dtype: object
```

In [46]:
```
df['Name'].str[::2] # alternate characters
```

Out[46]:
```
0                    Ban,M.Oe ars
1      Cmns r.Jh rde Foec rgsTae)
2                     Hiknn is an
3          Ftel,Ms aqe et Ll a el
4                    Aln r ila er
                  ...
886                   Mnvl,Rv uzs
887                Gaa,Ms.Mrae dt
888          Jhso,Ms.CteieHln"are
889                   Bh,M.Kr oel
890                    Doe,M.Ptik
Name: Name, Length: 891, dtype: object
```

In [47]:
```
df['Name'].str[::-1] # reverse
```

Out[47]:
```
0                                sirraH newO .rM ,dnuarB
1      )reyahT sggirB ecnerolF( yeldarB nhoJ .srM ,sg...
2                                 aniaL .ssiM ,nenikkieH
3           )leeP yaM yliL( htaeH seuqcaJ .srM ,ellertuF
4                               yrneH mailliW .rM ,nellA
                             ...
886                                sazouJ .veR ,alivtnoM
887                         htidE teragraM .ssiM ,maharG
888             "eirraC" neleH enirehtaC .ssiM ,notsnhoJ
889                                llewoH lraK .rM ,rheB
890                                  kcirtaP .rM ,yelooD
Name: Name, Length: 891, dtype: object
```

In [ ]:
```

```

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

Timestamp Object

Time stamps reference particular moments in time (e.g., Oct 24th, 2022 at 7:00pm)

Vectorized date and time operations are a powerful tool for working with date and time data. They can be used to quickly and easily perform a wide variety of operations on date and time data.

Creating Timestamp objects

```
In [2]: # creating a timestamp
        pd.Timestamp('2023/05/12')
        # This time stamp contains year-month- Day ,hour-minute-Second

Out[2]: Timestamp('2023-05-12 00:00:00')
```

```
In [3]: # type
        type(pd.Timestamp('2023/05/12'))

Out[3]: pandas._libs.tslibs.timestamps.Timestamp
```

```
In [4]: # Variations
        pd.Timestamp('2023-05-12')

Out[4]: Timestamp('2023-05-12 00:00:00')
```

```
In [5]: pd.Timestamp('2023,05,12')

Out[5]: Timestamp('2023-12-01 00:00:00')
```

```
In [6]: pd.Timestamp('2023.05.12')

Out[6]: Timestamp('2023-05-12 00:00:00')
```

```
In [7]: # only year
        pd.Timestamp('2023') # It Automatically assigns First day of the year.

Out[7]: Timestamp('2023-01-01 00:00:00')
```

```
In [8]: # Using text
        pd.Timestamp('12th May 2023')

Out[8]: Timestamp('2023-05-12 00:00:00')
```

```
In [9]: # Provide time also
        pd.Timestamp('12th May 2023 4:40PM')

Out[9]: Timestamp('2023-05-12 16:40:00')
```

In [10]:

```
# using Python's datetime object
import datetime as dt

x = pd.Timestamp(dt.datetime(2023,5,12,4,42,56))
x
```

Out[10]:

```
Timestamp('2023-05-12 04:42:56')
```

In [12]:

```
# Fetching attributes
x.year
```

Out[12]:

```
2023
```

In [15]:

```
x.day
```

Out[15]:

```
12
```

In [17]:

```
x.time()
```

Out[17]:

```
datetime.time(4, 42, 56)
```

In [18]:

```
x.month
```

Out[18]:

```
5
```

why separate objects to handle data and time when python already has datetime functionality?

- syntax wise datetime is very convenient
- But the performance takes a hit while working with huge data. List vs Numpy Array
- The weaknesses of Python's datetime format inspired the NumPy team to add a set of native time series data type to NumPy.
- The datetime64 dtype encodes dates as 64-bit integers, and thus allows arrays of dates to be represented very compactly.

In [19]:

