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

Selecting fewer city for ML Ready

- CA California
- TX Texas
- NY New York
- PA Pennsylvania

In [2]:
```
states = ['CA', 'TX', 'NY', 'PA']
chunks = []

for chunk in pd.read_json(
        './yelp_dataset/yelp_academic_dataset_business.json',
        lines=True,
        chunksize=100000):

    filtered = chunk[chunk['state'].isin(states)]
    chunks.append(filtered)

business_df = pd.concat(chunks, ignore_index=True)

business_df.shape
business_df.head()
```

Out[2]:

	business_id	name	address	city	state	postal_code	l
0	Pns2l4eNsfO8kk83dixA6A	Abby Rappoport, LAC, CMQ	1616 Chapala St, Ste 2	Santa Barbara	CA	93101	34
1	MTSW4McQd7CbVtyjqoe9mw	St Honore Pastries	935 Race St	Philadelphia	PA	19107	39
2	mWMc6_wTdE0EUBKIGXDVfA	Perkiomen Valley Brewery	101 Walnut St	Green Lane	PA	18054	40
3	MUTTqe8uqyMdBl186RmNeA	Tuna Bar	205 Race St	Philadelphia	PA	19106	39
4	ROeacJQwBeh05Rqg7F6TCg	BAP	1224 South St	Philadelphia	PA	19147	39

In [3]:
```
business_df = business_df[[
    'business_id',
    'name',
    'city',
    'state',
    'latitude',
    'longitude',
    'categories',
    'stars',
    'review_count',
]]
```

In [4]:
```
cuisine_keywords = ["Indian", "Chinese", "Italian", "Mexican", "Japanese", "Thai
                    "Korean", "French", "Mediterranean", "American", "Vietnamese
                    "Greek", "Spanish", "Lebanese", "Turkish", "Brazilian", "Car
                    "Coffee", "Bakery", "Dessert", "Ice Cream", "Pizza", "Bar",
                     "Burger", "Sushi", "BBQ", "Pasta",
                    "Sandwiches", "Tea", "Juice", "Seafood",
                    "Burger", "Sushi", "BBQ", "Pasta","Chicken Wings",
                    "Sandwich", "Tea", "Juice", "Snack", "Seafood",
                    "Vegan", "Vegetarian","American (Traditional)","American (Ne
```

Again filtering the finanalized keywords from given dataset

In [5]:
```
allowed_food = {kw.lower() for kw in cuisine_keywords}


def extract_food_categories(categories):
    if pd.isna(categories):
        return []

    category_list = [c.strip().lower() for c in categories.split(',')]

    return [c.title() for c in category_list if c in allowed_food]



business_df["food_categories"] = business_df["categories"].apply(extract_food_ca
business_df = business_df[business_df["food_categories"].map(len) > 0]
business_df.shape
```

Out[5]:
```
(10896, 10)
```

In [6]:
```
business_df
```

Out[6]:

	business_id	name	city	state	latitude	longitu
3	MUTTqe8uqyMdBl186RmNeA	Tuna Bar	Philadelphia	PA	39.953949	-75.143
4	ROeacJQwBeh05Rqg7F6TCg	BAP	Philadelphia	PA	39.943223	-75.162
7	QdN72BWoyFypdGJhhI5r7g	Bar One	Philadelphia	PA	39.939825	-75.157
8	Mjboz24M9NlBeiOJKLEd_Q	DeSandro on Main	Philadelphia	PA	40.022466	-75.218
10	kV_Q1oqis8Qli8dUoGpTyQ	Ardmore Pizza	Ardmore	PA	40.006707	-75.289
...	...	...	...	...	...	
39234	gPr1io7ks0Eo3FDsnDTYfg	Tata Cafe	Philadelphia	PA	40.060414	-75.191
39236	wVxXRFf10zTTAs11nr4xeA	PrimoHoagies	Philadelphia	PA	40.032483	-75.214
39239	8n93L-ilMAsvwUatarykSg	Kitchen Gia	Philadelphia	PA	39.951018	-75.198
39241	l9eLGG9ZKpLJzboZq-9LRQ	Wawa	Clifton Heights	PA	39.925656	-75.310
39245	WnT9NIzQgLlILjPT0kEcsQ	Adelita Taqueria & Restaurant	Philadelphia	PA	39.935982	-75.158

10896 rows × 10 columns

In [7]:
```
business_df["food_categories"].value_counts(normalize=True).head(10)
```

Out[7]:
```
food_categories
[Sandwiches]                0.104442
[Pizza]                     0.081957
[American (Traditional)]    0.079203
[American (New)]            0.066722
[Mexican]                   0.064611
[Chinese]                   0.058003
[Italian]                   0.034967
[Japanese]                  0.028726
[Seafood]                   0.023862
[Pizza, Italian]            0.020650
Name: proportion, dtype: float64
```

In [8]:
```
business_df["food_categories"] = business_df["food_categories"].apply(
    lambda x: sorted(x) if isinstance(x, list) else x
)
```

In [9]:
```
business_df["food_categories"].value_counts(normalize=True).head(10)
```

Out[9]:
```
food_categories
[Sandwiches]                0.104442
[Pizza]                     0.081957
[American (Traditional)]    0.079203
[American (New)]            0.066722
[Mexican]                   0.064611
[Chinese]                   0.058003
[Italian, Pizza]            0.038913
[Italian]                   0.034967
[Japanese]                  0.028726
[Seafood]                   0.023862
Name: proportion, dtype: float64
```

mapping categories for ML model

In [10]:
```
craving_map = {
    "Hot_Hearty_Food": [
        "Indian", "Chinese", "Thai", "Korean", "Mexican",
        "Italian", "BBQ", "Pizza", "Pasta", "Chicken Wings",
        "American (Traditional)", "American (New)","Japanese"
    ],

    "Comfort_Food": [
        "Burger", "Sandwich", "Sandwiches", "Snack",
        "American", "Brazilian", "Caribbean"
    ],

    "Cold_Sweet_Food": [
        "Ice Cream", "Dessert", "Bakery", "Juice"
    ],

    "Light_Healthy_Food": [
        "Vegan", "Vegetarian", "Seafood", "Mediterranean",
        "Greek", "Vietnamese", "Lebanese", "Turkish"
    ],

    "Cafe_Beverages": [
        "Coffee", "Tea"
    ],
```

```
    "Alcohol_Social": [
        "Bar"
    ]
}
```

mapping function

In [11]:
```
def map_to_cravings(cuisine_list, craving_map):
    cravings = set()
    for cuisine in cuisine_list:
        for craving, keywords in craving_map.items():
            if cuisine in keywords:
                cravings.add(craving)
    return list(cravings)
```

In [12]:
```
business_df["craving_type"] = business_df["food_categories"].apply(
    lambda x: map_to_cravings(x, craving_map)
)
```

In [13]:
```
business_df.head()
```

Out[13]:

	business_id	name	city	state	latitude	longitude	c
3	MUTTqe8uqyMdBl186RmNeA	Tuna Bar	Philadelphia	PA	39.953949	-75.143226	S Re
4	ROeacJQwBeh05Rqg7F6TCg	BAP	Philadelphia	PA	39.943223	-75.162568	Re
7	QdN72BWoyFypdGJhhI5r7g	Bar One	Philadelphia	PA	39.939825	-75.157447	
8	Mjboz24M9NlBeiOJKLEd_Q	DeSandro on Main	Philadelphia	PA	40.022466	-75.218314	Re Sa
10	kV_Q1oqis8Qli8dUoGpTyQ	Ardmore Pizza	Ardmore	PA	40.006707	-75.289671	Re

Checking null values

In [14]:
```
business_df.isnull().sum()
```

Out[14]:
```
business_id        0
name               0
city               0
state              0
latitude           0
longitude          0
categories         0
stars              0
review_count       0
food_categories    0
craving_type       0
dtype: int64
```

In [15]:
```
business_df.shape
```

Out[15]:
```
(10896, 11)
```

Setup + filter businesses (PA & CA)

In [16]:
```
import pandas as pd
import os
from datetime import datetime
from meteostat import Point, Daily

# Keep only these states (based on what you found)
states = ['PA', 'CA']

# Clean columns
business_df['state'] = business_df['state'].astype(str).str.strip().str.upper()
business_df['city'] = business_df['city'].astype(str).str.strip()

# Filter for locations with coords
biz_locations = (
    business_df[business_df['state'].isin(states)]
    [['business_id', 'city', 'state', 'latitude', 'longitude']]
    .dropna(subset=['latitude', 'longitude', 'city', 'state'])
    .copy()
)

biz_locations['state'].value_counts()
```

Out[16]:
```
state
PA    10006
CA      890
Name: count, dtype: int64
```

Select top K cities per state (controls Meteostat calls)

In [17]:
```
K = 15  # change to 5 if you want even fewer calls

city_counts = (
    biz_locations
    .groupby(['state', 'city'])
    .size()
    .reset_index(name='business_count')
    .sort_values(['state', 'business_count'], ascending=[True, False])
)
```

```
top_cities = city_counts.groupby('state', group_keys=False).head(K)

print("Cities selected per state:")
display(top_cities.groupby('state').size())
top_cities.head()
```

```
Cities selected per state:
state
CA     8
PA    15
dtype: int64
```

Out[17]:

	state	city	business_count
5	CA	Santa Barbara	583
1	CA	Goleta	175
0	CA	Carpinteria	60
2	CA	Isla Vista	46
3	CA	Montecito	21

In [20]:

```
start = datetime(2020, 1, 1)
end   = datetime(2022, 12, 31)

cache_file = f"meteostat_weather_PA_CA_top{K}_cities_2020_2022.csv"

if os.path.exists(cache_file):
    weather_df = pd.read_csv(cache_file, parse_dates=['date'])
    print("Loaded weather from cache:", cache_file)
else:
    weather_data = []

    for _, row in top_cities.iterrows():
        city = row['city']
        state = row['state']

        # Representative point: mean coords of all businesses in that city-state
        coords = biz_locations[
            (biz_locations['city'] == city) &
            (biz_locations['state'] == state)
        ][['latitude', 'longitude']].mean()

        point = Point(coords['latitude'], coords['longitude'])

        w = Daily(point, start, end).fetch().reset_index()

        # Meteostat often returns 'time' column after reset_index()
        if 'time' in w.columns:
            w = w.rename(columns={'time': 'date'})

        w['city'] = city
        w['state'] = state

        weather_data.append(w)

    weather_df = pd.concat(weather_data, ignore_index=True)
```

```
    # Keep only columns you will use (add more if needed)
    keep_cols = ['city', 'state', 'date', 'tavg', 'prcp', 'snow', 'wspd', 'pres'
    weather_df = weather_df[[c for c in keep_cols if c in weather_df.columns]]

    weather_df.to_csv(cache_file, index=False)
    print("Saved weather cache:", cache_file)

weather_df.head()
```

```
Loaded weather from cache: meteostat_weather_PA_CA_top15_cities_2020_2022.csv
```

Out[20]:

	city	state	date	tavg	prcp	snow	wspd	pres
0	Santa Barbara	CA	2020-01-01	11.3	0.0	0.0	6.5	1015.7
1	Santa Barbara	CA	2020-01-02	14.7	0.0	0.0	7.6	1014.6
2	Santa Barbara	CA	2020-01-03	11.5	0.0	0.0	4.3	1022.6
3	Santa Barbara	CA	2020-01-04	9.9	0.0	0.0	3.6	1026.1
4	Santa Barbara	CA	2020-01-05	11.7	0.0	0.0	9.4	1024.8

In [21]:

```
def get_season(month):
    if month in [12, 1, 2]:
        return 'Winter'
    elif month in [3, 4, 5]:
        return 'Spring'
    elif month in [6, 7, 8]:
        return 'Summer'
    else:
        return 'Fall'

weather_df['season'] = weather_df['date'].dt.month.apply(get_season)

# Optional: drop rows missing core weather values
weather_df = weather_df.dropna(subset=['tavg', 'prcp', 'snow'], how='any')

weather_df[['state']].value_counts(), weather_df.head()
```

Out[21]:

```
(state
 PA       8768
 CA       3098
 Name: count, dtype: int64,
             city state       date  tavg  prcp  snow  wspd    pres  season
 0  Santa Barbara    CA 2020-01-01  11.3   0.0   0.0   6.5  1015.7  Winter
 1  Santa Barbara    CA 2020-01-02  14.7   0.0   0.0   7.6  1014.6  Winter
 2  Santa Barbara    CA 2020-01-03  11.5   0.0   0.0   4.3  1022.6  Winter
 3  Santa Barbara    CA 2020-01-04   9.9   0.0   0.0   3.6  1026.1  Winter
 4  Santa Barbara    CA 2020-01-05  11.7   0.0   0.0   9.4  1024.8  Winter)
```

In [22]:

```
print("Weather date range:", weather_df['date'].min(), "to", weather_df['date'].
print("States in weather:", weather_df['state'].unique())
print("Unique city-state points:", weather_df[['city','state']].drop_duplicates(
weather_df.isna().mean().sort_values(ascending=False).head(10)
```

```
Weather date range: 2020-01-01 00:00:00 to 2022-12-31 00:00:00
States in weather: ['CA' 'PA']
Unique city-state points: 16
```

Out[22]:
```
pres      0.00295
city      0.00000
state     0.00000
tavg      0.00000
date      0.00000
prcp      0.00000
snow      0.00000
wspd      0.00000
season    0.00000
dtype: float64
```

This is for checking the data

In [30]:
```
# review_df = pd.read_json(
#     './yelp_dataset/yelp_academic_dataset_review.json',
#     lines=True,
#     dtype={
#         'business_id': str,
#         'user_id': str,
#         'date': str,
#         'stars': float,
#         'useful': int,
#         'funny': int,
#         'cool': int,
#     }
# )

# review_df.shape
# review_df.head()

review_df = pd.read_json(
    './yelp_dataset/yelp_academic_dataset_review.json',
    lines=True,
    nrows=100   # change to 100 / 500 / 1000
)

review_df.shape
review_df.head()
```

Out[30]:

	review_id	user_id	business_id	stars
0	KU_O5udG6zpxOg-VcAEodg	mh_-eMZ6K5RLWhZyISBhwA	XQfwVwDr-v0ZS3_CbbE5Xw	3
1	BiTunyQ73aT9WBnpR9DZGw	OyoGAe7OKpv6SyGZT5g77Q	7ATYjTIgM3jUlt4UM3IypQ	5
2	saUsX_uimxRlCVr67Z4Jig	8g_iMtfSiwikVnbP2etR0A	YjUWPpI6HXG530lwP-fb2A	3
3	AqPFMleE6RsU23_auESxiA	_7bHUi9Uuf5__HHc_Q8guQ	kxX2SOes4o-D3ZQBkiMRfA	5
4	Sx8TMOWLNuJBWer-0pcmoA	bcjbaE6dDog4jkNY91ncLQ	e4Vwtrqf-wpJfwesgvdgxQ	4

actual code

In [24]:

```
biz_key = (
    business_df[business_df['state'].isin(states)]
    [['business_id', 'city', 'state', 'craving_type']]
    .dropna()
)

biz_key.shape

review_file = './yelp_dataset/yelp_academic_dataset_review.json'

chunksize = 100_000   # you can use 50_000 if RAM is low

review_chunks = []

for chunk in pd.read_json(
    review_file,
    lines=True,
```

```
    chunksize=chunksize
):
    # Parse date
    chunk['date'] = pd.to_datetime(chunk['date'], errors='coerce')

    # Filter to date range early (BIG memory saver)
    chunk = chunk[
        (chunk['date'] >= '2020-01-01') &
        (chunk['date'] <= '2022-12-31')
    ]

    # Filter to PA & CA businesses early
    chunk = chunk[chunk['business_id'].isin(biz_key['business_id'])]

    # Keep only required columns
    chunk = chunk[['review_id', 'business_id', 'date', 'stars']]

    if not chunk.empty:
        review_chunks.append(chunk)

print("Chunks processed:", len(review_chunks))
```

```
Chunks processed: 46
```

In [25]:
```
review_df_filtered = pd.concat(review_chunks, ignore_index=True)

review_df_filtered.shape
review_df_filtered.head()
```

Out[25]:

	review_id	business_id	date	stars
0	5-tLhwWjSzHYN6NyMy9Suw	bdfZdB2MTXlT6-RBjSIpQg	2020-01-26 21:21:04	4
1	4M72cXIgMLwXo8METuXZeQ	MbzgGsMQpGyVrUJXi_Jw0Q	2020-01-08 07:25:10	5
2	J1LZjzbs5bFubvS135SD2g	dChRGpit9fM_kZK5pafNyA	2020-01-20 00:36:44	5
3	UH6UMf46vhjiYtslE0ESPQ	iHdrLu8deF5GceB0V1rPhA	2020-02-08 02:18:46	5
4	qrjp2TICzzF06_QlAM39vA	iDtIMWJVIGYspg5JvJKaOw	2020-02-01 02:11:02	1

In [26]:
```
reviews_enriched = review_df_filtered.merge(
    biz_key,
    on='business_id',
    how='inner'
)

# Convert datetime to date only (for weather join)
reviews_enriched['date'] = reviews_enriched['date'].dt.date

reviews_enriched.shape, reviews_enriched.head()
```

Out[26]:
```
((148363, 7),
                 review_id             business_id        date  stars  \
 0  5-tLhwWjSzHYN6NyMy9Suw  bdfZdB2MTXlT6-RBjSIpQg  2020-01-26      4
 1  4M72cXIgMLwXo8METuXZeQ  MbzgGsMQpGyVrUJXi_Jw0Q  2020-01-08      5
 2  J1LZjzbs5bFubvS135SD2g  dChRGpit9fM_kZK5pafNyA  2020-01-20      5
 3  UH6UMf46vhjiYtslE0ESPQ  iHdrLu8deF5GceB0V1rPhA  2020-02-08      5
 4  qrjp2TICzzF06_QlAM39vA  iDtIMWJVIGYspg5JvJKaOw  2020-02-01      1

            city state                          craving_type
 0    Isla Vista    CA  [Hot_Hearty_Food, Light_Healthy_Food]
 1  Santa Barbara    CA                    [Hot_Hearty_Food]
 2   Philadelphia    PA                    [Hot_Hearty_Food]
 3  Santa Barbara    CA  [Hot_Hearty_Food, Light_Healthy_Food]
 4     Wynnewood    PA                    [Hot_Hearty_Food]  )
```

saving intermediate file

In [35]:
```
reviews_enriched.to_parquet(
    "reviews_enriched_PA_CA_2020_2022.parquet",
    index=False
)
```

This is just to see what's there

In [27]:
```
review_df_sample = pd.read_json(
    './yelp_dataset/yelp_academic_dataset_checkin.json',
    lines=True,
    nrows=100   # change to 100 / 500 / 1000
)

review_df_sample.shape
review_df_sample.head()
```

Out[27]:

	business_id	date
0	---kPU91CF4Lq2-WlRu9Lw	2020-03-13 21:10:56, 2020-06-02 22:18:06, 2020...
1	--0iUa4sNDFiZFrAdIWhZQ	2010-09-13 21:43:09, 2011-05-04 23:08:15, 2011...
2	--30_8IhuyMHbSOcNWd6DQ	2013-06-14 23:29:17, 2014-08-13 23:20:22
3	--7PUidqRWpRSpXebiyxTg	2011-02-15 17:12:00, 2011-07-28 02:46:10, 2012...
4	--7jw19RH9JKXgFohspgQw	2014-04-21 20:42:11, 2014-04-28 21:04:46, 2014...

In [28]:
```
states = ['PA', 'CA']

biz_key = (
    business_df[business_df['state'].isin(states)]
    [['business_id', 'city', 'state', 'craving_type']]
    .dropna()
)

biz_ids = set(biz_key['business_id'].unique())
len(biz_ids)
```

Out[28]:
```
10896
```

In [29]:
```
checkin_file = './yelp_dataset/yelp_academic_dataset_checkin.json'
chunksize = 50_000   # adjust (50k/100k) depending on RAM

# We'll accumulate daily counts in a dictionary (business_id, date) -> count
from collections import Counter
daily_counter = Counter()

for chunk in pd.read_json(checkin_file, lines=True, chunksize=chunksize):

    # Keep only business_id in PA/CA
    chunk = chunk[chunk['business_id'].isin(biz_ids)]
    if chunk.empty:
        continue

    # Split timestamp list and explode
    chunk['date_list'] = chunk['date'].astype(str).str.split(', ')
    exploded = chunk[['business_id', 'date_list']].explode('date_list', ignore_i

    # Parse datetime
    exploded['checkin_dt'] = pd.to_datetime(exploded['date_list'], errors='coerc

    # Filter 2020-2022 early
    mask = (exploded['checkin_dt'] >= '2020-01-01') & (exploded['checkin_dt'] <=
    exploded = exploded[mask]
    if exploded.empty:
        continue

    exploded['date'] = exploded['checkin_dt'].dt.date

    # Count per business per day in this chunk
    grp = exploded.groupby(['business_id', 'date']).size()

    # Add to global counter
    for (bid, d), cnt in grp.items():
        daily_counter[(bid, d)] += int(cnt)

print("Unique (business_id, date) pairs counted:", len(daily_counter))
```

```
Unique (business_id, date) pairs counted: 93750
```

In [30]:
```
checkins_daily = pd.DataFrame(
    [(bid, d, cnt) for (bid, d), cnt in daily_counter.items()],
    columns=['business_id', 'date', 'checkin_count']
)
```

In [31]:
```
print("checkins_daily shape:", checkins_daily.shape)
checkins_daily.head(30)
```

```
checkins_daily shape: (93750, 3)
```

Out[31]:

	business_id	date	checkin_count
0	--epgcb7xHGuJ-4PUeSLAw	2020-02-09	1
1	--epgcb7xHGuJ-4PUeSLAw	2020-05-31	1
2	--epgcb7xHGuJ-4PUeSLAw	2020-10-12	1
3	--epgcb7xHGuJ-4PUeSLAw	2020-11-07	1
4	--epgcb7xHGuJ-4PUeSLAw	2021-04-03	1
5	-0FX23yAacC4bbLaGPvyxw	2020-02-01	1
6	-0FX23yAacC4bbLaGPvyxw	2020-02-07	1
7	-0FX23yAacC4bbLaGPvyxw	2020-06-13	1
8	-0FX23yAacC4bbLaGPvyxw	2020-08-07	1
9	-0FX23yAacC4bbLaGPvyxw	2020-08-18	1
10	-0FX23yAacC4bbLaGPvyxw	2020-09-27	1
11	-0FX23yAacC4bbLaGPvyxw	2020-10-18	1
12	-0FX23yAacC4bbLaGPvyxw	2020-11-06	1
13	-0FX23yAacC4bbLaGPvyxw	2021-04-17	1
14	-0FX23yAacC4bbLaGPvyxw	2021-05-02	1
15	-0FX23yAacC4bbLaGPvyxw	2021-06-19	1
16	-0FX23yAacC4bbLaGPvyxw	2021-08-31	1
17	-0FX23yAacC4bbLaGPvyxw	2021-09-05	2
18	-0FX23yAacC4bbLaGPvyxw	2021-09-25	1
19	-0FX23yAacC4bbLaGPvyxw	2021-10-06	1
20	-0FX23yAacC4bbLaGPvyxw	2021-10-17	1
21	-0FX23yAacC4bbLaGPvyxw	2021-10-30	1
22	-0FX23yAacC4bbLaGPvyxw	2021-12-04	1
23	-0FX23yAacC4bbLaGPvyxw	2021-12-11	1
24	-0TffRSXXIlBYVbb5AwfTg	2020-01-01	1
25	-0TffRSXXIlBYVbb5AwfTg	2020-01-18	1
26	-0TffRSXXIlBYVbb5AwfTg	2020-01-21	1
27	-0TffRSXXIlBYVbb5AwfTg	2020-01-23	1
28	-0TffRSXXIlBYVbb5AwfTg	2020-01-25	1
29	-0TffRSXXIlBYVbb5AwfTg	2020-01-31	1

In [32]:
```
checkins_daily.shape
```

Out[32]:
```
(93750, 3)
```

- checkins_daily = pd.read_parquet("checkins_daily_PA_CA_2020_2022.parquet")
- To read the below file

In [44]:
```
checkins_daily.to_parquet("checkins_daily_PA_CA_2020_2022.parquet", index=False)
```

In [33]:
```
# Ensure weather_df date format is compatible
weather_df['date'] = pd.to_datetime(weather_df['date'], errors='coerce').dt.date

checkins_enriched = checkins_daily.merge(
    biz_key,
    on='business_id',
    how='inner'
)

checkin_weather_df = checkins_enriched.merge(
    weather_df,
    on=['city','state','date'],
    how='inner'
)

checkin_weather_df.shape, checkin_weather_df.head()
```

Out[33]:
```
((55257, 12),
               business_id        date  checkin_count          city state  \
 0  -0TffRSXXIlBYVbb5AwfTg  2020-01-01              1  Philadelphia    PA
 1  -0TffRSXXIlBYVbb5AwfTg  2020-01-18              1  Philadelphia    PA
 2  -0TffRSXXIlBYVbb5AwfTg  2020-01-21              1  Philadelphia    PA
 3  -0TffRSXXIlBYVbb5AwfTg  2020-01-23              1  Philadelphia    PA
 4  -0TffRSXXIlBYVbb5AwfTg  2020-01-25              1  Philadelphia    PA

         craving_type  tavg  prcp  snow  wspd    pres  season
 0  [Hot_Hearty_Food]   4.8   0.0   0.0  14.8  1009.9  Winter
 1  [Hot_Hearty_Food]  -3.8   6.4   0.0  14.8  1028.0  Winter
 2  [Hot_Hearty_Food]  -3.2   0.0   0.0  15.5  1031.6  Winter
 3  [Hot_Hearty_Food]   0.6   0.0   0.0   2.2  1029.4  Winter
 4  [Hot_Hearty_Food]   7.8  40.6   0.0  20.2  1012.5  Winter  )
```

Build Review-Weather dataset

In [34]:
```
# Ensure date formats match
weather_df['date'] = pd.to_datetime(weather_df['date'], errors='coerce').dt.date
review_df_filtered['date'] = pd.to_datetime(review_df_filtered['date'], errors='

reviews_enriched = review_df_filtered.merge(
    biz_key[['business_id','city','state','craving_type']],
    on='business_id',
    how='inner'
)

review_weather_df = reviews_enriched.merge(
    weather_df,
    on=['city','state','date'],
    how='inner'
)

review_weather_df.shape, review_weather_df.head()
```

Out[34]: ((83645, 13),

	review_id	business_id	date	stars	\
0	5-tLhwWjSzHYN6NyMy9Suw	bdfZdB2MTXlT6-RBjSIpQg	2020-01-26	4	
1	4M72cXIgMLwXo8METuXZeQ	MbzgGsMQpGyVrUJXi_Jw0Q	2020-01-08	5	
2	J1LZjzbs5bFubvS135SD2g	dChRGpit9fM_kZK5pafNyA	2020-01-20	5	
3	UH6UMf46vhjiYtslE0ESPQ	iHdrLu8deF5GceB0V1rPhA	2020-02-08	5	
4	Z44AVfLHEztjNk-OdFLBxw	-3AooxIkg38UyUdlz5oXdw	2020-03-06	5	

	city	state	craving_type	tavg	prcp	\
0	Isla Vista	CA	[Hot_Hearty_Food, Light_Healthy_Food]	13.5	0.0	
1	Santa Barbara	CA	[Hot_Hearty_Food]	12.3	0.0	
2	Philadelphia	PA	[Hot_Hearty_Food]	-2.3	0.0	
3	Santa Barbara	CA	[Hot_Hearty_Food, Light_Healthy_Food]	10.7	0.0	
4	Santa Barbara	CA	[Hot_Hearty_Food]	12.8	0.0	

	snow	wspd	pres	season
0	0.0	6.5	1020.3	Winter
1	0.0	11.2	1015.5	Winter
2	0.0	21.6	1025.5	Winter
3	0.0	4.7	1015.4	Winter
4	0.0	10.4	1016.1	Spring

)

Create ML table from CHECKINS (craving_type × season)

In [48]:
```
import numpy as np

def list_to_str(x):
    if isinstance(x, list):
        return x[0] if len(x) > 0 else np.nan
    return x

checkin_weather_df['craving_type'] = checkin_weather_df['craving_type'].apply(li
```

In [51]:
```
business_df['craving_type'] = business_df['craving_type'].apply(list_to_str)
biz_key['craving_type'] = biz_key['craving_type'].apply(list_to_str)
```

In [52]:
```
ml_checkins = (
    checkin_weather_df
    .groupby(['craving_type','season'])
    .agg(
        avg_temp=('tavg','mean'),
        avg_prcp=('prcp','mean'),
        avg_snow=('snow','mean'),
        avg_wind=('wspd','mean'),
        avg_pressure=('pres','mean'),
        checkin_volume=('checkin_count','sum'),
        active_days=('date','nunique'),
        unique_businesses=('business_id','nunique')
    )
    .reset_index()
)

ml_checkins.head()
```

Out[52]:

	craving_type	season	avg_temp	avg_prcp	avg_snow	avg_wind	avg_pressure
0	Comfort_Food	Fall	15.912946	2.032639	0.000000	11.464290	1018.213289
1	Comfort_Food	Spring	12.405437	1.978596	0.000000	14.402753	1017.768992
2	Comfort_Food	Summer	24.169133	3.960694	0.000000	11.266590	1015.045491
3	Comfort_Food	Winter	4.819920	2.213679	0.282869	13.478398	1018.813105
4	Hot_Hearty_Food	Fall	15.840211	1.986661	0.000000	11.306767	1017.794846

In [54]:
```
def list_to_str(x):
    if isinstance(x, list):
        return x[0] if len(x) > 0 else np.nan
    return x

review_weather_df['craving_type'] = review_weather_df['craving_type'].apply(list
```

In [55]:
```
for df in [business_df, biz_key, checkin_weather_df]:
    if 'craving_type' in df.columns:
        df['craving_type'] = df['craving_type'].apply(list_to_str)
```

In [56]:
```
ml_reviews = (
    review_weather_df
    .groupby(['craving_type','season'])
    .agg(
        avg_rating=('stars','mean'),
        review_volume=('review_id','count')
    )
    .reset_index()
)

ml_reviews.head()
```

Out[56]:

	craving_type	season	avg_rating	review_volume
0	Comfort_Food	Fall	3.852219	2321
1	Comfort_Food	Spring	3.921979	1961
2	Comfort_Food	Summer	3.904308	2414
3	Comfort_Food	Winter	3.990406	2710
4	Hot_Hearty_Food	Fall	3.889855	16097

In [ ]:
```
ml_df = ml_checkins.merge(
    ml_reviews,
    on=['craving_type','season'],
    how='left'
)

# Fill missing review metrics (if a craving-season had checkins but no reviews)
ml_df[['avg_rating','review_volume']] = ml_df[['avg_rating','review_volume']].fi

ml_df.shape, ml_df.head()
```

Out[ ]:
```
((12, 12),
       craving_type  season   avg_temp  avg_prcp  avg_snow   avg_wind  \
 0     Comfort_Food    Fall  15.912946  2.032639  0.000000  11.464290
 1     Comfort_Food  Spring  12.405437  1.978596  0.000000  14.402753
 2     Comfort_Food  Summer  24.169133  3.960694  0.000000  11.266590
 3     Comfort_Food  Winter   4.819920  2.213679  0.282869  13.478398
 4  Hot_Hearty_Food    Fall  15.840211  1.986661  0.000000  11.306767

    avg_pressure  checkin_volume  active_days  unique_businesses  avg_rating  \
 0   1018.213289            2097          182                316    3.852219
 1   1017.768992            1589          180                307    3.921979
 2   1015.045491            1990          184                302    3.904308
 3   1018.813105            2621          199                363    3.990406
 4   1017.794846           11717          182               1739    3.889855

    review_volume
 0           2321
 1           1961
 2           2414
 3           2710
 4          16097  )
```

In [58]:
```
def add_intensity(group):
    if group['checkin_volume'].nunique() < 3:
        group['checkin_intensity'] = 'Medium'
    else:
        group['checkin_intensity'] = pd.qcut(
            group['checkin_volume'].rank(method='first'),
            q=3,
            labels=['Low','Medium','High']
        )
    return group

ml_df = ml_df.groupby('season', group_keys=False).apply(add_intensity)
ml_df.head()
```

```
DeprecationWarning: DataFrameGroupBy.apply operated on the grouping columns. This
behavior is deprecated, and in a future version of pandas the grouping columns wi
ll be excluded from the operation. Either pass `include_groups=False` to exclude
the groupings or explicitly select the grouping columns after groupby to silence
this warning.
```

Out[58]:

	craving_type	season	avg_temp	avg_prcp	avg_snow	avg_wind	avg_pressure
0	Comfort_Food	Fall	15.912946	2.032639	0.000000	11.464290	1018.213289
1	Comfort_Food	Spring	12.405437	1.978596	0.000000	14.402753	1017.768992
2	Comfort_Food	Summer	24.169133	3.960694	0.000000	11.266590	1015.045491
3	Comfort_Food	Winter	4.819920	2.213679	0.282869	13.478398	1018.813105
4	Hot_Hearty_Food	Fall	15.840211	1.986661	0.000000	11.306767	1017.794846

In [59]:
```
ml_df.to_csv("ml_ready_table_PA_2020_2022.csv", index=False)
ml_df.to_parquet("ml_ready_table_PA_2020_2022.parquet", index=False)
```

In [60]:
```
checkin_weather_df['state'].value_counts()
```

```
weather_df['state'].value_counts()
```

Out[60]:
```
state
PA    8768
CA    3098
Name: count, dtype: int64
```

In [62]:
```
ml_df
```

Out[62]:

	craving_type	season	avg_temp	avg_prcp	avg_snow	avg_wind	avg_pressur
0	Comfort_Food	Fall	15.912946	2.032639	0.000000	11.464290	1018.21328
1	Comfort_Food	Spring	12.405437	1.978596	0.000000	14.402753	1017.76899
2	Comfort_Food	Summer	24.169133	3.960694	0.000000	11.266590	1015.04549
3	Comfort_Food	Winter	4.819920	2.213679	0.282869	13.478398	1018.81310
4	Hot_Hearty_Food	Fall	15.840211	1.986661	0.000000	11.306767	1017.79484
5	Hot_Hearty_Food	Spring	12.393860	2.521659	0.000000	14.433800	1017.79994
6	Hot_Hearty_Food	Summer	23.870461	3.902481	0.000000	11.296005	1015.16257
7	Hot_Hearty_Food	Winter	5.347411	2.158728	0.230880	13.000780	1018.95900
8	Light_Healthy_Food	Fall	15.912879	1.828375	0.000000	10.886708	1017.51497
9	Light_Healthy_Food	Spring	12.762081	2.498733	0.000000	14.226244	1017.26396
10	Light_Healthy_Food	Summer	23.304971	2.663231	0.000000	11.093787	1014.94671
11	Light_Healthy_Food	Winter	5.733001	1.855482	0.219823	12.633998	1018.98096

Continue after ML ready dataset

In [35]:
```
import pandas as pd
import numpy as np

df = checkin_weather_df.copy()

# Keep only what we need (add/remove weather columns as you have them)
feature_cols_num = ['tavg','tmin','tmax','prcp','snow','wspd','pres']  # adjust
feature_cols_cat = ['season','city','state']

# Basic cleaning
df = df.dropna(subset=['craving_type'])  # target must exist

# Ensure numeric cols exist (ignore missing ones safely)
feature_cols_num = [c for c in feature_cols_num if c in df.columns]

# Optional: remove rows where all weather is missing
df = df.dropna(subset=feature_cols_num, how='all')

X = df[feature_cols_num + feature_cols_cat].copy()
y = df['craving_type'].astype(str)

print("Rows:", len(df))
```

```
print("Classes:", y.nunique())
y.value_counts().head(10)
```

```
Rows: 55257
Classes: 8
```

Out[35]:

```
craving_type
['Hot_Hearty_Food']                                          29871
['Hot_Hearty_Food', 'Light_Healthy_Food']                     6852
['Comfort_Food']                                              6165
['Light_Healthy_Food']                                        4854
['Hot_Hearty_Food', 'Comfort_Food']                           4583
['Hot_Hearty_Food', 'Comfort_Food', 'Light_Healthy_Food']      1104
['Comfort_Food', 'Light_Healthy_Food']                        1100
[]                                                             728
Name: count, dtype: int64
```

Train/test split (time-based = more realistic)

Use 2020–2021 train, 2022 test (looks professional + avoids leakage).

In [36]:

```
df['date'] = pd.to_datetime(df['date'])

train_df = df[df['date'] < '2022-01-01'].copy()
test_df  = df[df['date'] >= '2022-01-01'].copy()

X_train = train_df[feature_cols_num + feature_cols_cat]
y_train = train_df['craving_type'].astype(str)

X_test  = test_df[feature_cols_num + feature_cols_cat]
y_test  = test_df['craving_type'].astype(str)

print("Train:", X_train.shape, "Test:", X_test.shape)
```

```
Train: (54388, 8) Test: (869, 8)
```

Pipeline (OneHot + Impute) + Logistic Regression (baseline)

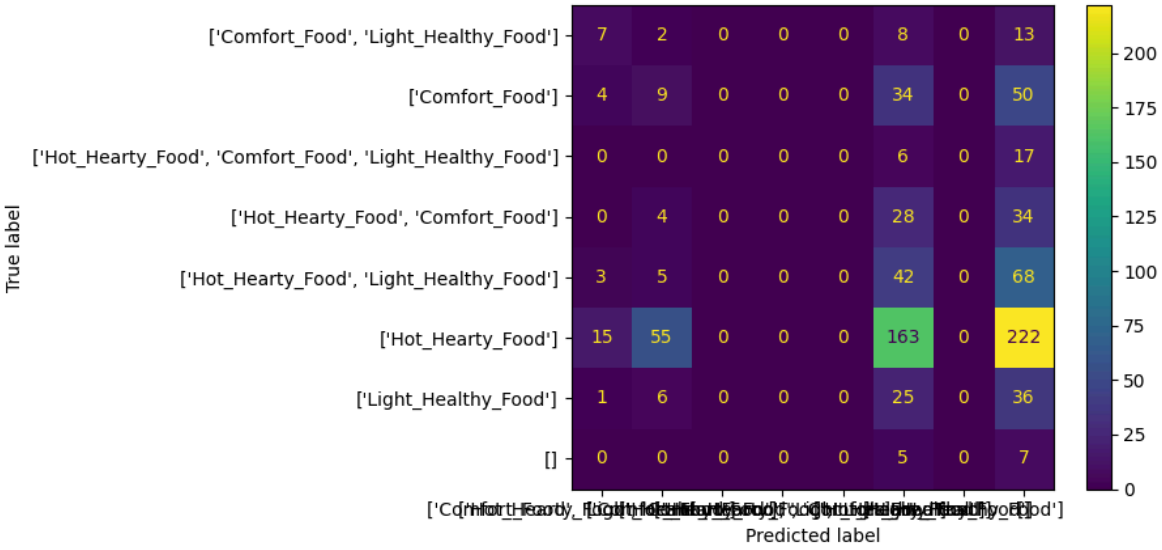
In [37]:

```
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import OneHotEncoder
from sklearn.impute import SimpleImputer
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, confusion_matrix, ConfusionMa

numeric_transformer = Pipeline(steps=[
    ("imputer", SimpleImputer(strategy="median"))
])

categorical_transformer = Pipeline(steps=[
    ("imputer", SimpleImputer(strategy="most_frequent")),
    ("onehot", OneHotEncoder(handle_unknown="ignore"))
])

preprocess = ColumnTransformer(
    transformers=[
        ("num", numeric_transformer, feature_cols_num),
        ("cat", categorical_transformer, feature_cols_cat),
    ]
)
```

```
logreg = Pipeline(steps=[
    ("preprocess", preprocess),
    ("model", LogisticRegression(
        max_iter=2000,
        class_weight="balanced",
        multi_class="auto"
    ))
])

logreg.fit(X_train, y_train)
pred_lr = logreg.predict(X_test)

print(classification_report(y_test, pred_lr))
cm = confusion_matrix(y_test, pred_lr, labels=logreg.named_steps["model"].classe
ConfusionMatrixDisplay(cm, display_labels=logreg.named_steps["model"].classes_).
```

```
FutureWarning: 'multi_class' was deprecated in version 1.5 and will be removed in
1.7. From then on, it will always use 'multinomial'. Leave it to its default valu
e to avoid this warning.
ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. OF ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
                                                    precision    recall  f
1-score   support

                  ['Comfort_Food', 'Light_Healthy_Food']       0.23      0.23
0.23        30
                                       ['Comfort_Food']       0.11      0.09
0.10        97
['Hot_Hearty_Food', 'Comfort_Food', 'Light_Healthy_Food']       0.00      0.00
0.00        23
                    ['Hot_Hearty_Food', 'Comfort_Food']       0.00      0.00
0.00        66
                ['Hot_Hearty_Food', 'Light_Healthy_Food']       0.00      0.00
0.00       118
                                    ['Hot_Hearty_Food']       0.52      0.36
0.43       455
                                ['Light_Healthy_Food']       0.00      0.00
0.00        68
                                                    []       0.02      0.58
0.03        12

                                             accuracy
0.21       869
                                            macro avg       0.11      0.16
0.10       869
                                         weighted avg       0.30      0.21
0.24       869
```

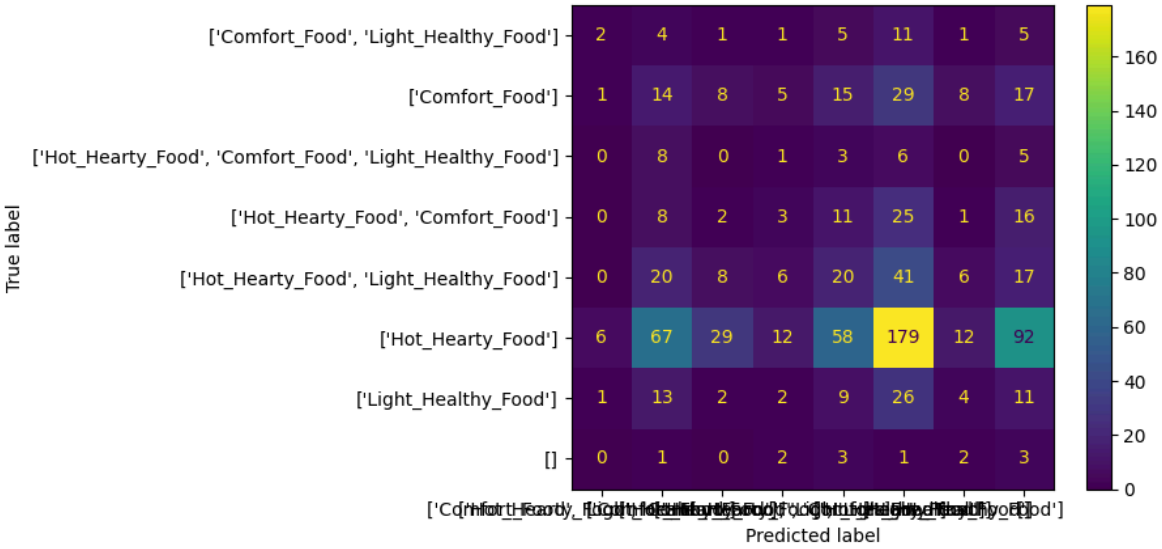
Out[37]: <sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x1ee87a67ad0>



In [38]:
```
from sklearn.ensemble import RandomForestClassifier

rf = Pipeline(steps=[
    ("preprocess", preprocess),
    ("model", RandomForestClassifier(
        n_estimators=300,
        random_state=42,
        class_weight="balanced_subsample",
        n_jobs=-1
    ))
])

rf.fit(X_train, y_train)
pred_rf = rf.predict(X_test)

print(classification_report(y_test, pred_rf))
cm = confusion_matrix(y_test, pred_rf, labels=rf.named_steps["model"].classes_)
ConfusionMatrixDisplay(cm, display_labels=rf.named_steps["model"].classes_).plot
```

```
                                                                precision    recall  f
1-score   support

                     ['Comfort_Food', 'Light_Healthy_Food']       0.20      0.07
0.10        30
                                          ['Comfort_Food']       0.10      0.14
0.12        97
['Hot_Hearty_Food', 'Comfort_Food', 'Light_Healthy_Food']       0.00      0.00
0.00        23
                        ['Hot_Hearty_Food', 'Comfort_Food']       0.09      0.05
0.06        66
                    ['Hot_Hearty_Food', 'Light_Healthy_Food']       0.16      0.17
0.17       118
                                       ['Hot_Hearty_Food']       0.56      0.39
0.46       455
                                    ['Light_Healthy_Food']       0.12      0.06
0.08        68
                                                        []       0.02      0.25
0.03        12

                                                 accuracy
0.26       869
                                                macro avg       0.16      0.14
0.13       869
                                             weighted avg       0.35      0.26
0.29       869
```

Out[38]: <sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x1ee882fd910>



A) Feature importance for Random Forest

In [39]:
```
import pandas as pd

# Get feature names after preprocessing
ohe = rf.named_steps["preprocess"].named_transformers_["cat"].named_steps["oneho
cat_features = ohe.get_feature_names_out(feature_cols_cat)

all_features = list(feature_cols_num) + list(cat_features)

importances = rf.named_steps["model"].feature_importances_
fi = pd.DataFrame({"feature": all_features, "importance": importances}).sort_val
```

```
fi.head(20)
```

Out[39]:

	feature	importance
4	pres	0.259647
0	tavg	0.256633
3	wspd	0.234414
1	prcp	0.090248
10	city_Carpinteria	0.023904
13	city_King of Prussia	0.019215
6	season_Spring	0.010978
5	season_Fall	0.010603
9	city_Ardmore	0.009954
8	season_Winter	0.009372
20	city_Santa Barbara	0.009189
18	city_Philadelphia	0.008476
7	season_Summer	0.008284
11	city_Goleta	0.007398
16	city_Montecito	0.006235
2	snow	0.005371
24	city_West Chester	0.004720
26	state_PA	0.004518
25	state_CA	0.004512
15	city_Media	0.003935

In [ ]: