Working with Missing Data in Pandas

Difficulty Level : Easy Last Updated : 20 May, 2021

Missing Data can occur when no information is provided for one or more items or for a whole unit. Missing Data is a very big problem in a real-life scenarios. Missing Data can also refer to as `NA`(Not Available) values in pandas. In DataFrame sometimes many datasets simply arrive with missing data, either because it exists and was not collected or it never existed. For Example, Suppose different users being surveyed may choose not to share their income, some users may choose not to share the address in this way many datasets went missing.

In Pandas missing data is represented by two value:

- None: None is a Python singleton object that is often used for missing data in Python code.
- NaN : NaN (an acronym for Not a Number), is a special floating-point value recognized by all systems that use the standard IEEE floating-point representation

Pandas treat `None` and `NaN` as essentially interchangeable for indicating missing or null values. To facilitate this convention, there are several useful functions for detecting, removing, and replacing null values in Pandas DataFrame :

- isnull()
- notnull()
- dropna()
- fillna()

- fillna()
- replace()
- interpolate()

In this article we are using CSV file, to download the CSV file used, Click Here.

Checking for missing values using `isnull()` and `notnull()`

In order to check missing values in Pandas DataFrame, we use a function `isnull()` and `notnull()`. Both function help in checking whether a value is `NaN` or not. These function can also be used in Pandas Series in order to find null values in a series.

Checking for missing values using `isnull()`

In order to check null values in Pandas DataFrame, we use `isnull()` function this function return dataframe of Boolean values which are True for NaN values.

Code #1:

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, 45, 56, np.nan],
        'Third Score':[np.nan, 40, 80, 98]}

# creating a dataframe from list
df = pd.DataFrame(dict)

# using isnull() function
df.isnull()
```

Output:

	First Score	Second Score	Third Score
0	False	False	True
1	False	False	False
2	True	False	False
3	False	True	False

Code #2:

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# creating bool series True for NaN values
bool_series = pd.isnull(data["Gender"])

# filtering data
# displaying data only with Gender = NaN
data[bool_series]
```

Output:

As shown in the output image, only the rows having `Gender = NULL` are displayed.

	First Name	Gender	Start Date	Last Login Time	Salary	Bonus %	Senior Management	Team
20	Lois	NaN	4/22/1995	7:18 PM	64714	4.934	True	Legal
22	Joshua	NaN	3/8/2012	1:58 AM	90816	18.816	True	Client Services
27	Scott	NaN	7/11/1991	6:58 PM	122367	5.218	False	Legal
31	Joyce	NaN	2/20/2005	2:40 PM	88657	12.752	False	Product
41	Christine	NaN	6/28/2015	1:08 AM	66582	11.308	True	Business Development
49	Chris	NaN	1/24/1980	12:13 PM	113590	3.055	False	Sales
51	NaN	NaN	12/17/2011	8:29 AM	41126	14.009	NaN	Sales
53	Alan	NaN	3/3/2014	1:28 PM	40341	17.578	True	Finance
60	Paula	NaN	11/23/2005	2:01 PM	48866	4.271	False	Distribution
64	Kathleen	NaN	4/11/1990	6:46 PM	77834	18.771	False	Business Development
69	Irene	NaN	7/14/2015	4:31 PM	100863	4.382	True	Finance
70	Todd	NaN	6/10/2003	2:26 PM	84692	6.617	False	Client Services
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
939	Ralph	NaN	7/28/1995	6:53 PM	70635	2.147	False	Client Services
945	Gerald	NaN	4/15/1989	12:44 PM	93712	17.426	True	Distribution
961	Antonio	NaN	6/18/1989	9:37 PM	103050	3.050	False	Legal
972	Victor	NaN	7/28/2006	2:49 PM	76381	11.159	True	Sales
985	Stephen	NaN	7/10/1983	8:10 PM	85668	1.909	False	Legal
989	Justin	NaN	2/10/1991	4:58 PM	38344	3.794	False	Legal
995	Henry	NaN	11/23/2014	6:09 AM	132483	16.655	False	Distribution

145 rows × 8 columns

Checking for missing values using `notnull()`

In order to check null values in Pandas Dataframe, we use notnull() function this function return dataframe of Boolean values which are False for NaN values.

