In [1]:
```
# import pandas library
import pandas as pd
```

In [2]:
```
# import numpy libary
import numpy as np
```

In [3]:
```
# import matplotlib for graphing
import matplotlib.pyplot as plt
```

1 Instacart Orders Data

instacart_orders.csv: each row corresponds to one order on the Instacart app

- **order_id**: ID number that uniquely identifies each order
- **user_id**: ID number that uniquely identifies each customer account
- **order_number**: the number of times this customer has placed an order
- **order_dow**: day of the week that the order placed (which day is 0 is uncertain)
- **order_hour_of_day**: hour of the day that the order was placed
- **days_since_prior_order**: number of days since this customer placed their previous order

In [4]:
```
# import csv
df_instacart_orders = pd.read_csv("/datasets/instacart_orders.csv",sep=';')
df_instacart_orders.head()
```

Out[4]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

2 Products Data

products.csv: each row corresponds to a unique product that customers can buy

- **'product_id'**: ID number that uniquely identifies each product
- **'product_name'**: name of the product
- **'aisle_id'**: ID number that uniquely identifies each grocery aisle category
- **'department_id'**: ID number that uniquely identifies each grocery department category

In [5]:
```
# import csv
df_products = pd.read_csv("/datasets/products.csv",sep=';')
df_products.head()
```

Out[5]:

	product_id	product_name	aisle_id	department_id
0	1	Chocolate Sandwich Cookies	61	19
1	2	All-Seasons Salt	104	13
2	3	Robust Golden Unsweetened Oolong Tea	94	7
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1
4	5	Green Chile Anytime Sauce	5	13

3 Aisles Data

aisles.csv

- **'aisle_id'**: ID number that uniquely identifies each grocery aisle category
- **'aisle'**: name of the aisle

In [6]:
```
# import csv
df_aisles = pd.read_csv("/datasets/aisles.csv",sep=';')
df_aisles.head()
```

Out[6]:

	aisle_id	aisle
0	1	prepared soups salads
1	2	specialty cheeses
2	3	energy granola bars
3	4	instant foods
4	5	marinades meat preparation

4 Departments Data

departments.csv

- **'department_id'**: ID number that uniquely identifies each grocery department category
- **'department'**: name of the department

In [7]:
```
# import csv
df_departments = pd.read_csv("/datasets/departments.csv",sep=";")
df_departments.head()
```

Out[7]:

	department_id	department
0	1	frozen
1	2	other
2	3	bakery
3	4	produce
4	5	alcohol

5 Order Products Data

order_products.csv: each row corresponds to one item placed in an order

- **'order_id'**: ID number that uniquely identifies each order
- **'product_id'**: ID number that uniquely identifies each product
- **'add_to_cart_order'**: the sequential order in which each item was placed in the cart
- **'reordered'**: 0 if the customer has never ordered this product before, 1 if they have

In [8]:
```
# import csv
df_order_products = pd.read_csv("/datasets/order_products.csv",sep=';')
df_order_products.head()
```

Out[8]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17.0	0
1	567889	1560	1.0	1
2	2261212	26683	1.0	1
3	491251	8670	35.0	1
4	2571142	1940	5.0	1

Find and remove duplicate values (and describe why you make your choices)

`orders` data frame

In [9]:
```
# Check for duplicated orders
dups = df_instacart_orders.duplicated().sum()
print(f"There are {dups} duplicates")
```

```
There are 15 duplicates
```

In [10]:
```
print(f'Here are the {dups} rows')
df_instacart_orders[df_instacart_orders.duplicated()]
```

Here are the 15 rows

Out[10]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since
145574	794638	50898	24	3	2	
223105	2160484	107525	16	3	2	
230807	1918001	188546	14	3	2	
266232	1782114	106752	1	3	2	
273805	1112182	202304	84	3	2	
284038	2845099	31189	11	3	2	
311713	1021560	53767	3	3	2	
321100	408114	68324	4	3	2	
323900	1919531	191501	32	3	2	
345917	2232988	82565	1	3	2	
371905	391768	57671	19	3	2	
394347	467134	63189	21	3	2	
411408	1286742	183220	48	3	2	
415163	2282673	86751	49	3	2	
441599	2125197	14050	48	3	2	

All duplicateds were on a Wednesay and at 2:am

In [11]:
```
# Check for all orders placed Wednesday at 2:00 AM
```

In [12]:
```
df_instacart_orders['order_dow'].unique()
```

Out[12]:
```
array([6, 5, 0, 4, 3, 1, 2])
```

We can assume 0=sunday, 1=monday,...,6=saturday because 0 means to start and the day of the week starts sundays.

In [13]:
```
# Make a new column of the days of the week
day_of_week = {0:'sunday',
               1:'monday',
               2:'tuesday',
               3:'wednesday',
               4:'thursday',
               5:'friday',
               6:'saturday'}

df_instacart_orders['day_of_week'] = df_instacart_orders['order_dow'].replac
df_instacart_orders.head()
```

Out[13]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

In [14]:
```
hours = sorted([i for i in df_instacart_orders['order_hour_of_day'].unique()
print(hours)
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 2
1, 22, 23]
```

This data follows the 0-23 hour time and not USA Time. So 2:00 am = 2

In [15]:
```
# orders placed at wednesy at 2:00 am
orders_wed_2am = df_instacart_orders.query("day_of_week == 'wednesday' & orc
orders_wed_2am.head()
```

Out[15]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_p
4838	2766110	162084	41	3	2	
5156	2190225	138285	18	3	2	
15506	553049	58599	13	3	2	
18420	382357	120200	19	3	2	
24691	690242	77357	2	3	2	

In [16]:
```
# Remove duplicate orders
df_instacart_orders = df_instacart_orders.drop_duplicates().reset_index(drop
df_instacart_orders.head()
```

Out[16]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

In [17]:
```
# Double check for duplicate rows
dups = df_instacart_orders.duplicated().sum()
print(f"There are {dups} duplicates")
```

```
There are 0 duplicates
```

In [18]:
```
# Double check for duplicate order IDs only
df_instacart_orders.shape
```

Out[18]:
```
(478952, 7)
```

In [19]:
```
df_instacart_orders['order_id'].nunique()
```

Out[19]:
```
478952
```

Since number of rows match the number of unique rows for the order Id column, there is no duplicates order Id numbers.

In [20]:
```
# Convert columns to correct data types
df_instacart_orders['day_of_week'] = df_instacart_orders['day_of_week'].asty
```

In [21]:
```
df_instacart_orders.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 478952 entries, 0 to 478951
Data columns (total 7 columns):
 #   Column                  Non-Null Count   Dtype
---  ------                  --------------   -----
 0   order_id                478952 non-null  int64
 1   user_id                 478952 non-null  int64
 2   order_number            478952 non-null  int64
 3   order_dow               478952 non-null  int64
 4   order_hour_of_day       478952 non-null  int64
 5   days_since_prior_order  450135 non-null  float64
 6   day_of_week             478952 non-null  category
dtypes: category(1), float64(1), int64(5)
memory usage: 22.4 MB
```

`products` data frame

In [22]:
```
df_products.head()
```

Out[22]:

	product_id	product_name	aisle_id	department_id
0	1	Chocolate Sandwich Cookies	61	19
1	2	All-Seasons Salt	104	13
2	3	Robust Golden Unsweetened Oolong Tea	94	7
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1
4	5	Green Chile Anytime Sauce	5	13

In [23]:
```
# Check for fully duplicate rows
dups = df_products.duplicated().sum()
print(f"There are {dups} full duplicated rows.")
```

```
There are 0 full duplicated rows.
```

In [24]:
```
# Check for just duplicate product IDs
df_products.shape
```

Out[24]:
```
(49694, 4)
```

In [25]:
```
df_products['product_id'].nunique()
```

Out[25]:
```
49694
```

The number of rows equal the number of unique values for the product id column, so no full duplicates in this columns