```
import numpy as np
date = np.array('2023-05-12', dtype=np.datetime64)
date
```

Out[19]:

```
array('2023-05-12', dtype='datetime64[D]')
```

In [21]:

```
# We can operate vector operations on Date.
date + np.arange(20)
```

Out[21]:

```
array(['2023-05-12', '2023-05-13', '2023-05-14', '2023-05-15',
       '2023-05-16', '2023-05-17', '2023-05-18', '2023-05-19',
       '2023-05-20', '2023-05-21', '2023-05-22', '2023-05-23',
       '2023-05-24', '2023-05-25', '2023-05-26', '2023-05-27',
       '2023-05-28', '2023-05-29', '2023-05-30', '2023-05-31'],
      dtype='datetime64[D]')
```

- Because of the uniform type in NumPy datetime64 arrays, this type of operation can be accomplished much more quickly than if we were working directly with Python's datetime objects, especially as arrays get large
- Pandas **Timestamp** object combines the ease-of-use of python datetime with the efficient storage and vectorized interface of numpy.datetime64
- From a group of these Timestamp objects, Pandas can construct a DatetimeIndex that can be used to index data in a Series or DataFrame

DatetimeIndex Object

A collection of pandas timestamp

In [22]:
```
# using strings
pd.DatetimeIndex(['2023/05/12','2023/01/01','2025/01/22'])
```

Out[22]:
```
DatetimeIndex(['2023-05-12', '2023-01-01', '2025-01-22'], dtype='datetime64[ns]', freq=None)
```

In [23]:
```
pd.DatetimeIndex(['2023/05/12','2023/01/01','2025/01/22'])[0]
```

Out[23]:
```
Timestamp('2023-05-12 00:00:00')
```

In [25]:
```
# type
type(pd.DatetimeIndex(['2023/05/12','2023/01/01','2025/01/22']))
```

Out[25]:
```
pandas.core.indexes.datetimes.DatetimeIndex
```

To store a **single date**, we use Timestamp.
And to store **multiple date** and time we use date time index.

In [26]:
```
# using python datetime object
pd.DatetimeIndex([dt.datetime(2023,5,12),dt.datetime(2023,1,1),dt.datetime(2025,1,1)])
```

Out[26]:
```
DatetimeIndex(['2023-05-12', '2023-01-01', '2025-01-01'], dtype='datetime64[ns]', freq=None)
```

In [27]:
```
# using pd.timestamps
dt_index = pd.DatetimeIndex([pd.Timestamp(2023,1,1),pd.Timestamp(2022,1,1),pd.Timestamp(2021,1,1)]
```

In [28]:
```
dt_index
```

Out[28]:
```
DatetimeIndex(['2023-01-01', '2022-01-01', '2021-01-01'], dtype='datetime64[ns]', freq=None)
```

In [29]:
```
# using datatimeindex as series index

pd.Series([1,2,3],index=dt_index)
```

Out[29]:
```
2023-01-01    1
2022-01-01    2
2021-01-01    3
dtype: int64
```

date_range function

In [33]:
```
# generate daily dates in a given range
pd.date_range(start='2023/5/12',end='2023/6/12',freq='D')
```

Out[33]:
```
DatetimeIndex(['2023-05-12', '2023-05-13', '2023-05-14', '2023-05-15',
               '2023-05-16', '2023-05-17', '2023-05-18', '2023-05-19',
               '2023-05-20', '2023-05-21', '2023-05-22', '2023-05-23',
               '2023-05-24', '2023-05-25', '2023-05-26', '2023-05-27',
               '2023-05-28', '2023-05-29', '2023-05-30', '2023-05-31',
               '2023-06-01', '2023-06-02', '2023-06-03', '2023-06-04',
               '2023-06-05', '2023-06-06', '2023-06-07', '2023-06-08',
               '2023-06-09', '2023-06-10', '2023-06-11', '2023-06-12'],
              dtype='datetime64[ns]', freq='D')
```

```
In [34]: # Alternate days
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='2D')

Out[34]: DatetimeIndex(['2023-05-12', '2023-05-14', '2023-05-16', '2023-05-18',
                        '2023-05-20', '2023-05-22', '2023-05-24', '2023-05-26',
                        '2023-05-28', '2023-05-30', '2023-06-01', '2023-06-03',
                        '2023-06-05', '2023-06-07', '2023-06-09', '2023-06-11'],
                       dtype='datetime64[ns]', freq='2D')
```

```
In [35]: # 2 days gap
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='3D')

Out[35]: DatetimeIndex(['2023-05-12', '2023-05-15', '2023-05-18', '2023-05-21',
                        '2023-05-24', '2023-05-27', '2023-05-30', '2023-06-02',
                        '2023-06-05', '2023-06-08', '2023-06-11'],
                       dtype='datetime64[ns]', freq='3D')
```

```
In [36]: # B -> business days (MON- FRI)
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='B')

Out[36]: DatetimeIndex(['2023-05-12', '2023-05-15', '2023-05-16', '2023-05-17',
                        '2023-05-18', '2023-05-19', '2023-05-22', '2023-05-23',
                        '2023-05-24', '2023-05-25', '2023-05-26', '2023-05-29',
                        '2023-05-30', '2023-05-31', '2023-06-01', '2023-06-02',
                        '2023-06-05', '2023-06-06', '2023-06-07', '2023-06-08',
                        '2023-06-09', '2023-06-12'],
                       dtype='datetime64[ns]', freq='B')
```

```
In [37]: # W -> one week per day (SUN)
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='w')

Out[37]: DatetimeIndex(['2023-05-14', '2023-05-21', '2023-05-28', '2023-06-04',
                        '2023-06-11'],
                       dtype='datetime64[ns]', freq='W-SUN')
```

```
In [38]: # if you want specific Day (THU)
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='w-THU')

Out[38]: DatetimeIndex(['2023-05-18', '2023-05-25', '2023-06-01', '2023-06-08'], dtype='datetime64[ns]', f
         req='W-THU')
```

```
In [39]: # H -> Hourly data(factor)
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='H')

Out[39]: DatetimeIndex(['2023-05-12 00:00:00', '2023-05-12 01:00:00',
                        '2023-05-12 02:00:00', '2023-05-12 03:00:00',
                        '2023-05-12 04:00:00', '2023-05-12 05:00:00',
                        '2023-05-12 06:00:00', '2023-05-12 07:00:00',
                        '2023-05-12 08:00:00', '2023-05-12 09:00:00',
                        ...
                        '2023-06-11 15:00:00', '2023-06-11 16:00:00',
                        '2023-06-11 17:00:00', '2023-06-11 18:00:00',
                        '2023-06-11 19:00:00', '2023-06-11 20:00:00',
                        '2023-06-11 21:00:00', '2023-06-11 22:00:00',
                        '2023-06-11 23:00:00', '2023-06-12 00:00:00'],
                       dtype='datetime64[ns]', length=745, freq='H')
```

```
In [41]: # For every six hours
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='6H')
```

```
Out[41]: DatetimeIndex(['2023-05-12 00:00:00', '2023-05-12 06:00:00',
                        '2023-05-12 12:00:00', '2023-05-12 18:00:00',
                        '2023-05-13 00:00:00', '2023-05-13 06:00:00',
                        '2023-05-13 12:00:00', '2023-05-13 18:00:00',
                        '2023-05-14 00:00:00', '2023-05-14 06:00:00',
                        ...
                        '2023-06-09 18:00:00', '2023-06-10 00:00:00',
                        '2023-06-10 06:00:00', '2023-06-10 12:00:00',
                        '2023-06-10 18:00:00', '2023-06-11 00:00:00',
                        '2023-06-11 06:00:00', '2023-06-11 12:00:00',
                        '2023-06-11 18:00:00', '2023-06-12 00:00:00'],
                       dtype='datetime64[ns]', length=125, freq='6H')
```

```
In [42]: # M -> Month end
         pd.date_range(start='2023/5/12',end='2023/6/12',freq='M')
```

```
Out[42]: DatetimeIndex(['2023-05-31'], dtype='datetime64[ns]', freq='M')
```

```
In [47]: # MS -> Month start
         pd.date_range(start='2023/5/12',end='2028/6/12',freq='MS')
```

```
Out[47]: DatetimeIndex(['2023-06-01', '2023-07-01', '2023-08-01', '2023-09-01',
                        '2023-10-01', '2023-11-01', '2023-12-01', '2024-01-01',
                        '2024-02-01', '2024-03-01', '2024-04-01', '2024-05-01',
                        '2024-06-01', '2024-07-01', '2024-08-01', '2024-09-01',
                        '2024-10-01', '2024-11-01', '2024-12-01', '2025-01-01',
                        '2025-02-01', '2025-03-01', '2025-04-01', '2025-05-01',
                        '2025-06-01', '2025-07-01', '2025-08-01', '2025-09-01',
                        '2025-10-01', '2025-11-01', '2025-12-01', '2026-01-01',
                        '2026-02-01', '2026-03-01', '2026-04-01', '2026-05-01',
                        '2026-06-01', '2026-07-01', '2026-08-01', '2026-09-01',
                        '2026-10-01', '2026-11-01', '2026-12-01', '2027-01-01',
                        '2027-02-01', '2027-03-01', '2027-04-01', '2027-05-01',
                        '2027-06-01', '2027-07-01', '2027-08-01', '2027-09-01',
                        '2027-10-01', '2027-11-01', '2027-12-01', '2028-01-01',
                        '2028-02-01', '2028-03-01', '2028-04-01', '2028-05-01',
                        '2028-06-01'],
                       dtype='datetime64[ns]', freq='MS')
```

```
In [46]: # A -> Year end
         pd.date_range(start='2023/5/12',end='2030/6/12',freq='A')
```

```
Out[46]: DatetimeIndex(['2023-12-31', '2024-12-31', '2025-12-31', '2026-12-31',
                        '2027-12-31', '2028-12-31', '2029-12-31'],
                       dtype='datetime64[ns]', freq='A-DEC')
```

```
In [49]: # using periods(number of results)
         pd.date_range(start='2023/5/12',periods =30,freq='D')
```

```
Out[49]: DatetimeIndex(['2023-05-12', '2023-05-13', '2023-05-14', '2023-05-15',
                        '2023-05-16', '2023-05-17', '2023-05-18', '2023-05-19',
                        '2023-05-20', '2023-05-21', '2023-05-22', '2023-05-23',
                        '2023-05-24', '2023-05-25', '2023-05-26', '2023-05-27',
                        '2023-05-28', '2023-05-29', '2023-05-30', '2023-05-31',
                        '2023-06-01', '2023-06-02', '2023-06-03', '2023-06-04',
                        '2023-06-05', '2023-06-06', '2023-06-07', '2023-06-08',
                        '2023-06-09', '2023-06-10'],
                       dtype='datetime64[ns]', freq='D')
```

In [50]:

```
# Hour (using periods)
pd.date_range(start='2023/5/12',periods =30,freq='H')
```

Out[50]:

```
DatetimeIndex(['2023-05-12 00:00:00', '2023-05-12 01:00:00',
               '2023-05-12 02:00:00', '2023-05-12 03:00:00',
               '2023-05-12 04:00:00', '2023-05-12 05:00:00',
               '2023-05-12 06:00:00', '2023-05-12 07:00:00',
               '2023-05-12 08:00:00', '2023-05-12 09:00:00',
               '2023-05-12 10:00:00', '2023-05-12 11:00:00',
               '2023-05-12 12:00:00', '2023-05-12 13:00:00',
               '2023-05-12 14:00:00', '2023-05-12 15:00:00',
               '2023-05-12 16:00:00', '2023-05-12 17:00:00',
               '2023-05-12 18:00:00', '2023-05-12 19:00:00',
               '2023-05-12 20:00:00', '2023-05-12 21:00:00',
               '2023-05-12 22:00:00', '2023-05-12 23:00:00',
               '2023-05-13 00:00:00', '2023-05-13 01:00:00',
               '2023-05-13 02:00:00', '2023-05-13 03:00:00',
               '2023-05-13 04:00:00', '2023-05-13 05:00:00'],
              dtype='datetime64[ns]', freq='H')
```

In [51]:

```
# 6 Hours (using periods)
pd.date_range(start='2023/5/12',periods =30,freq='6H')
```

Out[51]:

```
DatetimeIndex(['2023-05-12 00:00:00', '2023-05-12 06:00:00',
               '2023-05-12 12:00:00', '2023-05-12 18:00:00',
               '2023-05-13 00:00:00', '2023-05-13 06:00:00',
               '2023-05-13 12:00:00', '2023-05-13 18:00:00',
               '2023-05-14 00:00:00', '2023-05-14 06:00:00',
               '2023-05-14 12:00:00', '2023-05-14 18:00:00',
               '2023-05-15 00:00:00', '2023-05-15 06:00:00',
               '2023-05-15 12:00:00', '2023-05-15 18:00:00',
               '2023-05-16 00:00:00', '2023-05-16 06:00:00',
               '2023-05-16 12:00:00', '2023-05-16 18:00:00',
               '2023-05-17 00:00:00', '2023-05-17 06:00:00',
               '2023-05-17 12:00:00', '2023-05-17 18:00:00',
               '2023-05-18 00:00:00', '2023-05-18 06:00:00',
               '2023-05-18 12:00:00', '2023-05-18 18:00:00',
               '2023-05-19 00:00:00', '2023-05-19 06:00:00'],
              dtype='datetime64[ns]', freq='6H')
```

In [52]:

```
# Month (using periods)
pd.date_range(start='2023/5/12',periods =30,freq='M')
```

Out[52]:

```
DatetimeIndex(['2023-05-31', '2023-06-30', '2023-07-31', '2023-08-31',
               '2023-09-30', '2023-10-31', '2023-11-30', '2023-12-31',
               '2024-01-31', '2024-02-29', '2024-03-31', '2024-04-30',
               '2024-05-31', '2024-06-30', '2024-07-31', '2024-08-31',
               '2024-09-30', '2024-10-31', '2024-11-30', '2024-12-31',
               '2025-01-31', '2025-02-28', '2025-03-31', '2025-04-30',
               '2025-05-31', '2025-06-30', '2025-07-31', '2025-08-31',
               '2025-09-30', '2025-10-31'],
              dtype='datetime64[ns]', freq='M')
```

to_datetime function

converts an existing objects to pandas timestamp/datetimeindex object

In [59]:

```
# simple series example
s = pd.Series(['2023/5/12','2022/1/1','2021/2/1'])
pd.to_datetime(s).dt.year # converting string to datetime
```

Out[59]:

```
0    2023
1    2022
2    2021
dtype: int64
```

In [60]:

```
pd.to_datetime(s).dt.day
```

Out[60]:

```
0    12
1     1
2     1
dtype: int64
```

In [61]:

```
pd.to_datetime(s).dt.day_name()
```

Out[61]:

```
0      Friday
1    Saturday
2      Monday
dtype: object
```

In [62]:

```
pd.to_datetime(s).dt.month_name()
```

Out[62]:

```
0         May
1     January
2    February
dtype: object
```

In [63]:

```
# with errors -> coerce

s = pd.Series(['2023/1/1','2022/1/1','2021/130/1'])
pd.to_datetime(s,errors='coerce') #NaT = Not a Time
```

Out[63]:

```
0   2023-01-01
1   2022-01-01
2          NaT
dtype: datetime64[ns]
```

In [64]:

```
pd.to_datetime(s,errors='coerce').dt.year
```

Out[64]:

```
0    2023.0
1    2022.0
2       NaN
dtype: float64
```

In [65]:

```
pd.to_datetime(s,errors='coerce').dt.month_name()
```

Out[65]:

```
0    January
1    January
2        NaN
dtype: object
```

Real World example

In [66]:

```
df = pd.read_csv("expense_data.csv")
```

In [69]:

```
df.head()
```

Out[69]:

	Date	Account	Category	Subcategory	Note	INR	Income/Expense	Note.1	Amount	Currency	Account.1
0	3/2/2022 10:11	CUB - online payment	Food	NaN	Brownie	50.0	Expense	NaN	50.0	INR	50.0
1	3/2/2022 10:11	CUB - online payment	Other	NaN	To lended people	300.0	Expense	NaN	300.0	INR	300.0
2	3/1/2022 19:50	CUB - online payment	Food	NaN	Dinner	78.0	Expense	NaN	78.0	INR	78.0
3	3/1/2022 18:56	CUB - online payment	Transportation	NaN	Metro	30.0	Expense	NaN	30.0	INR	30.0
4	3/1/2022 18:22	CUB - online payment	Food	NaN	Snacks	67.0	Expense	NaN	67.0	INR	67.0

In [70]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 277 entries, 0 to 276
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   Date            277 non-null    object 
 1   Account         277 non-null    object 
 2   Category        277 non-null    object 
 3   Subcategory     0 non-null      float64
 4   Note            273 non-null    object 
 5   INR             277 non-null    float64
 6   Income/Expense  277 non-null    object 
 7   Note.1          0 non-null      float64
 8   Amount          277 non-null    float64
 9   Currency        277 non-null    object 
 10  Account.1       277 non-null    float64
dtypes: float64(5), object(6)
memory usage: 23.9+ KB
```

In [72]:

```
# converting object to date time type
df['Date'] = pd.to_datetime(df['Date'])
```

In [73]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 277 entries, 0 to 276
Data columns (total 11 columns):
 #   Column          Non-Null Count  Dtype         
---  ------          --------------  -----         
 0   Date            277 non-null    datetime64[ns]
 1   Account         277 non-null    object        
 2   Category        277 non-null    object        
 3   Subcategory     0 non-null      float64       
 4   Note            273 non-null    object        
 5   INR             277 non-null    float64       
 6   Income/Expense  277 non-null    object        
 7   Note.1          0 non-null      float64       
 8   Amount          277 non-null    float64       
 9   Currency        277 non-null    object        
 10  Account.1       277 non-null    float64       
dtypes: datetime64[ns](1), float64(5), object(5)
memory usage: 23.9+ KB
```

dt accessor

Accessor object for datetimelike properties of the Series values.

In [75]:
```
df['Date'].dt.year
```

Out[75]:
```
0      2022
1      2022
2      2022
3      2022
4      2022
       ... 
272    2021
273    2021
274    2021
275    2021
276    2021
Name: Date, Length: 277, dtype: int64
```

In [76]:
```
df['Date'].dt.month
```

Out[76]:
```
0       3
1       3
2       3
3       3
4       3
       ..
272    11
273    11
274    11
275    11
276    11
Name: Date, Length: 277, dtype: int64
```

In [77]:
```
df['Date'].dt.month_name()
```

Out[77]:
```
0         March
1         March
2         March
3         March
4         March
         ...   
272    November
273    November
274    November
275    November
276    November
Name: Date, Length: 277, dtype: object
```

In [80]:
```
df['Date'].dt.day_name()
```

Out[80]:
```
0      Wednesday
1      Wednesday
2        Tuesday
3        Tuesday
4        Tuesday
         ...    
272       Monday
273       Monday
274       Sunday
275       Sunday
276       Sunday
Name: Date, Length: 277, dtype: object
```

In [86]:
```
df['Date'].dt.is_month_end
```

Out[86]:
```
0      False
1      False
2      False
3      False
4      False
       ...  
272    False
273    False
274    False
275    False
276    False
Name: Date, Length: 277, dtype: bool
```

In [87]:
```
df['Date'].dt.is_year_end
```

Out[87]:
```
0      False
1      False
2      False
3      False
4      False
       ...  
272    False
273    False
274    False
275    False
276    False
Name: Date, Length: 277, dtype: bool
```

In [90]:
```
df['Date'].dt.is_quarter_end
```

Out[90]:
```
0      False
1      False
2      False
3      False
4      False
       ...  
272    False
273    False
274    False
275    False
276    False
Name: Date, Length: 277, dtype: bool
```

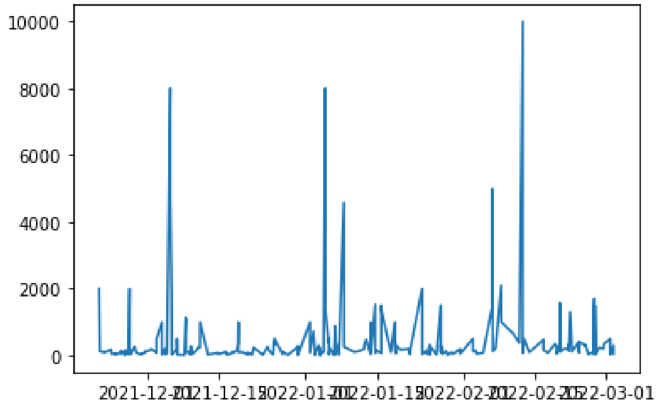
In [91]:
```
df['Date'].dt.is_quarter_start
```

Out[91]:
```
0      False
1      False
2      False
3      False
4      False
       ...  
272    False
273    False
274    False
275    False
276    False
Name: Date, Length: 277, dtype: bool
```

In [94]:
```
## Plot Graph
import matplotlib.pyplot as plt
```

In [95]:
```
plt.plot(df['Date'],df['INR'])
```

Out[95]:
```
[<matplotlib.lines.Line2D at 0x18193cb1790>]
```



In [96]:
```
# Money spent day name wise (bar chart)
df['day_name'] = df['Date'].dt.day_name()
```

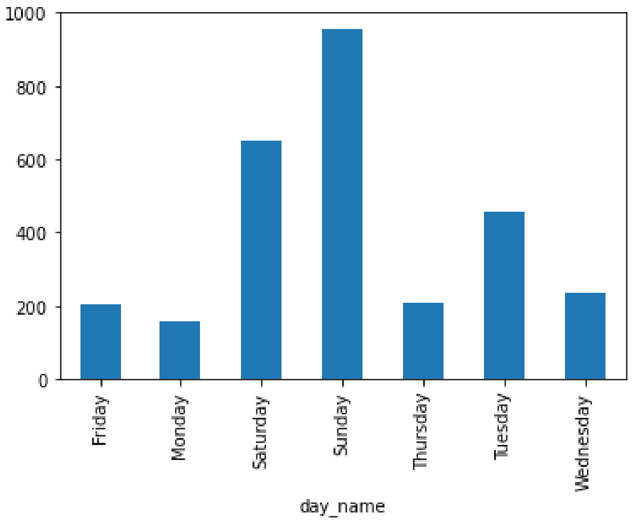
In [97]:
```
df.head()
```

Out[97]:

	Date	Account	Category	Subcategory	Note	INR	Income/Expense	Note.1	Amount	Currency	Account.1
0	2022-03-02 10:11:00	CUB - online payment	Food	NaN	Brownie	50.0	Expense	NaN	50.0	INR	50.0
1	2022-03-02 10:11:00	CUB - online payment	Other	NaN	To lended people	300.0	Expense	NaN	300.0	INR	300.0
2	2022-03-01 19:50:00	CUB - online payment	Food	NaN	Dinner	78.0	Expense	NaN	78.0	INR	78.0
3	2022-03-01 18:56:00	CUB - online payment	Transportation	NaN	Metro	30.0	Expense	NaN	30.0	INR	30.0
4	2022-03-01 18:22:00	CUB - online payment	Food	NaN	Snacks	67.0	Expense	NaN	67.0	INR	67.0

In [99]:
```
df.groupby('day_name')['INR'].mean().plot(kind='bar')
```

Out[99]:
```
<AxesSubplot:xlabel='day_name'>
```



In [100]:
```
# Money spent month name wise (pie chart)
df['month_name'] = df['Date'].dt.month_name()
```

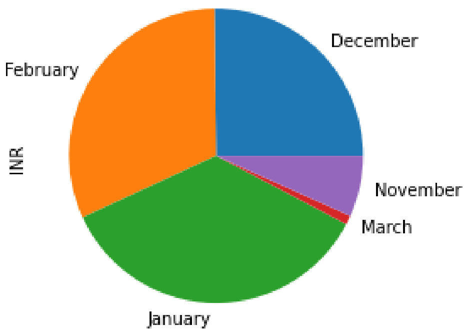
In [101]:
```
df.head()
```

Out[101]:

	Date	Account	Category	Subcategory	Note	INR	Income/Expense	Note.1	Amount	Currency	Account.1
0	2022-03-02 10:11:00	CUB - online payment	Food	NaN	Brownie	50.0	Expense	NaN	50.0	INR	50.0
1	2022-03-02 10:11:00	CUB - online payment	Other	NaN	To lended people	300.0	Expense	NaN	300.0	INR	300.0
2	2022-03-01 19:50:00	CUB - online payment	Food	NaN	Dinner	78.0	Expense	NaN	78.0	INR	78.0
3	2022-03-01 18:56:00	CUB - online payment	Transportation	NaN	Metro	30.0	Expense	NaN	30.0	INR	30.0
4	2022-03-01 18:22:00	CUB - online payment	Food	NaN	Snacks	67.0	Expense	NaN	67.0	INR	67.0

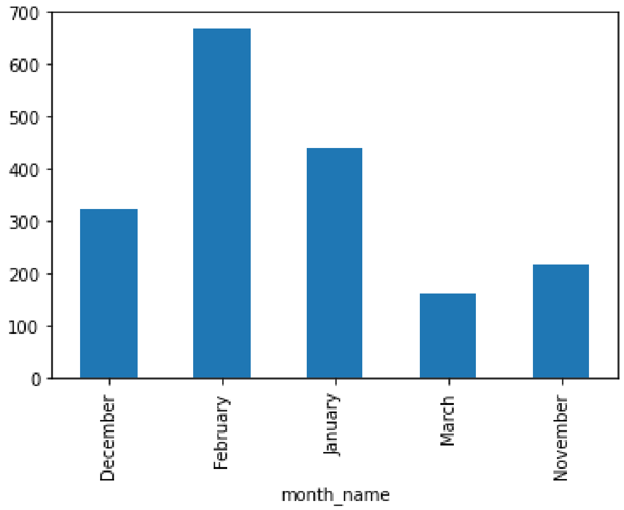
In [102]:
```
df.groupby('month_name')['INR'].sum().plot(kind = 'pie')
```

Out[102]:
```
<AxesSubplot:ylabel='INR'>
```



In [109]:
```
# Average
df.groupby('month_name')['INR'].mean().plot(kind ='bar')
```

Out[109]:
```
<AxesSubplot:xlabel='month_name'>
```


December
February
January
March
November
month_name