Code #3:

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, 45, 56, np.nan],
        'Third Score':[np.nan, 40, 80, 98]}

# creating a dataframe using dictionary
df = pd.DataFrame(dict)

# using notnull() function
df.notnull()
```

Output:

	First Score	Second Score	Third Score
0	True	True	False
1	True	True	True
2	False	True	True
3	True	False	True

Code #4:

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# creating bool series True for NaN values
bool_series = pd.notnull(data["Gender"])

# filtering data
# displayind data only with Gender = Not NaN
data[bool_series]
```

Output:

As shown in the output image, only the rows having `Gender = NOT NULL` are displayed.

	First Name	Gender	Start Date	Last Login Time	Salary	Bonus %	Senior Management	Team
0	Douglas	Male	8/6/1993	12:42 PM	97308	6.945	True	Marketing
1	Thomas	Male	3/31/1996	6:53 AM	61933	4.170	True	NaN
2	Maria	Female	4/23/1993	11:17 AM	130590	11.858	False	Finance
3	Jerry	Male	3/4/2005	1:00 PM	138705	9.340	True	Finance
4	Larry	Male	1/24/1998	4:47 PM	101004	1.389	True	Client Services
5	Dennis	Male	4/18/1987	1:35 AM	115163	10.125	False	Legal
6	Ruby	Female	8/17/1987	4:20 PM	65476	10.012	True	Product
7	NaN	Female	7/20/2015	10:43 AM	45906	11.598	NaN	Finance
8	Angela	Female	11/22/2005	6:29 AM	95570	18.523	True	Engineering
9	Frances	Female	8/8/2002	6:51 AM	139852	7.524	True	Business Development
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
994	George	Male	6/21/2013	5:47 PM	98874	4.479	True	Marketing
996	Phillip	Male	1/31/1984	6:30 AM	42392	19.675	False	Finance
997	Russell	Male	5/20/2013	12:39 PM	96914	1.421	False	Product
998	Larry	Male	4/20/2013	4:45 PM	60500	11.985	False	Business Development
999	Albert	Male	5/15/2012	6:24 PM	129949	10.169	True	Sales

855 rows × 8 columns

Filling missing values using `fillna()`, `replace()` and `interpolate()`

In order to fill null values in a datasets, we use `fillna()`, `replace()` and `interpolate()` function these function replace NaN values with some value of their own. All these function help in filling a null values in datasets of a DataFrame. Interpolate() function is basically used to fill `NA` values in the dataframe but it uses various interpolation technique to fill the missing values rather than hard-coding the value.

Code #1: Filling null values with a single value

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, 45, 56, np.nan],
        'Third Score':[np.nan, 40, 80, 98]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

# filling missing value using fillna()
df.fillna(0)
```

Output:

	First Score	Second Score	Third Score
0	100.0	30.0	0.0
1	90.0	45.0	40.0
2	0.0	56.0	80.0
3	95.0	0.0	98.0

Code #2: Filling null values with the previous ones

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
```

```
        'Second Score': [30, 45, 56, np.nan],
        'Third Score':[np.nan, 40, 80, 98]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

# filling a missing value with
# previous ones
df.fillna(method ='pad')
```

Output:

	First Score	Second Score	Third Score
0	100.0	30.0	NaN
1	90.0	45.0	40.0
2	90.0	56.0	80.0
3	95.0	56.0	98.0

Code #3: Filling null value with the next ones

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, 45, 56, np.nan],
        'Third Score':[np.nan, 40, 80, 98]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

# filling  null value using fillna() function
df.fillna(method ='bfill')
```

Output:

	First Score	Second Score	Third Score
0	100.0	30.0	40.0
1	90.0	45.0	40.0
2	95.0	56.0	80.0
3	95.0	NaN	98.0

Code #4: Filling null values in CSV File

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# Printing the first 10 to 24 rows of
# the data frame for visualization
data[10:25]
```

	First Name	Gender	Start Date	Last Login Time	Salary	Bonus %	Senior Management	Team
10	Louise	Female	8/12/1980	9:01 AM	63241	15.132	True	NaN
11	Julie	Female	10/26/1997	3:19 PM	102508	12.637	True	Legal
12	Brandon	Male	12/1/1980	1:08 AM	112807	17.492	True	Human Resources
13	Gary	Male	1/27/2008	11:40 PM	109831	5.831	False	Sales
14	Kimberly	Female	1/14/1999	7:13 AM	41426	14.543	True	Finance
15	Lillian	Female	6/5/2016	6:09 AM	59414	1.256	False	Product
16	Jeremy	Male	9/21/2010	5:56 AM	90370	7.369	False	Human Resources
17	Shawn	Male	12/7/1986	7:45 PM	111737	6.414	False	Product
18	Diana	Female	10/23/1981	10:27 AM	132940	19.082	False	Client Services
19	Donna	Female	7/22/2010	3:48 AM	81014	1.894	False	Product
20	Lois	NaN	4/22/1995	7:18 PM	64714	4.934	True	Legal
21	Matthew	Male	9/5/1995	2:12 AM	100612	13.645	False	Marketing
22	Joshua	NaN	3/8/2012	1:58 AM	90816	18.816	True	Client Services
23	NaN	Male	6/14/2012	4:19 PM	125792	5.042	NaN	NaN
24	John	Male	7/1/1992	10:08 PM	97950	13.873	False	Client Services

Now we are going to fill all the null values in Gender column with “No Gender”

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# filling a null values using fillna()
data["Gender"].fillna("No Gender", inplace = True)

data
```

Output:

10	Louise	Female	8/12/1980	9:01 AM	63241	15.132	True	NaN
11	Julie	Female	10/26/1997	3:19 PM	102508	12.637	True	Legal
12	Brandon	Male	12/1/1980	1:08 AM	112807	17.492	True	Human Resources
13	Gary	Male	1/27/2008	11:40 PM	109831	5.831	False	Sales
14	Kimberly	Female	1/14/1999	7:13 AM	41426	14.543	True	Finance
15	Lillian	Female	6/5/2016	6:09 AM	59414	1.256	False	Product
16	Jeremy	Male	9/21/2010	5:56 AM	90370	7.369	False	Human Resources
17	Shawn	Male	12/7/1986	7:45 PM	111737	6.414	False	Product
18	Diana	Female	10/23/1981	10:27 AM	132940	19.082	False	Client Services
19	Donna	Female	7/22/2010	3:48 AM	81014	1.894	False	Product
20	Lois	No Gender	4/22/1995	7:18 PM	64714	4.934	True	Legal
21	Matthew	Male	9/5/1995	2:12 AM	100612	13.645	False	Marketing
22	Joshua	No Gender	3/8/2012	1:58 AM	90816	18.816	True	Client Services
23	NaN	Male	6/14/2012	4:19 PM	125792	5.042	NaN	NaN
24	John	Male	7/1/1992	10:08 PM	97950	13.873	False	Client Services

Code #5: Filling a null values using replace() method

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# Printing the first 10 to 24 rows of
# the data frame for visualization
data[10:25]
```

Output:

	First Name	Gender	Start Date	Last Login Time	Salary	Bonus %	Senior Management	Team
10	Louise	Female	8/12/1980	9:01 AM	63241	15.132	True	NaN
11	Julie	Female	10/26/1997	3:19 PM	102508	12.637	True	Legal
12	Brandon	Male	12/1/1980	1:08 AM	112807	17.492	True	Human Resources
13	Gary	Male	1/27/2008	11:40 PM	109831	5.831	False	Sales
14	Kimberly	Female	1/14/1999	7:13 AM	41426	14.543	True	Finance
15	Lillian	Female	6/5/2016	6:09 AM	59414	1.256	False	Product
16	Jeremy	Male	9/21/2010	5:56 AM	90370	7.369	False	Human Resources
17	Shawn	Male	12/7/1986	7:45 PM	111737	6.414	False	Product
18	Diana	Female	10/23/1981	10:27 AM	132940	19.082	False	Client Services
19	Donna	Female	7/22/2010	3:48 AM	81014	1.894	False	Product
20	Lois	NaN	4/22/1995	7:18 PM	64714	4.934	True	Legal
21	Matthew	Male	9/5/1995	2:12 AM	100612	13.645	False	Marketing
22	Joshua	NaN	3/8/2012	1:58 AM	90816	18.816	True	Client Services
23	NaN	Male	6/14/2012	4:19 PM	125792	5.042	NaN	NaN

Now we are going to replace the all Nan value in the data frame with -99 value.

```
# importing pandas package
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")

# will replace  Nan value in dataframe with value -99
data.replace(to_replace = np.nan, value = -99)
```

Output:

10	Louise	Female	8/12/1980	9:01 AM	63241	15.132	True	-99
11	Julie	Female	10/26/1997	3:19 PM	102508	12.637	True	Legal
12	Brandon	Male	12/1/1980	1:08 AM	112807	17.492	True	Human Resources
13	Gary	Male	1/27/2008	11:40 PM	109831	5.831	False	Sales
14	Kimberly	Female	1/14/1999	7:13 AM	41426	14.543	True	Finance
15	Lillian	Female	6/5/2016	6:09 AM	59414	1.256	False	Product
16	Jeremy	Male	9/21/2010	5:56 AM	90370	7.369	False	Human Resources
17	Shawn	Male	12/7/1986	7:45 PM	111737	6.414	False	Product
18	Diana	Female	10/23/1981	10:27 AM	132940	19.082	False	Client Services
19	Donna	Female	7/22/2010	3:48 AM	81014	1.894	False	Product
20	Lois	-99	4/22/1995	7:18 PM	64714	4.934	True	Legal
21	Matthew	Male	9/5/1995	2:12 AM	100612	13.645	False	Marketing
22	Joshua	-99	3/8/2012	1:58 AM	90816	18.816	True	Client Services
23	-99	Male	6/14/2012	4:19 PM	125792	5.042	-99	-99
24	John	Male	7/1/1992	10:08 PM	97950	13.873	False	Client Services

Code #6: Using interpolate() function to fill the missing values using linear method.

```
# importing pandas as pd
import pandas as pd

# Creating the dataframe
df = pd.DataFrame({"A":[12, 4, 5, None, 1],
                   "B":[None, 2, 54, 3, None],
                   "C":[20, 16, None, 3, 8],
                   "D":[14, 3, None, None, 6]})

# Print the dataframe
df
```

	A	B	C	D
0	12.0	NaN	20.0	14.0
1	4.0	2.0	16.0	3.0
2	5.0	54.0	NaN	NaN
3	NaN	3.0	3.0	NaN
4	1.0	NaN	8.0	6.0

Let’s interpolate the missing values using Linear method. Note that Linear method ignore the

index and treat the values as equally spaced.

```
# to interpolate the missing values
df.interpolate(method ='linear', limit_direction ='forward')
```

Output:

	A	B	C	D
0	12.0	NaN	20.0	14.0
1	4.0	2.0	16.0	3.0
2	5.0	54.0	9.5	4.0
3	3.0	3.0	3.0	5.0
4	1.0	3.0	8.0	6.0

As we can see the output, values in the first row could not get filled as the direction of filling of values is forward and there is no previous value which could have been used in interpolation.

Dropping missing values using `dropna()`

In order to drop a null values from a dataframe, we used `dropna()` function this function drop Rows/Columns of datasets with Null values in different ways.

Code #1: Dropping rows with at least 1 null value.

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, 40, 80, 98],
```

```
        'Fourth Score':[np.nan, np.nan, np.nan, 65]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

df
```

	First Score	Second Score	Third Score	Fourth Score
0	100.0	30.0	52	NaN
1	90.0	NaN	40	NaN
2	NaN	45.0	80	NaN
3	95.0	56.0	98	65.0

Now we drop rows with at least one Nan value (Null value)

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, 90, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, 40, 80, 98],
        'Fourth Score':[np.nan, np.nan, np.nan, 65]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

# using dropna() function
df.dropna()
```

Output:

	First Score	Second Score	Third Score	Fourth Score
3	95.0	56.0	98	65.0

Code #2: Dropping rows if all values in that row are missing.

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, np.nan, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, np.nan, 80, 98],
        'Fourth Score':[np.nan, np.nan, np.nan, 65]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

df
```

	First Score	Second Score	Third Score	Fourth Score
0	100.0	30.0	52.0	NaN
1	NaN	NaN	NaN	NaN
2	NaN	45.0	80.0	NaN
3	95.0	56.0	98.0	65.0

Now we drop a rows whose all data is missing or contain null values(NaN)

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, np.nan, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, np.nan, 80, 98],
```

```
        'Fourth Score':[np.nan, np.nan, np.nan, 65]}

df = pd.DataFrame(dict)

# using dropna() function
df.dropna(how = 'all')
```

Output:

	First Score	Second Score	Third Score	Fourth Score
0	100.0	30.0	52.0	NaN
2	NaN	45.0	80.0	NaN
3	95.0	56.0	98.0	65.0

Code #3: Dropping columns with at least 1 null value.

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, np.nan, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, np.nan, 80, 98],
        'Fourth Score':[60, 67, 68, 65]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

df
```

	First Score	Second Score	Third Score	Fourth Score
0	100.0	30.0	52.0	60
1	NaN	NaN	NaN	67
2	NaN	45.0	80.0	68
3	95.0	56.0	98.0	65

Now we drop a columns which have at least 1 missing values

```
# importing pandas as pd
import pandas as pd

# importing numpy as np
import numpy as np

# dictionary of lists
dict = {'First Score':[100, np.nan, np.nan, 95],
        'Second Score': [30, np.nan, 45, 56],
        'Third Score':[52, np.nan, 80, 98],
        'Fourth Score':[60, 67, 68, 65]}

# creating a dataframe from dictionary
df = pd.DataFrame(dict)

# using dropna() function
df.dropna(axis = 1)
```

Output :

	Fourth Score
0	60
1	67
2	68
3	65

Code #4: Dropping Rows with at least 1 null value in CSV file

```
# importing pandas module
import pandas as pd

# making data frame from csv file
data = pd.read_csv("employees.csv")
```

```
# making new data frame with dropped NA values
new_data = data.dropna(axis = 0, how ='any')

new_data
```

Output:

	First Name	Gender	Start Date	Last Login Time	Salary	Bonus %	Senior Management	Team
0	Douglas	Male	8/6/1993	12:42 PM	97308	6.945	True	Marketing
2	Maria	Female	4/23/1993	11:17 AM	130590	11.858	False	Finance
3	Jerry	Male	3/4/2005	1:00 PM	138705	9.340	True	Finance
4	Larry	Male	1/24/1998	4:47 PM	101004	1.389	True	Client Services
5	Dennis	Male	4/18/1987	1:35 AM	115163	10.125	False	Legal
6	Ruby	Female	8/17/1987	4:20 PM	65476	10.012	True	Product
8	Angela	Female	11/22/2005	6:29 AM	95570	18.523	True	Engineering
9	Frances	Female	8/8/2002	6:51 AM	139852	7.524	True	Business Development
11	Julie	Female	10/26/1997	3:19 PM	102508	12.637	True	Legal
12	Brandon	Male	12/1/1980	1:08 AM	112807	17.492	True	Human Resources
13	Gary	Male	1/27/2008	11:40 PM	109831	5.831	False	Sales
14	Kimberly	Female	1/14/1999	7:13 AM	41426	14.543	True	Finance
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
993	Tina	Female	5/15/1997	3:53 PM	56450	19.040	True	Engineering
994	George	Male	6/21/2013	5:47 PM	98874	4.479	True	Marketing
996	Phillip	Male	1/31/1984	6:30 AM	42392	19.675	False	Finance
997	Russell	Male	5/20/2013	12:39 PM	96914	1.421	False	Product
998	Larry	Male	4/20/2013	4:45 PM	60500	11.985	False	Business Development
999	Albert	Male	5/15/2012	6:24 PM	129949	10.169	True	Sales

764 rows × 8 columns

Now we compare sizes of data frames so that we can come to know how many rows had at least 1 Null value

```
print("Old data frame length:", len(data))
print("New data frame length:", len(new_data))
print("Number of rows with at least 1 NA value: ", (len(data)-len(new_data)))
```

Output :

```
Old data frame length: 1000
New data frame length: 764
Number of rows with at least 1 NA value:  236
```

Since the difference is 236, there were 236 rows which had at least 1 Null value in any column.

Like 0

Previous Next

RECOMMENDED ARTICLES

Page : 1 2 3

Python | Working with Pandas and XlsxWriter | Set - 1
26, Dec 18

Working with database using Pandas
04, Mar 20

Python | Working with Pandas and XlsxWriter | Set – 2
28, Dec 18

Python | Working with date and time using Pandas
20, Sep 18

Python | Working with Pandas and XlsxWriter | Set – 3
28, Dec 18

Working with excel files using Pandas
13, Feb 20

Drop rows from Pandas dataframe with missing values or NaN in columns
29, Jun 20

Count NaN or missing values in Pandas DataFrame
01, Jul 20