In [26]:
```
# Check for just duplicate product names (convert names to lowercase to comp
def normalize_lower(col):
    if pd.isna(col):
        return col
    else:
        return col.lower()
```

In [27]:
```
df_products["product_name_lower"] = df_products["product_name"].apply(normal
df_products.head()
```

Out[27]:

	product_id	product_name	aisle_id	department_id	product_name_lower
0	1	Chocolate Sandwich Cookies	61	19	chocolate sandwich cookies
1	2	All-Seasons Salt	104	13	all-seasons salt
2	3	Robust Golden Unsweetened Oolong Tea	94	7	robust golden unsweetened oolong tea
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1	smart ones classic favorites mini rigatoni wit...
4	5	Green Chile Anytime Sauce	5	13	green chile anytime sauce

In [28]:
```
# Check if there are duplicates in the product name lower column
product_lower = df_products['product_name_lower'].value_counts(ascending = F
product_lower[product_lower>1]
```

Out[28]:
```
green tea with ginseng and honey             3
cream of tartar                              2
cosmic brownies with chocolate chip candy    2
skinless & boneless sardines in olive oil    2
lavender & chamomile baby powder             2
                                            ..
high performance energy drink                2
balsamic vinegar of modena                   2
salsa medium                                 2
bag of oranges                               2
chunk light tuna in water                    2
Name: product_name_lower, Length: 103, dtype: int64
```

There are 103 product names that have more than 1 repeated product names. We we drop them.

In [29]:
```
# Count how many duplicates for the new product name column
dups = df_products['product_name_lower'].duplicated().sum()
print(f"There are {dups} duplicated rows with the lowercase column product r
```

```
There are 1361 duplicated rows with the lowercase column product name
```

In [30]:
```
# To make sure these are true duplicates, we need to include the other colum
# Some products could have same name but different aisles/department
cols = ['aisle_id','department_id','product_name_lower']
dups = df_products[cols].duplicated().sum()
print(f"There are {dups} duplicated rows with the lowercase column product r
```

```
There are 1344 duplicated rows with the lowercase column product name.(inclu
ding the other cols)
```

It means after we made them lowercase, there were items that shared different differet aisle id and department id

In [31]:
```
df_products = df_products.drop_duplicates(subset=cols).reset_index(drop=True
df_products.shape
```

Out[31]:
```
(48350, 5)
```

In [32]:
```
# Check for duplicate product names that aren't missing
df_products[df_products['product_name_lower'].notna()].duplicated().sum()
```

Out[32]:
```
0
```

In [33]:
```
# checking for more duplicates
def normalize_other(col):
    '''This function will check for strong conditions'''
    if pd.isna(col):
        return col
    else:
        col = col.lower() # make all lowercase
        col = col.strip() # strip the white spaces
        col = " ".join( col.split() ) # erase the extra white spaces in betw
        col = col.replace('-','') # remove -
        col = col.replace(' ','') # make one word
        return col
```

In [34]:
```
df_products["product_name_lower_2"] = df_products["product_name_lower"].appl
df_products.head()
```

Out[34]:

	product_id	product_name	aisle_id	department_id	product_name_lower	
0	1	Chocolate Sandwich Cookies	61	19	chocolate sandwich cookies	
1	2	All-Seasons Salt	104	13	all-seasons salt	
2	3	Robust Golden Unsweetened Oolong Tea	94	7	robust golden unsweetened oolong tea	
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38	1	smart ones classic favorites mini rigatoni wit...	smartone
4	5	Green Chile Anytime Sauce	5	13	green chile anytime sauce	

In [35]:
```
cols2 = ['aisle_id','department_id','product_name_lower_2']
dups = df_products[cols2].duplicated().sum()
print(f"There are {dups} more duplicated rows.")
```

```
There are 256 more duplicated rows.
```

In [36]:
```
df_products = df_products.drop_duplicates(subset=cols2).reset_index(drop=Tru
df_products.shape
```

Out[36]:
```
(48094, 6)
```

In [37]:
```
# Convert df back to its orignal columns
df_products = df_products[["product_id","product_name","aisle_id"]]
df_products.head()
```

Out[37]:

	product_id	product_name	aisle_id
0	1	Chocolate Sandwich Cookies	61
1	2	All-Seasons Salt	104
2	3	Robust Golden Unsweetened Oolong Tea	94
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38
4	5	Green Chile Anytime Sauce	5

In [38]:
```
df_products.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 48094 entries, 0 to 48093
Data columns (total 3 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   product_id    48094 non-null  int64 
 1   product_name  48093 non-null  object
 2   aisle_id      48094 non-null  int64 
dtypes: int64(2), object(1)
memory usage: 1.1+ MB
```

`departments` data frame

In [39]:
```
df_departments['department'] = df_departments['department'].astype('category
```

In [40]:
```
df_departments.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 21 entries, 0 to 20
Data columns (total 2 columns):
 #   Column         Non-Null Count  Dtype   
---  ------         --------------  -----   
 0   department_id  21 non-null     int64   
 1   department     21 non-null     category
dtypes: category(1), int64(1)
memory usage: 1.0 KB
```

In [41]:
```
df_departments.head()
```

Out[41]:

	department_id	department
0	1	frozen
1	2	other
2	3	bakery
3	4	produce
4	5	alcohol

`aisles` data frame

In [42]:
```
df_aisles['aisle'] = df_aisles['aisle'].astype('category')
```

In [43]:
```
df_aisles.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 134 entries, 0 to 133
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype   
---  ------    --------------  -----   
 0   aisle_id  134 non-null    int64   
 1   aisle     134 non-null    category
dtypes: category(1), int64(1)
memory usage: 6.6 KB
```

In [44]:
```
# Check for duplicates
df_aisles['aisle'].duplicated().sum()
df_aisles.duplicated().sum()
```

Out[44]:
```
0
```

`order_products` data frame

In [45]:
```
df_order_products.info(null_counts=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4545007 entries, 0 to 4545006
Data columns (total 4 columns):
 #   Column             Non-Null Count    Dtype  
---  ------             --------------    -----  
 0   order_id           4545007 non-null  int64  
 1   product_id         4545007 non-null  int64  
 2   add_to_cart_order  4544171 non-null  float64
 3   reordered          4545007 non-null  int64  
dtypes: float64(1), int64(3)
memory usage: 138.7 MB
```

In [46]:
```
df_order_products.head()
```

Out[46]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17.0	0
1	567889	1560	1.0	1
2	2261212	26683	1.0	1
3	491251	8670	35.0	1
4	2571142	1940	5.0	1

In [47]:
```
# Check for fullly duplicate rows
dups = df_order_products.duplicated().sum()
print(f"The are {dups} fully duplicated rows")
```

```
The are 0 fully duplicated rows
```

In [48]:
```
# Double check for any other tricky duplicates
```

It is ok for values in the same column to repeat because:

1.) order_id: If order_id is shown more than once, then there was other items brought in the same order 2.) product_id: you can buy the same product for the same order id 3.) reorded: its ok for this column to repeat.

Find and remove missing values

`products` data frame

In [49]:
```
df_products.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 48094 entries, 0 to 48093
Data columns (total 3 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   product_id    48094 non-null  int64 
 1   product_name  48093 non-null  object
 2   aisle_id      48094 non-null  int64 
dtypes: int64(2), object(1)
memory usage: 1.1+ MB
```

In [50]:
```
df_products.isna().sum()
```

Out[50]:
```
product_id      0
product_name    1
aisle_id        0
dtype: int64
```

In [51]:
```
# Are all of the missing product names associated with aisle ID 100?
df_products[df_products['product_name'].isna()]
```

Out[51]:

	product_id	product_name	aisle_id
37	38	NaN	100

The missing value for product name is assoicated with aisle id # 100

In [52]:
```
# Are all of the missing product names associated with department ID 21?

df_departments.sort_values(by='department')
```

Out[52]:

	department_id	department
4	5	alcohol
17	18	babies
2	3	bakery
6	7	beverages
13	14	breakfast
9	10	bulk
14	15	canned goods
15	16	dairy eggs
19	20	deli
8	9	dry goods pasta
0	1	frozen
16	17	household
5	6	international
11	12	meat seafood
20	21	missing
1	2	other
12	13	pantry
10	11	personal care
7	8	pets
3	4	produce
18	19	snacks

The is only a missing department for department id # 21.

