Análise de Tendências em Dados de Busca de Aplicativos Usando Algoritmos de Aprendizado Não Supervisionado

IMD3003 – Aprendizado de Máquina Não-Supervisionado 2025.2

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Contexto e Inspiração

O Modelo do iFood

Este trabalho baseia-se no modelo inovador desenvolvido pelo iFood, apresentado pelo CEO da empresa em entrevista. A plataforma utiliza algoritmos avançados para identificar tendências emergentes com base nas buscas dos usuários.

O sistema considera três dimensões essenciais: o **texto pesquisado**, o **horário da busca** e a **região geográfica**. Essa combinação permite detectar demandas latentes e conectar restaurantes a oportunidades de mercado ainda não exploradas.

Objetivo do Trabalho

Identificar Tendências

Detectar padrões de comportamento de usuários em buscas por restaurantes usando aprendizado não-supervisionado

Aplicar Algoritmos

Utilizar K-Means, Agglomerative Clustering e Embeddings para agrupar dados de forma inteligente

Recomendar Restaurantes

Selecionar estabelecimentos capazes de atender demandas identificadas pelos clusters

Conjuntos de Dados Utilizados

Dados do Uber Eats (Kaggle)

Conjunto de dados contendo listas de restaurantes e seus respectivos cardápios nos Estados Unidos, parceiros do Uber Eats. Este dataset forneceu informações sobre categorias, localizações e características dos estabelecimentos.
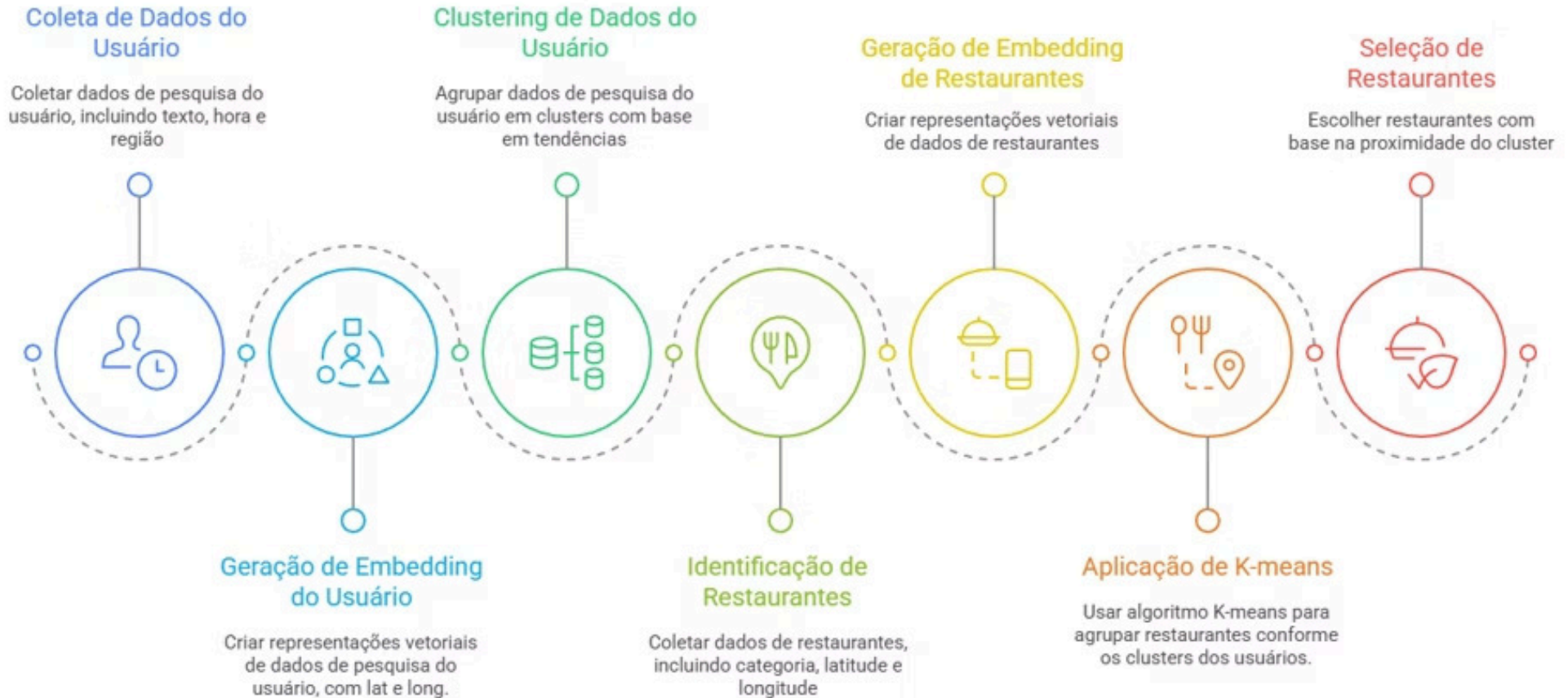
Fonte: kaggle.com/datasets/ahmedshahriarsakib/uber-eats-usa-restaurants-menus

Dados Sintéticos de Buscas

Como informações de buscas reais não estavam disponíveis publicamente, foi necessário criar um conjunto de dados sintéticos simulando buscas de usuários, incluindo termos pesquisados, data, horário e localização geográfica.

Dataset desenvolvido especificamente para este projeto

Processo de Identificação de Tendências e Seleção de Restaurantes

Coleta de Dados do Usuário
Coletar dados de pesquisa do usuário, incluindo texto, hora e região

Geração de Embedding do Usuário
Criar representações vetoriais de dados de pesquisa do usuário, com lat e long.

Clustering de Dados do Usuário
Agrupar dados de pesquisa do usuário em clusters com base em tendências

Identificação de Restaurantes
Coletar dados de restaurantes, incluindo categoria, latitude e longitude

Geração de Embedding de Restaurantes
Criar representações vetoriais de dados de restaurantes

Aplicação de K-means
Usar algoritmo K-means para agrupar restaurantes conforme os clusters dos usuários.

Seleção de Restaurantes
Escolher restaurantes com base na proximidade do cluster

Determinação do Número Ideal de Clusters

Método do Cotovelo

Avaliação da variação da inércia para diferentes valores de k, identificando o ponto onde a redução deixa de ser significativa.

Cluster Hierárquico Aglomerativo

Análise de dendrogramas para identificar visualmente o k mais adequado com base nas distâncias entre junções.

Resultados: Clusters por Período

1 | **Breakfast - 2 Clusters**

Menor volume de buscas. Tendências identificadas: opções rápidas e saudáveis para início do dia
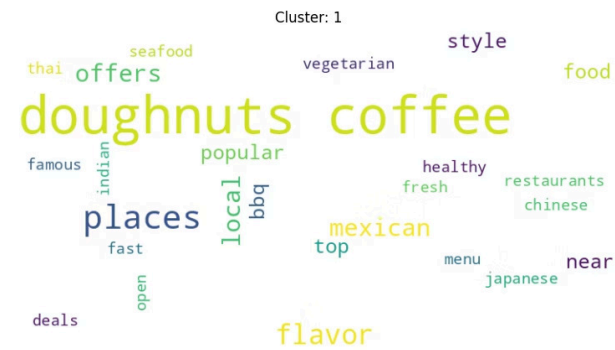
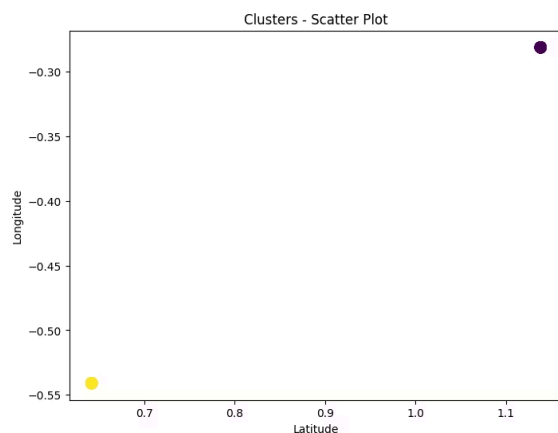**2** | **Lunch - 4 Clusters**

Maior diversidade de preferências. Padrões incluem fast food, comida caseira, opções executivas e refeições rápidas

3 | **Dinner - 3 Clusters**

Variedade moderada. Tendências focadas em refeições completas, pizza/fast food e opções premium

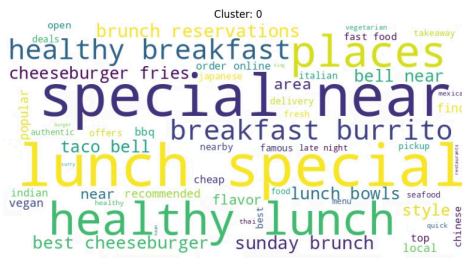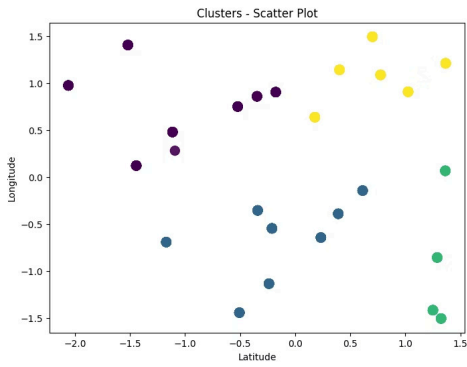# Análise Visual dos Clusters - Breakfast
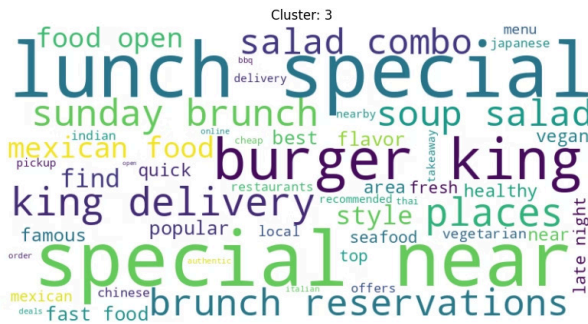
Análise Visual dos Clusters - Breakfast

name	category	price_range	clusters	prob
Starbucks (Central Entrance & Anderson Rd)	bakery breakfast brunch cafe coffee amp tea	$	0	0.573743
Dunkin' (3110 Tower Ave)	breakfast brunch donuts	$	0	0.572991
Pretzelmaker (1600 Miller Trunk Hwy)	fast food bakery desserts	$	0	0.568115
Cold Stone Creamery (1017 W Central Entrance)	ice cream frozen yogurt desserts cupcakes	$	0	0.565338
Caribou Coffee (627 West Central Entrance)	cafe sandwich	$$	0	0.565230
Cold Stone Creamery (349 Canal Park Drive)	ice cream frozen yogurt desserts cupcakes	$	0	0.565225
Caribou Coffee (2100 London Road)	cafe sandwich	$$	0	0.565153
Perkins Restaurant & Bakery (103 E 2nd Str...	breakfast brunch american dinner bakery	$$	0	0.564048
Cabin Coffee Co-Rice Lake Wi	coffee tea american breakfast brunch	$$	0	0.563212
Starbucks (Hastings & Kirk)	bakery breakfast brunch cafe coffee amp tea	$	0	0.563073
Taco Bell (1031 West Central Entrance)	burritos fast food mexican	$	0	0.562726
Taco Bell (201 North 44th Ave. W)	burritos fast food mexican	$	0	0.562550
Dunkin' (1431 South Hastings Way)	breakfast brunch donuts	$	0	0.562343
Dairy Queen Grill & Chill (3100 Tower Ave)	american fast food ice cream amp frozen yogurt	$	0	0.562204
Papa Murphy's (4602 Grand Avenue Suite 400)	pizza american desserts	$$	0	0.562148
Next Door Cafe	coffee tea american breakfast brunch	$$	0	0.561829
Bean Bag Coffee House	coffee tea american breakfast brunch	$$	0	0.561694
Starbucks (Highway 52 & South 17th)	bakery breakfast brunch cafe coffee amp tea	$	0	0.561390
Starbucks (Rib Mountain & Highway 51)	bakery breakfast brunch cafe coffee amp tea	$	0	0.561071
CVS (2631 TOWER AVENUE)	everyday essentials convenience pharmacy snacks	$	0	0.561059

name	category	price_range	clusters	prob
Daylight Donuts	desserts breakfast brunch coffee tea bakery	$	1	0.572229
Taco Bell (610 East St George Blvd)	burritos fast food mexican	$	1	0.571456
Taco Bell (1418 West Sunset Blvd)	burritos fast food mexican	$	1	0.571386
Taco Bell (1330 S Providence Center Drive)	burritos mexican tacos	$	1	0.570470
Starbucks (W Sunset Blvd & N Bluff St)	bakery breakfast brunch cafe coffee amp tea	$	1	0.569992
Starbucks (Providence Crossing- Cedar Cit)	bakery breakfast brunch cafe coffee amp tea	$	1	0.569855
Sweet Rolled Tacos	desserts vegetarian coffee tea healthy	$	1	0.569076
Costa Vida (2376 Red Cliffs Dr)	mexican new mexican comfort food	$	1	0.568748
El Patron Mexican Food	mexican latin american new mexican tacos burri...	$	1	0.568735
Crumbl Cookies (UT - St. George Bluff)	desserts coffee tea	$	1	0.568682
Hokulia Shaved Ice	desserts coffee tea	$$	1	0.568647
Cheesecake Culture	desserts american coffee tea	$	1	0.568504
Costa Vida (1415 S Providence Center Drive)	mexican comfort food	$	1	0.567917
Swig (Boulevard)	desserts bakery pastry	unknown	1	0.567850
Jalapeños Authentic Mexican Food (700 S)	mexican new mexican tacos	unknown	1	0.567809
Tacos Plaza	mexican new mexican tacos	unknown	1	0.567806
Great Harvest Bread Co (922 East Brigham Rd)	american breakfast brunch desserts	$	1	0.567616
The Sweet Tooth Fairy	american breakfast brunch desserts	$$$$	1	0.567569
The Sugar Cookie	american breakfast brunch desserts	$	1	0.567563
Cheesecake Culture	american breakfast brunch desserts	unknown	1	0.567558

Análise Visual dos Clusters - Lunch

Análise Visual dos Clusters - Lunch

Análise Visual dos Clusters - Lunch

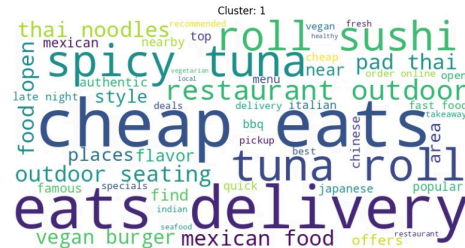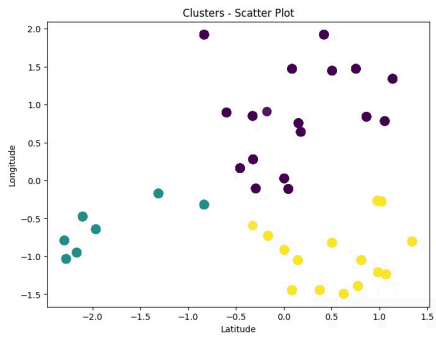| name	category	price_range	clusters	prob
Applebee's (Dothan)	diner burgers breakfast brunch comfort food pa...	$$	0	0.466474
Outback Steakhouse (2925 Ross Clark Circle)	burgers american sandwiches steak seafood sala...	$	0	0.463516
Zaxby's (1800 Gulf Shores Pkwy)	burgers american sandwiches family meals	$	0	0.463206
Denny's (2190 Ross Clark Circle)	american breakfast brunch coffee tea dinner de...	$$	0	0.463148
Cracker Barrel Old Country Store (3150 S McKen...	burgers american sandwiches family meals	$	0	0.461532
Metro Diner (Dothan)	diner breakfast brunch burgers comfort food fa...	$$	0	0.459597
Chick-fil-A (3013 S Mckenzie St)	american fried chicken family meals southern s...	$	0	0.458887
A Sweet Secret Bakery & Cafe	american breakfast brunch desserts	$$	0	0.458620
Honey Baked Ham (Foley)	sandwich american comfort food family meals	$	0	0.458381
Burger King (1501 Gulf Shores Parkway)	american burger fast food family meals	$	0	0.458305
Mile Marker 158 Dockside	seafood salads sandwich healthy family meals e...	$$	0	0.457837
Applebee's (Foley)	burgers american sandwiches comfort food pasta...	$	0	0.457635
Chicken Salad Chick (0183 - Gulf Shores, AL)	sandwich chicken salads	$$	0	0.457158
Chili's (3083 Montgomery Highway)	american burgers salads family meals healthy c...	$$	0	0.456652
Arby's (1551 Gulf Shores Pkwy)	american sandwich fast food kids friendly	$	0	0.456528
Chicken N' Biscuits by Cracker Barrel (3150 S ...	american comfort food fried chicken family mea...	$$	0	0.456443
O'Charley's (3060 S McKenzie St)	american family meals	$$	0	0.455438
Shoney's (3054 Ross Clark Circle SW)	burgers american sandwiches family meals	$	0	0.455025
The Ruby Slipper | Orange Beach	american sandwiches breakfast brunch	$	0	0.454608
Market Fresh (1551 GULF SHORES PKWY)	american fast food sandwich	$	0	0.454069

name	category	price_range	clusters	prob
Black Bear Diner (1245 South Main Street)	american burgers comfort food diner breakfast ...	$$	1	0.417509
Thrilled Cheese (7061 S. Desert Blvd.)	sandwich new american comfort food	unknown	1	0.417033
Chicken N' Biscuits by Cracker Barrel (7540 Re...	american comfort food fried chicken family mea...	$$	1	0.416904
Pei Wei (7500 N Mesa St. Suite 101)	chicken salads asian chinese asian fusion thai...	$$	1	0.416796
Black Bear Diner (965 Hoodoo Way)	american burgers comfort food steak chicken di...	$$	1	0.416709
Chick-fil-A (10721 Gateway South Blvd.)	american fried chicken family meals southern s...	$	1	0.416524
Charleys Cheesesteaks - Outlet Shoppes at El P...	sandwich american comfort food		1	0.416327
Chick-fil-A (15 S River Rd Ste 500)	american fried chicken family meals southern s...	$	1	0.416253
Ciros Bar & Kitchen	mexican seafood burgers	$$	1	0.416155
Chili's (7600 N. Mesa)	american burgers salads family meals healthy c...	$$	1	0.416018
Nachos Muchachos (4151 North Mesa St)	mexican american sandwiches	$	1	0.415773
Chili's (311 N. Redcliff Dr.)	american burgers salads family meals healthy c...	$$	1	0.415754
Ernies Cafe Bar and Grill	mexican burgers seafood	$$	1	0.415719
PJ Fresh (3001 Mountain Pass Blvd)	burgers american sandwiches	$	1	0.415519
Thrilled Cheese (655 Sunland Park Drive, Suite C)	sandwich new american comfort food	unknown	1	0.415262
Dia De Los Pescados	seafood american sandwiches mexican tacos	unknown	1	0.415226
Quik Wok Express	chinese affordable meals vegetarian friendly	unknown	1	0.415195
Carl's Jr. (6031 N Mesa St)	fast food burgers salads burritos american hea...	$	1	0.414620
Royal Pandas	asian fusion chinese seafood family meals	$	1	0.414594
Cracker Barrel Old Country Store (7540 Remcon ...	burgers american sandwiches family meals	$	1	0.414592

Análise Visual dos Clusters - Lunch

name	category	price_range	clusters	prob
Taco Bell (1429 S Blaine St)	burritos fast food mexican	$	2	0.485429
Taco Bell (450 Bridge St)	burritos fast food mexican	$	2	0.485268
Taco Bell (425 NE STADIUM WAY)	burritos fast food mexican	$	2	0.484374
Taco Bell (22312 E Appleway)	burritos fast food mexican	$	2	0.480989
Taco Bell (10620 East Sprague Avenue)	burritos fast food mexican	$	2	0.480307
Taco Bell (2626 First Street)	burritos fast food mexican	$	2	0.479608
Taco Bell (825 W 3rd Ave)	burritos fast food mexican	$	2	0.479512
Taco Bell (6614 N Division St)	burritos fast food mexican	$	2	0.479192
Taco Bell (6404 N Ash St)	burritos fast food mexican	$	2	0.479074
Taco Bell (9664 N Newport Hwy)	burritos fast food mexican	$	2	0.479044
Marandos Restaurant	mexican latin american bar food	$	2	0.479044
Taco Bell (10510 W SR 2)	burritos fast food mexican	$	2	0.478889
Chipotle Mexican Grill (490 SE Brelsford Drive)	healthy mexican salads sandwich	$	2	0.478874
Taqueria 3 Pueblos	mexican sandwich exclusive eats	$	2	0.478629
Taco Bell (133 N Sullivan Rd)	burritos fast food mexican group friendly	$	2	0.477440
Etsi Bravo	american sandwiches tacos	unknown	2	0.477339
David's Pizza	pizza italian american exclusive eats	$	2	0.477105
Mi perla tapatia	mexican latin american new mexican exclusive eats	$	2	0.476809
Taco Bell (3010 East 29th Avenue)	burritos fast food mexican group friendly	$	2	0.476803
Taco Bell (4101 N Market St)	burritos fast food mexican group friendly	$	2	0.476429

name	category	price_range	clusters	prob
Burger King (4124 Freedom Way)	american burger fast food family meals	$	3	0.466952
Sheetz - 6 Cabela Dr (429)	american comfort food deli desserts dinner fas...	$	3	0.462767
Sheetz - 25 Gantzer Ridge Road (650)	american comfort food deli desserts dinner fas...	$	3	0.462758
Sheetz - 887 National Rd (362)	american comfort food deli desserts dinner fas...	$	3	0.462673
Huddle House (4150 Freedom Way)	american breakfast amp brunch salads family meals	$	3	0.461298
Perkins Restaurant & Bakery (680 National Rd)	burgers american sandwiches family meals	$	3	0.460612
Sheetz - 239 Three Springs Road (234)	american comfort food deli desserts dinner fas...	$	3	0.459373
Chipotle Mexican Grill (225 Cabela Drive)	mexican salads	$	3	0.458252
Sheetz -1525 Main St (446)	american comfort food deli desserts dinner fas...	$	3	0.458158
Shelburne Tap House	burgers salads sandwiches	unknown	3	0.456882
Moe's Southwest Grill (1150 Williston Rd.)	mexican fast food	$	3	0.456522
Ground Round Bar & Grill	burgers american sandwiches exclusive eats	$	3	0.456499
Denny's (361 South Main Street)	american breakfast brunch coffee tea dinner de...	$$	3	0.456130
Sheetz - 5715 Hammonds Mill Rd (425)	american comfort food deli desserts dinner fas...	$	3	0.456115
Sheetz - 3522 Monongahela Boulevard (486)	american comfort food deli desserts dinner fas...	$	3	0.456068
Sheetz - 1012 University Ave (575)	american comfort food deli desserts dinner fas...	$	3	0.455495
Subway (3601 Main St)	fast food american sandwich	$	3	0.455348
Burger King (RR#3 Box 3240)	american burger family meals	$	3	0.455147
Applebee's (Rutland)	american bar food bbq burger chicken strips co...	$$	3	0.455129
The Elm Street Market	burgers american sandwiches	$$	3	0.454953

Análise Visual dos Clusters - Dinner

Análise Visual dos Clusters - Dinner

name	category	price_range	clusters	prob
The Burger Den (2039 W Main St)	american burgers comfort food vegetarian frien...	$$	0	0.618859
The Burger Den (3429 Orange Ave)	american burgers comfort food vegetarian frien...	$$	0	0.618609
Blissful Vegan Grill	vegan vegetarian burgers fast food american diner	unknown	0	0.615771
BJ's Restaurant & Brewhouse (Charlottesvil...	american burgers pizza family meals	$$	0	0.613529
MrBeast Burger (2380 Roanoke Street)	american burgers chicken desserts	$$	0	0.613212
MrBeast Burger (151 Coleman Drive)	american burgers chicken desserts	$$	0	0.612926
The Saucy Hen (500 MALL ROAD, SPACE #395)	bbq american chicken pasta burgers	$$	0	0.612775
MrBeast Burger (2082 Harper Road)	american burgers chicken desserts	$$	0	0.612691
MrBeast Burger (1355 Boxwood Terrace)	american burgers chicken desserts	$$	0	0.612570
MrBeast Burger (145 Commonwealth Avenue)	american burgers chicken desserts	$$	0	0.612530
Cracker Barrel Old Country Store (30 Hampton B...	burgers american sandwiches family meals	$	0	0.612526
Cracker Barrel Old Country Store (3153 Lee Hwy)	burgers american sandwiches family meals	$	0	0.612517
Logan's Roadhouse 335 (4740 Valley View Boulev...	burgers american sandwiches family meals	$	0	0.612512
Checkers (4110 1st Avenue)	american burger family meals	$$	0	0.612463
BurgerFi Charlottesville-5th Street Station	burgers american vegetarian friendly	$	0	0.612442
TGI Friday's (1598 - Roanoke, VA)	burgers bar food family meals	$$	0	0.612228
The House RVA	local specialities soul food chicken burgers	$	0	0.612179
Burger King (327 Ingleside Road)	american burger fast food	$	0	0.612116
Logan's Roadhouse 436 (1310 N. Eisenhower Drive)	burgers american sandwiches family meals	$	0	0.612029
Burger King (815 West Main Street)	american burger fast food	$	0	0.612021

name	category	price_range	clusters	prob
Palenque Grill (La Plaza Mall)	mexican latin american new mexican seafood ste...	$	1	0.543984
MORI - McAllen, TX	japanese asian sushi family meals	$	1	0.543837
Rebecca's Mexican Restaurant & Catering	mexican seafood salads	unknown	1	0.543673
Cockteleria La Patrona	seafood mexican snacks	unknown	1	0.541678
Palenque Grill (Edinburg)	mexican latin american new mexican seafood ste...	$	1	0.541422
Los Villa Taqueria (McColl)	mexican tacos burgers	unknown	1	0.541393
Chepuerco Restaurant	mexican latin american new mexican exclusive eats	$	1	0.541371
Woodreaux's Bar & Grill	american burgers sandwiches seafood wings fish...	$$	1	0.540798
Hayashi Hibachi (McAllen)	asian japanese seafood sushi family meals	$	1	0.540675
Taco Fiesta 956	burgers mexican tacos	$	1	0.539809
Red Lobster (701 W Expressway 83)	seafood american family meals	$$	1	0.539804
BJ's Restaurant & Brewhouse (McAllen #465)	american burgers pizza family meals	$$	1	0.538551
Pei Wei (3400 West Expressway 83)	chicken salads asian chinese asian fusion thai...	$$	1	0.538424
La Tostada Cocina	mexican latin american comfort food new mexica...	$	1	0.538299
Kumori Sushi & Teppanyaki (Palms Crossing)	japanese family friendly sushi seafood desserts	$$	1	0.538015
George Lopez Tacos (2000 South McColl Road)	mexican tacos family meals	unknown	1	0.537901
Taco Bell (107 W Griffin Parkway)	burritos fast food mexican	$	1	0.537888
Churromania ® La Plaza Mall	fast food desserts	unknown	1	0.537824
Red Lobster (7617 N. 10th Street)	seafood american family meals	$$	1	0.537724
Taco Bell (420 S. 10th)	burritos fast food mexican	$	1	0.537663

Análise Visual dos Clusters - Dinner

name	category	price_range	clusters	prob
Palenque Grill (La Plaza Mall)	mexican latin american new mexican seafood ste...	$	1	0.543984
MORI - McAllen, TX	japanese asian sushi family meals	$	1	0.543837
Rebecca's Mexican Restaurant & Catering	mexican seafood salads	unknown	1	0.543673
Cockteleria La Patrona	seafood mexican snacks	unknown	1	0.541678
Palenque Grill (Edinburg)	mexican latin american new mexican seafood ste...	$	1	0.541422
Los Villa Taqueria (McColl)	mexican tacos burgers	unknown	1	0.541393
Chepuerco Restaurant	mexican latin american new mexican exclusive eats	$	1	0.541371
Woodreaux's Bar & Grill	american burgers sandwiches seafood wings fish...	$$	1	0.540798
Hayashi Hibachi (McAllen)	asian japanese seafood sushi family meals	$	1	0.540675
Taco Fiesta 956	burgers mexican tacos	$	1	0.539809
Red Lobster (701 W Expressway 83)	seafood american family meals	$$	1	0.539804
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Churromania Ⓡ La Plaza Mall	fast food desserts	unknown	1	0.537824
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Taco Bell (420 S. 10th)	burritos fast food mexican	$	1	0.537663

Conclusões e Trabalhos Futuros

Resultados Alcançados

O objetivo foi atingido com sucesso: desenvolvimento de uma solução funcional capaz de identificar tendências e recomendar restaurantes usando algoritmos de aprendizado não-supervisionado

Oportunidades de Melhoria

- Fragmentar períodos do dia com maior granularidade
- Utilizar conjunto de dados real em vez de sintético
- Aumentar peso de latitude e longitude no agrupamento
- Incorporar price range como variável adicional