In [53]:
```
# What is this ailse and department?
df_aisles.query('aisle_id == 100')
```

Out[53]:

	aisle_id	aisle
99	100	missing

The aisle is missing with aisle id of 100 and the department is missing with department id of 21

In [54]:
```
# Fill missing product names with 'Unknown'
df_products['product_name'] = df_products['product_name'].fillna('Unknown')
df_products.loc[37]
```

Out[54]:
```
product_id           38
product_name    Unknown
aisle_id            100
Name: 37, dtype: object
```

`orders` data frame

In [55]:
```
df_instacart_orders.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 478952 entries, 0 to 478951
Data columns (total 7 columns):
 #   Column                  Non-Null Count   Dtype
---  ------                  --------------   -----
 0   order_id                478952 non-null  int64
 1   user_id                 478952 non-null  int64
 2   order_number            478952 non-null  int64
 3   order_dow               478952 non-null  int64
 4   order_hour_of_day       478952 non-null  int64
 5   days_since_prior_order  450135 non-null  float64
 6   day_of_week             478952 non-null  category
dtypes: category(1), float64(1), int64(5)
memory usage: 22.4 MB
```

In [56]:
```
df_instacart_orders.head()
```

Out[56]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

In [57]:
```
# Are there any missing values where it's not a customer's first order?
df_order_products.head()
```

Out[57]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17.0	0
1	567889	1560	1.0	1
2	2261212	26683	1.0	1
3	491251	8670	35.0	1
4	2571142	1940	5.0	1

In [58]:
```
df_merge = df_instacart_orders.merge(df_order_products,
                    how='inner',
                    on='order_id',
                    suffixes=['_df_instacart_orders','_df_order_products'])

df_merge.head()
```

Out[58]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1515936	183418	11	6	13	
2	1515936	183418	11	6	13	
3	1515936	183418	11	6	13	
4	1515936	183418	11	6	13	

In [59]:
```
# filter not first timers
df_merge.query("reordered==1").isna().sum()
```

Out[59]:
```
order_id                  0
user_id                   0
order_number              0
order_dow                 0
order_hour_of_day         0
days_since_prior_order    0
day_of_week               0
product_id                0
add_to_cart_order       319
reordered                 0
dtype: int64
```

There are 319 missing values in the add_to_cart_order column.

Data is too complex to determine how to fill in these missing values.

Will leave them missing for now.

`order_products` data frame

In [60]:
```
df_order_products.info(null_counts=True)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4545007 entries, 0 to 4545006
Data columns (total 4 columns):
 #   Column             Non-Null Count    Dtype  
---  ------             --------------    -----  
 0   order_id           4545007 non-null  int64  
 1   product_id         4545007 non-null  int64  
 2   add_to_cart_order  4544171 non-null  float64
 3   reordered          4545007 non-null  int64  
dtypes: float64(1), int64(3)
memory usage: 138.7 MB
```

In [61]:
```
df_order_products.head()
```

Out[61]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17.0	0
1	567889	1560	1.0	1
2	2261212	26683	1.0	1
3	491251	8670	35.0	1
4	2571142	1940	5.0	1

In [62]:
```
# What are the min and max values in this column?
col = "add_to_cart_order"
min1 = df_order_products['add_to_cart_order'].min()
max1 = df_order_products['add_to_cart_order'].max()
```

```
print(f"The min value for the {col} column is {min1}.)")
print(f"The max value for the {col} column is {max1}.)")
```

```
The min value for the add_to_cart_order column is 1.0.)
The max value for the add_to_cart_order column is 64.0.)
```

In [63]:
```
# Save all order IDs with at least one missing value in 'add_to_cart_order'
order_ids = list(df_order_products.query("@pd.isna(add_to_cart_order)")['orc
df = df_order_products.query("order_id in @order_ids")
df.head()
```

Out[63]:

	order_id	product_id	add_to_cart_order	reordered
267	2094761	31469	57.0	1
737	2449164	5068	NaN	0
1742	2997021	4920	37.0	0
3463	871281	40063	61.0	1
3535	171934	36397	7.0	0

In [64]:
```
df.query("@pd.isna(add_to_cart_order)")
```

Out[64]:

	order_id	product_id	add_to_cart_order	reordered
737	2449164	5068	NaN	0
9926	1968313	43867	NaN	0
14394	2926893	11688	NaN	0
16418	1717990	4142	NaN	0
30114	1959075	42828	NaN	1
...	...	...	...	...
4505662	1800005	7411	NaN	0
4511400	1633337	260	NaN	0
4517562	404157	9517	NaN	0
4534112	1673227	17835	NaN	0
4535739	1832957	17949	NaN	1

836 rows × 4 columns

In [65]:
```
df.query("add_to_cart_order==64")
```

Out[65]:

	order_id	product_id	add_to_cart_order	reordered
76044	1386261	31847	64.0	0
154176	854647	22922	64.0	0
177733	3383594	7970	64.0	0
213282	2470674	30257	64.0	0
233518	1968313	495	64.0	1
...	...	...	...	...
4148751	2999801	24722	64.0	1
4235552	3308010	3888	64.0	1
4409436	747668	31268	64.0	0
4419785	1633337	34	64.0	0
4432234	9310	21332	64.0	0

70 rows × 4 columns

In [66]:
```
# Do all orders with missing values have more than 64 products?
df.groupby('order_id').count()
```

Out[66]:

order_id	product_id	add_to_cart_order	reordered
9310	65	64	65
61355	127	64	127
102236	95	64	95
129627	69	64	69
165801	70	64	70
...	...	...	...
2999801	70	64	70
3125735	86	64	86
3308010	115	64	115
3347453	71	64	71
3383594	69	64	69

70 rows × 3 columns

In [67]:
```
df.groupby('order_id').size()
```

Out[67]:
```
order_id
9310        65
61355      127
102236      95
129627      69
165801      70
           ...
2999801     70
3125735     86
3308010    115
3347453     71
3383594     69
Length: 70, dtype: int64
```

We can see the count method counts non null values where the size method includes the null values. This could mean that orders passing 64 were null values

In [68]:
```
# Replace missing values with 999 and convert column to integer type
df_order_products['add_to_cart_order'] = df_order_products['add_to_cart_orde
df_order_products['add_to_cart_order'] = df_order_products['add_to_cart_orde
df_order_products.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4545007 entries, 0 to 4545006
Data columns (total 4 columns):
 #   Column             Dtype
---  ------             -----
 0   order_id           int64
 1   product_id         int64
 2   add_to_cart_order  int64
 3   reordered          int64
dtypes: int64(4)
memory usage: 138.7 MB
```

[A] Easy (must complete all to pass)

[A1] Verify that the `'order_hour_of_day'` and `'order_dow'` values in the `orders` tables are sensible (i.e. `'order_hour_of_day'` ranges from 0 to 23 and `'order_dow'` ranges from 0 to 6)

In [69]:
```
order_hour_of_day = sorted(list(df_instacart_orders['order_hour_of_day'].uni
order_hour_of_day
```

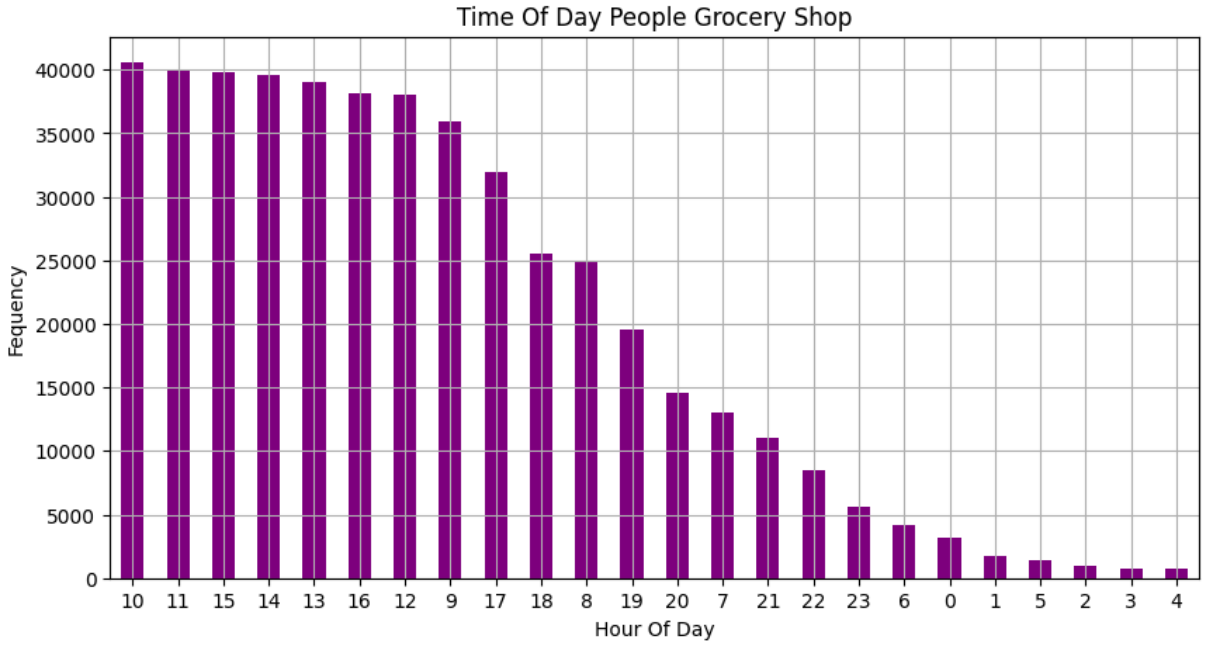
Out[69]:
```
[0,
 1,
 2,
 3,
 4,
 5,
 6,
 7,
 8,
 9,
 10,
 11,
 12,
 13,
 14,
 15,
 16,
 17,
 18,
 19,
 20,
 21,
 22,
 23]
```

In [70]:
```
order_dow = sorted(list(df_instacart_orders['order_dow'].unique()))
order_dow
```

Out[70]:
```
[0, 1, 2, 3, 4, 5, 6]
```

[A2] What time of day do people shop for groceries?

In [71]:
```
df_instacart_orders["order_hour_of_day"].value_counts().plot(kind="bar",
                                                             rot=0,
                                                             xlabel="Hour Of
                                                             ylabel="Fequenc
                                                             title="Time Of
                                                             figsize=[10,5],
                                                             grid=True,
                                                             color='purple')
plt.show()
```



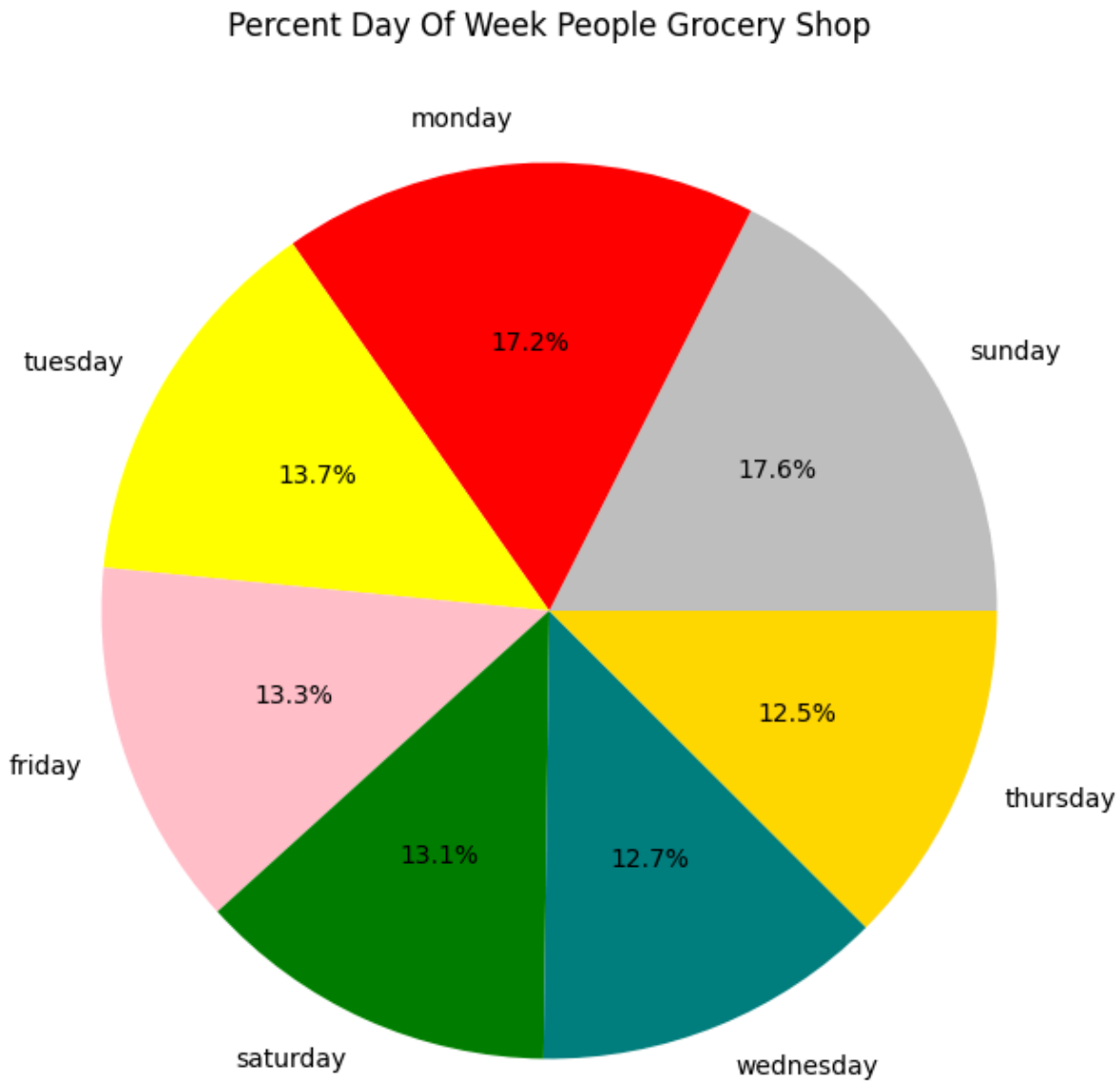
In [ ]:

[A3] What day of the week do people shop for groceries?

In [72]:
```
df_instacart_orders["day_of_week"].value_counts().plot(kind="bar",
                                                       rot=0,
                                                       xlabel="Day Of
                                                       ylabel="Fequenc
                                                       title="Day Of W
                                                       figsize=[10,5],
                                                       grid=True,
                                                       color='red')
plt.show()
```

In [73]:
```
df_instacart_orders["day_of_week"].value_counts().plot(kind="pie",
                                                       autopct="%1.1f%%",
                                                       figsize=[70,8],
                                                       title="Percent Day Of
                                                       ylabel='',
                                                       colors=['silver','red


plt.show()
```



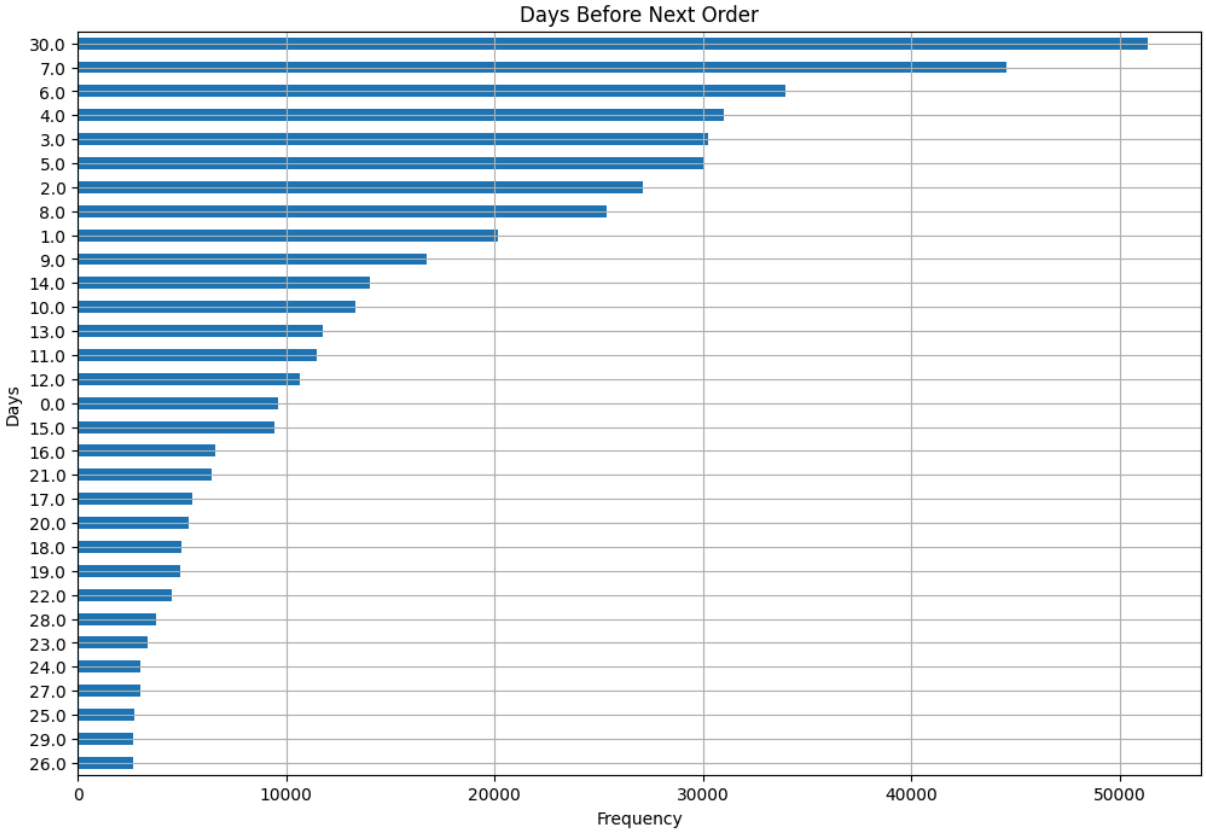
In [ ]:

[A4] How long do people wait until placing another order?

In [74]:
```
df_instacart_orders['days_since_prior_order'].value_counts(ascending=True).p




plt.xlabel('Frequency')
plt.ylabel('Days')
plt.show()
```



In [75]:
```
mean_days = df_instacart_orders['days_since_prior_order'].mean()
sd_days = df_instacart_orders['days_since_prior_order'].std(ddof=1)
print(f"On avergae, people wait about {mean_days:.0f} before placing another
print(f"It is expected that a person waits between {mean_days-sd_days:.0f} t
```

```
On avergae, people wait about 11 before placing another order.
It is expected that a person waits between 2 to 20 days until placing the ne
xt order.
```

In [ ]:
```
```

[B] Medium (must complete all to pass)

[B1] Is there a difference in `'order_hour_of_day'` distributions on Wednesdays and Saturdays? Plot the histograms for both days and describe the differences that you see.

In [76]:
```
def histogram_info(data, bin_size=10, minx = None,r=None ):
    '''
    r = rounding for width
    minx = custum min value
    bin_size = bin size
    data = data as a series
```

```
    '''
    print('will return bins,midpoints, and labels for intervals')

    # find min and max
    if minx == None:
        minx = min(data)
    else:
        pass
    maxy = max(data)
    n = len(data)
    width = np.ceil( (maxy - minx) / bin_size)
    if r == None:
        pass
    else:
        width = round( (maxy - minx) / bin_size,r)
    bins = [i for i in np.arange(minx,maxy+1,width)]

    while max(bins) < maxy:
        bins.append(max(bins)+width)

    midpoints = [(bins[i]+bins[i+1])/2 for i in range(len(bins)-1)]
    labels = [ f"[{bins[i]},{bins[i+1]})" for i in range(len(bins)-1)]
    labels[-1] = labels[-1][:-1] + "]"


    print(f'size:{n}')
    print(f'min:{minx}')
    print(f'max:{maxy}')
    print(f'bin size:{bin_size}')
    print(f'width:{width}')
    return bins,midpoints,labels
```

In [77]:
```
# distrubtion for saturday
saturdays = df_instacart_orders.query("day_of_week=='saturday'")['order_hour
# distrubtion for wednesday
wednesdays = df_instacart_orders.query("day_of_week=='wednesday'")['order_ho
```

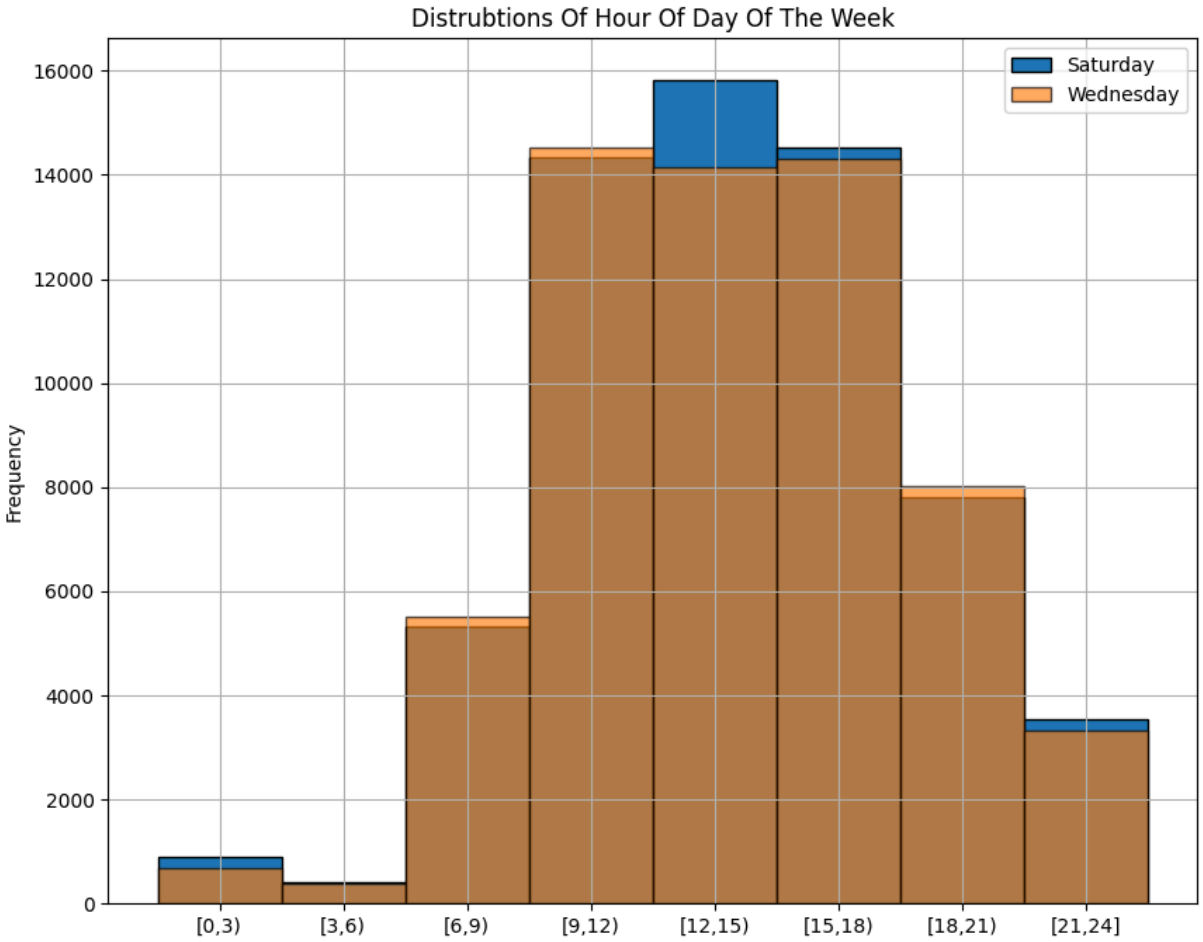
In [78]:
```
bins,midpoints,labels =histogram_info(saturdays)
labels = [i.replace('.0','') for i in labels] # remove decimals
```

```
will return bins,midpoints, and labels for intervals
size:62649
min:0
max:23
bin size:10
width:3.0
```

In [79]:
```
saturdays.plot(kind="hist",
               grid=True,
               xlabel='Hour Of Day',
               title='Distrubtions Of Hour Of Day Of The Week',
               figsize=[10,8],
               edgecolor='black',
               bins = bins)
plt.xticks(midpoints,labels)
```

```
wednesdays.plot(kind="hist",
                alpha=0.65,
                edgecolor='black',
                bins = bins)

plt.legend(['Saturday','Wednesday'])
plt.grid(True)
plt.show()
```



There doesn't seem to be a difference in the order hour of day distributions on Wednesdays and Saturdays.They appear to have the same shape. The majority of time people shop using instacart on Saturday and and Wednesdays are between the hours from 09:00 to 17:00.

In [ ]:

In [ ]:

[B2] What's the distribution for the number of orders per customer?

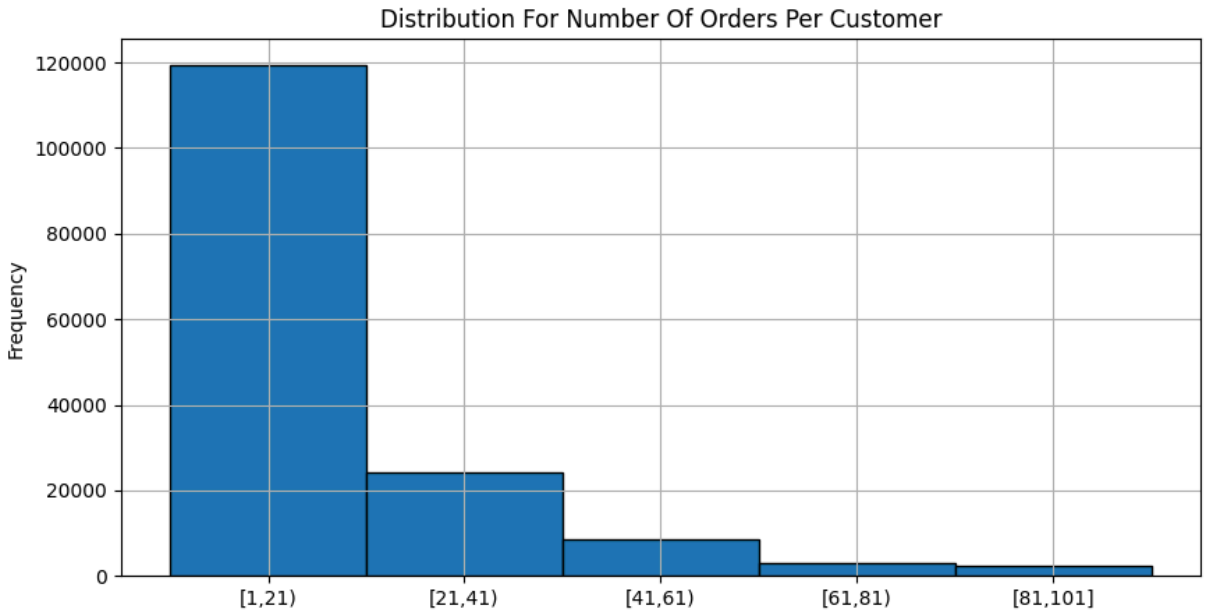
In [80]:
```
bins,midpoints,labels = histogram_info(df_instacart_orders.groupby('user_id'
```

```
labels = [i.replace('.0','') for i in labels] # remove decimals
```

```
will return bins,midpoints, and labels for intervals
size:157437
min:1
max:100
bin size:5
width:20.0
```

In [81]:
```
df_instacart_orders.groupby('user_id')['order_number'].max().plot(kind='hist
                                                                   edgecolor=
                                                                  figsize = [
                                                                  title='Dist
                                                                  xlabel = 'N
                                                                   grid = Tru
                                                                   bins=bins)


plt.xticks(midpoints,labels)
plt.show()
```



The distribution for the number of orders per customer is highly skewed to the right, meaning a lot of instacart customers have not made a high volume of orders. The majority of people have made between 1-20 orders.

[B3] What are the top 20 popular products (display their id and name)?

In [82]:
```
df_products.head()
```

Out[82]:

	product_id	product_name	aisle_id
0	1	Chocolate Sandwich Cookies	61
1	2	All-Seasons Salt	104
2	3	Robust Golden Unsweetened Oolong Tea	94
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38
4	5	Green Chile Anytime Sauce	5

In [83]:
```
df_instacart_orders.head()
```

Out[83]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

In [84]:
```
df_order_products.head()
```

Out[84]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17	0
1	567889	1560	1	1
2	2261212	26683	1	1
3	491251	8670	35	1
4	2571142	1940	5	1

In [85]:
```
df_merge1 = df_instacart_orders.merge(df_order_products,on='order_id',how='i
df_merge1.head()
```

Out[85]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1515936	183418	11	6	13	
2	1515936	183418	11	6	13	
3	1515936	183418	11	6	13	
4	1515936	183418	11	6	13	

In [86]:

```
df_merge2 = df_merge1.merge(df_products,on='product_id',how='inner')
cols = ['order_id','user_id','product_name','product_id']
df_clean = df_merge2[cols]
df_clean.head()
```

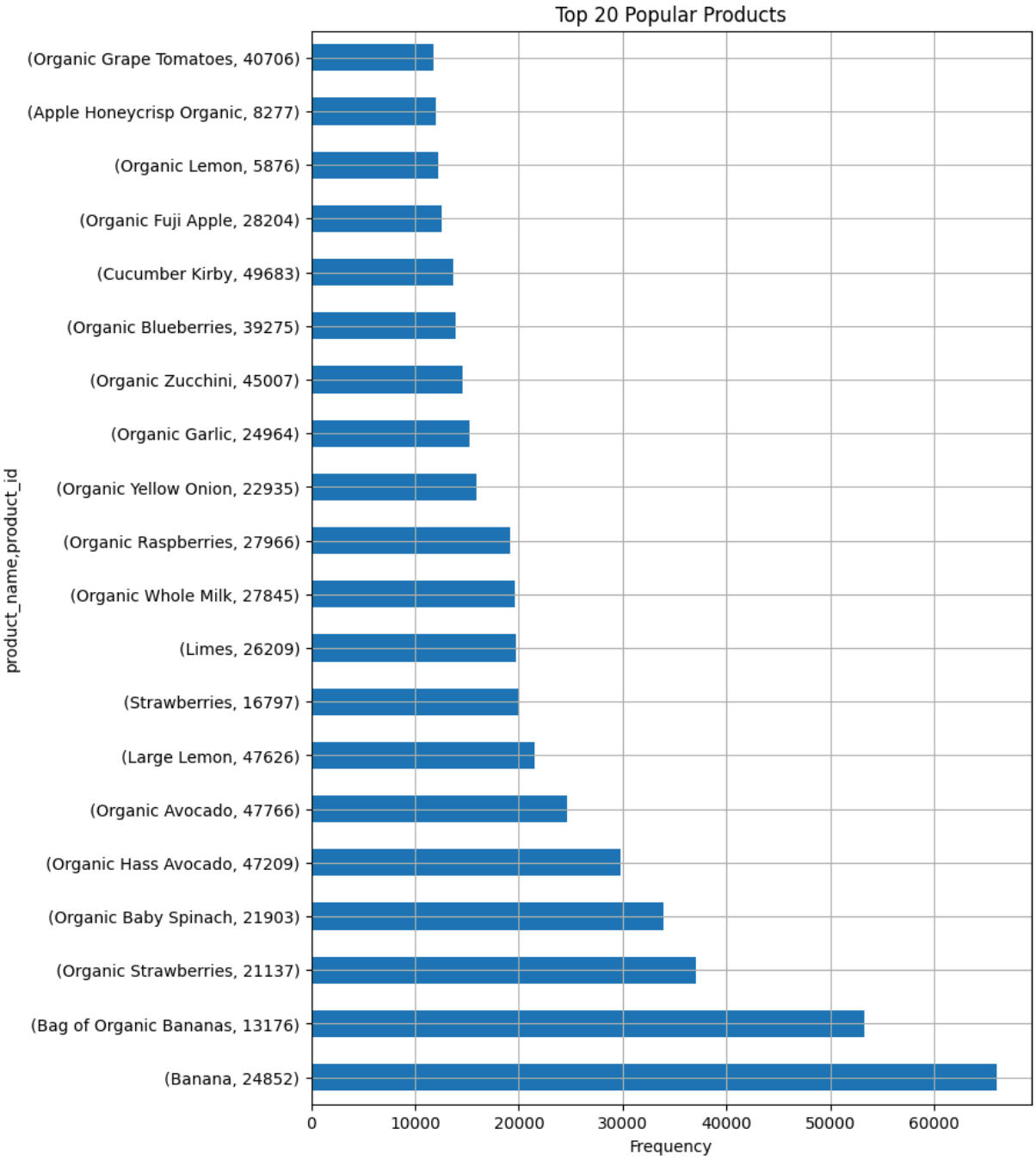
Out[86]:

	order_id	user_id	product_name	product_id
0	1515936	183418	Organic Butternut Squash	19048
1	787445	25685	Organic Butternut Squash	19048
2	1646929	205815	Organic Butternut Squash	19048
3	276490	1004	Organic Butternut Squash	19048
4	1300214	33481	Organic Butternut Squash	19048

In [87]:

```
df_clean_grouped = df_clean.groupby(['product_name','product_id']).agg(freq=
df_clean_grouped.head(20).plot(kind='barh',
                               figsize=[8,12],
                               grid=True,
                               ylabel ='Product Name & ID',
                               title = 'Top 20 Popular Products',
                               legend = False)

plt.xlabel('Frequency')
plt.show()
```



[C] Hard (must complete at least two to pass)

[C1] How many items do people typically buy in one order? What does the distribution look like?

In [88]:
```
df_clean = df_order_products.groupby('order_id').agg(freq=('product_id','cou
df_clean.head()
```

Out[88]:

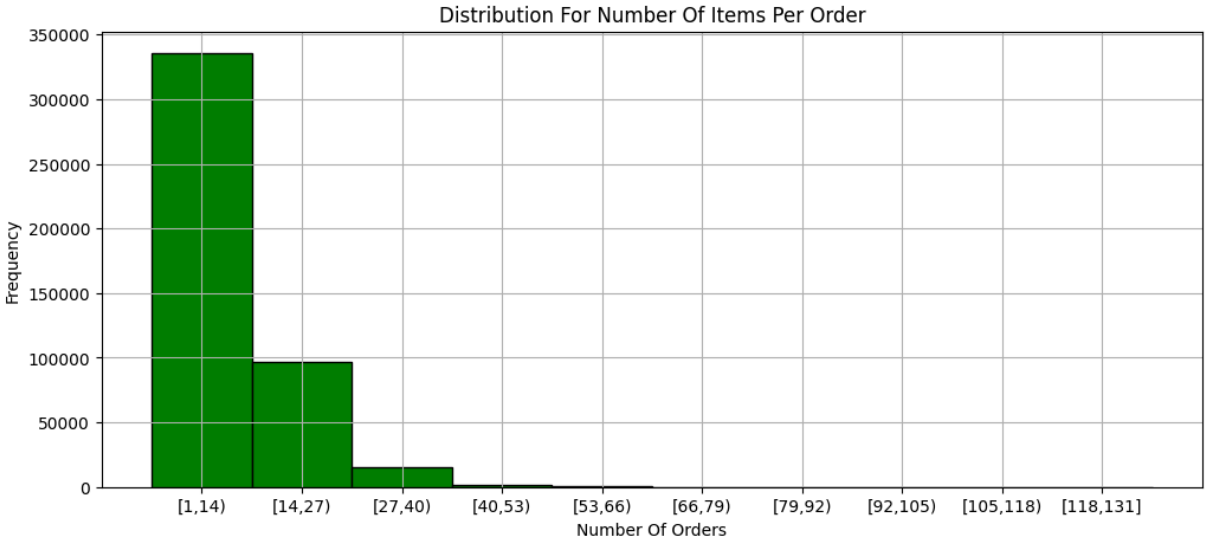
order_id	freq
4	13
9	15
11	5
19	3
20	8

In [89]:
```
bins,midpoints,labels = histogram_info(df_clean['freq'],bin_size=10)
labels = [i.replace('.0','') for i in labels] # remove decimals
```

```
will return bins,midpoints, and labels for intervals
size:450046
min:1
max:127
bin size:10
width:13.0
```

In [90]:
```
df_clean['freq'].plot(kind='hist',
                      edgecolor='black',
                      figsize = [12,5],
                      title='Distribution For Number Of Items Per Order',
                      xlabel = 'Number Of Orders',
                      grid = True,
                      bins=bins,
                      color='green')

plt.xticks(midpoints,labels)
plt.xlabel('Number Of Orders')
plt.show()
```



The distribution for number of items per order is highly skewd to the left. The majority of customers make purchase between 1 to 13 items per order.

[C2] What are the top 20 items that are reordered most frequently (display their names and product IDs)?

In [91]:
```
df_reordered = df_order_products.query("reordered ==1")
df_reordered.head()
```

Out[91]:

	order_id	product_id	add_to_cart_order	reordered
1	567889	1560	1	1
2	2261212	26683	1	1
3	491251	8670	35	1
4	2571142	1940	5	1
5	2456893	21616	4	1

In [92]:
```
# Indices of the top 20  most reordered items in order
index_top20 = list(df_reordered['product_id'].value_counts(ascending = False
```

In [93]:
```
cols = ['product_name','product_id']
# make sure its in order
top20 = df_products.query("product_id in @index_top20")[cols].set_index("pro
print('Top 20 items that are reordered most frequently ')
top20
```

```
Top 20 items that are reordered most frequently
```

Out[93]:

	product_id	product_name
0	24852	Banana
1	13176	Bag of Organic Bananas
2	21137	Organic Strawberries
3	21903	Organic Baby Spinach
4	47209	Organic Hass Avocado
5	47766	Organic Avocado
6	27845	Organic Whole Milk
7	47626	Large Lemon
8	27966	Organic Raspberries
9	16797	Strawberries
10	26209	Limes
11	22935	Organic Yellow Onion
12	24964	Organic Garlic
13	45007	Organic Zucchini
14	49683	Cucumber Kirby
15	28204	Organic Fuji Apple
16	8277	Apple Honeycrisp Organic
17	39275	Organic Blueberries
18	5876	Organic Lemon
19	49235	Organic Half & Half

[C3] For each product, what proportion of its orders are reorders?

In [94]:
```
proportion_product_reorder = df_order_products.groupby('product_id').agg(prc
proportion_product_reorder.head()
```

Out[94]:

product_id	proportion_product_reorders
1	56.428571
2	0.000000
3	73.809524
4	51.020408
7	50.000000

In [95]:
```
# Merge the products df with the new proportion df to get the names and
proportion_product_reorder = proportion_product_reorder.merge(df_products,ho

# Get the most important columns
cols = ['product_id','product_name','proportion_product_reorders']
proportion_product_reorder = proportion_product_reorder[cols]
proportion_product_reorder.head()
```

Out[95]:

	product_id	product_name	proportion_product_reorders
0	1	Chocolate Sandwich Cookies	56.428571
1	2	All-Seasons Salt	0.000000
2	3	Robust Golden Unsweetened Oolong Tea	73.809524
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	51.020408
4	7	Pure Coconut Water With Orange	50.000000

In [96]:
```
# clean the proportion_product_reorders column
proportion_product_reorder['proportion_product_reorders'] = proportion_produ
proportion_product_reorder.head()
```

Out[96]:

	product_id	product_name	proportion_product_reorders
0	1	Chocolate Sandwich Cookies	56.43%
1	2	All-Seasons Salt	0.0%
2	3	Robust Golden Unsweetened Oolong Tea	73.81%
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	51.02%
4	7	Pure Coconut Water With Orange	50.0%

[C4] For each customer, what proportion of their products ordered are reorders?

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

Out[97]:

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17	0
1	567889	1560	1	1
2	2261212	26683	1	1
3	491251	8670	35	1
4	2571142	1940	5	1

In [98]:
```
df_instacart_orders.head()
```

Out[98]:

	order_id	user_id	order_number	order_dow	order_hour_of_day	days_since_prior_
0	1515936	183418	11	6	13	
1	1690866	163593	5	5	12	
2	1454967	39980	4	5	19	
3	1768857	82516	56	0	20	
4	3007858	196724	2	4	12	

In [99]:
```
df_merge = df_order_products.merge(df_instacart_orders,on="order_id",how="ir
df_merge.head()
```

Out[99]:

	order_id	product_id	add_to_cart_order	reordered	user_id	order_number	order_
0	2141543	11440	17	0	58454	25	
1	2141543	31869	15	1	58454	25	
2	2141543	30233	9	1	58454	25	
3	2141543	27966	20	1	58454	25	
4	2141543	13176	2	1	58454	25	

In [100…
```
proportion_users_reorder = df_merge.groupby('user_id').agg(proportion_user_r
proportion_users_reorder.head()
```

Out[100…

user_id	proportion_user_reorders
2	3.846154
4	0.000000
5	66.666667
6	0.000000
7	92.857143

In [101…

```
# clean the proportion user reorders col
proportion_users_reorder['proportion_user_reorders'] = proportion_users_reor
proportion_users_reorder.head()
```

Out[101…

user_id	proportion_user_reorders
2	3.85%
4	0.0%
5	66.67%
6	0.0%
7	92.86%

[C5] What are the top 20 items that people put in their carts first?

In [102…

```
df_order_products.head()
```

Out[102…

	order_id	product_id	add_to_cart_order	reordered
0	2141543	11440	17	0
1	567889	1560	1	1
2	2261212	26683	1	1
3	491251	8670	35	1
4	2571142	1940	5	1

In [103…

```
df_products.head()
```

Out[103…

	product_id	product_name	aisle_id
0	1	Chocolate Sandwich Cookies	61
1	2	All-Seasons Salt	104
2	3	Robust Golden Unsweetened Oolong Tea	94
3	4	Smart Ones Classic Favorites Mini Rigatoni Wit...	38
4	5	Green Chile Anytime Sauce	5

In [104…

```
# Filter only products that are 1st
df_first = df_order_products.query("add_to_cart_order==1")

top20_1st_products = df_first['product_id'].value_counts().head(20).reset_ir
top20_1st_products.head()
```

Out[104…

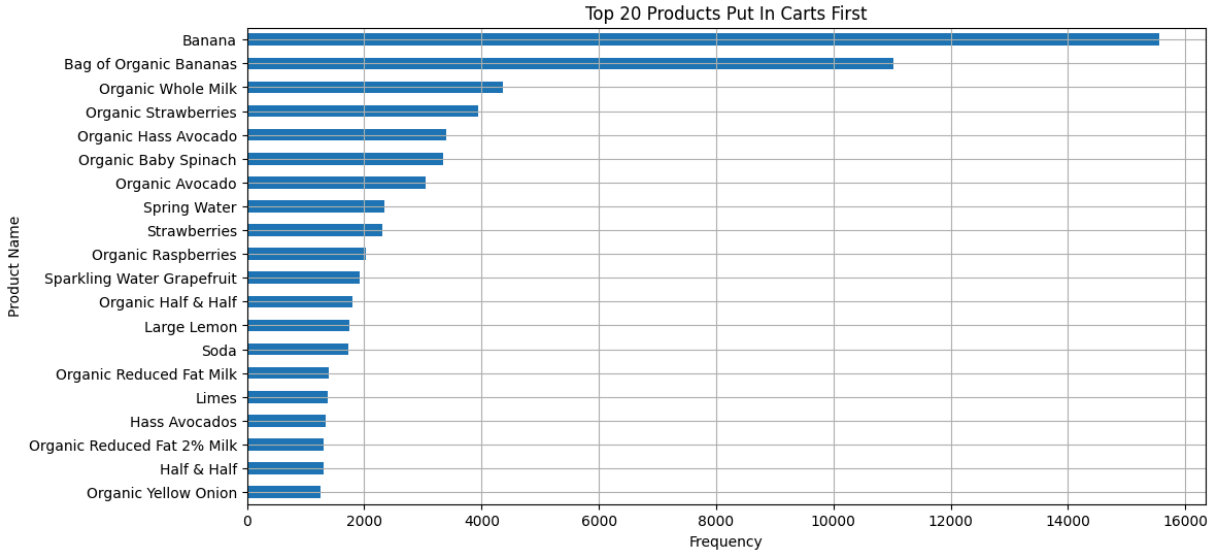
	product_id	Freq
0	24852	15562
1	13176	11026
2	27845	4363
3	21137	3946
4	47209	3390

In [105…

```
top20_1st_products_merge = top20_1st_products.merge(df_products,on='product_

# Plot
top20_1st_products_merge.plot(kind='barh',
                              xlabel = 'Product Name',
                              ylabel = 'Frequency',
                              title = 'Top 20 Products Put In Carts First',
                              figsize=[12,6],
                              legend=False,
                              grid = True)


plt.xlabel('Frequency')
plt.show()
```


Top 20 Products Put In Carts First
Banana
Bag of Organic Bananas
Organic Whole Milk
Organic Strawberries
Organic Hass Avocado
Organic Baby Spinach
Organic Avocado
Spring Water
Strawberries
Organic Raspberries
Sparkling Water Grapefruit
Organic Half & Half
Large Lemon
Soda
Organic Reduced Fat Milk
Limes
Hass Avocados
Organic Reduced Fat 2% Milk
Half & Half
Organic Yellow Onion
Product Name
0
2000
4000
6000
8000
10000
12000
14000
16000
Frequency

In [ ]: