Mastering EUC (End-User Chaos) and Service Desk Tickets using PowerShell

Analyzing and categorizing free response text data using PowerShell and Azure OpenAI

Frank Lesniak

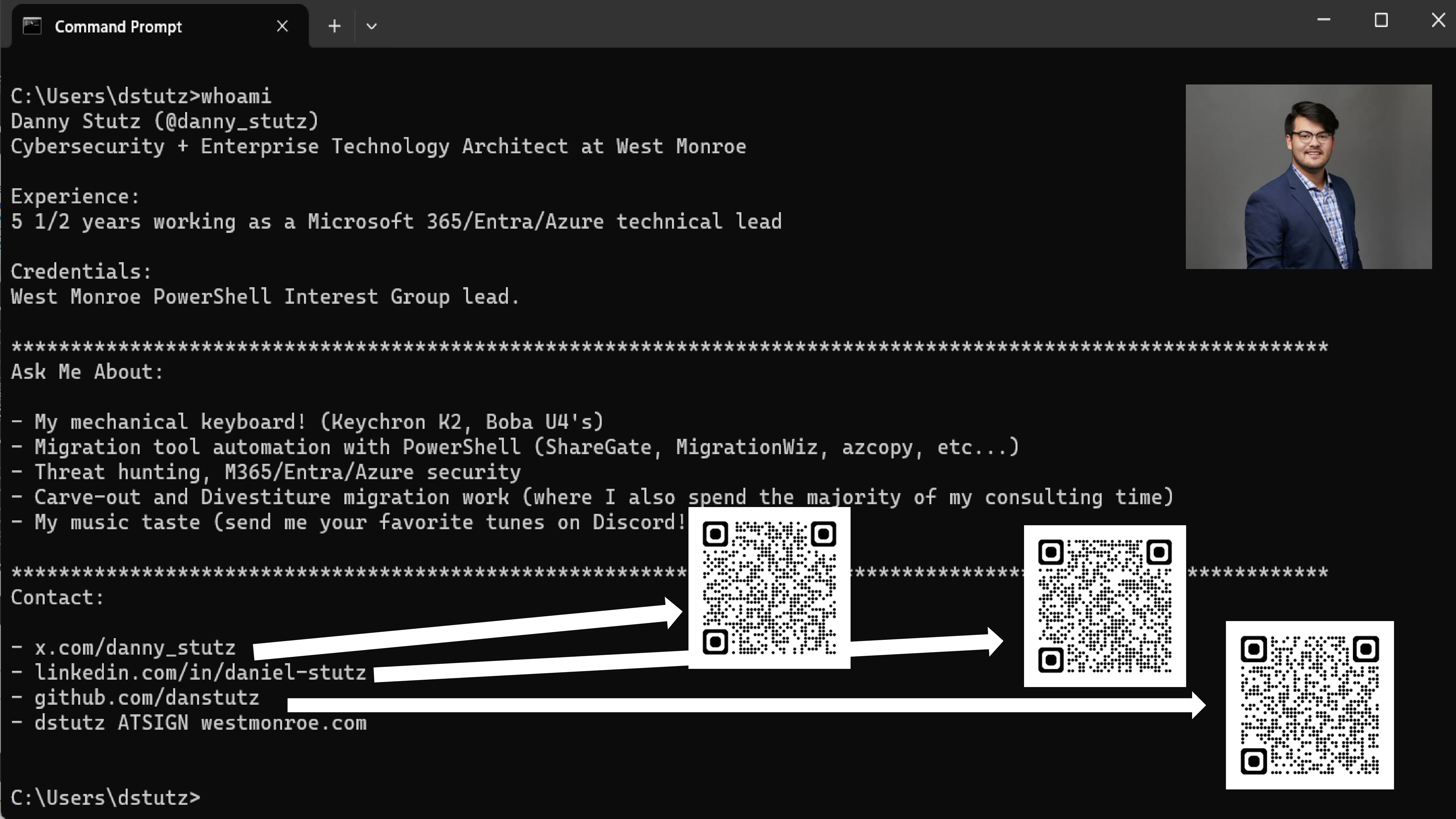
X: @FrankLesniak

Danny Stutz

X: @danny_stutz

Command Prompt

```
C:\Users\flesniak>whoami
Frank Lesniak (@franklesniak)
Sr. Cybersecurity & Enterprise Technology Architect at West Monroe

Experience:
Almost 20 years in consulting. Microsoft 365 (modern work) consulting team lead.

Credentials:
MCSEs. PowerShellin' since 2006.

***************************************************************************************************************
Ask Me About:

- PowerShell automation (duh!)
- Executing corporate divestitures and integrations - where I spent most of my consulting client time
- File server modernization - moving to Azure Files, Teams/SharePoint, etc.
- Retro video game software and FPGA emulation
- My upcoming home construction project

***************************************************************************************************************
Contact:

- x.com/franklesniak
- linkedin.com/in/flesniak
- github.com/franklesniak
- bsky.app/profile/franklesniak.com or infosec.exchange/@franklesniak
- flesniak ATSIGN westmonroe.com


C:\Users\flesniak>
```



```
C:\Users\dstutz>whoami
Danny Stutz (@danny_stutz)
Cybersecurity + Enterprise Technology Architect at West Monroe

Experience:
5 1/2 years working as a Microsoft 365/Entra/Azure technical lead

Credentials:
West Monroe PowerShell Interest Group lead.

*************************************************************************************************************
Ask Me About:

- My mechanical keyboard! (Keychron K2, Boba U4's)
- Migration tool automation with PowerShell (ShareGate, MigrationWiz, azcopy, etc...)
- Threat hunting, M365/Entra/Azure security
- Carve-out and Divestiture migration work (where I also spend the majority of my consulting time)
- My music taste (send me your favorite tunes on Discord!

*************************************************************************************************************
Contact:

- x.com/danny_stutz
- linkedin.com/in/daniel-stutz
- github.com/danstutz
- dstutz ATSIGN westmonroe.com


C:\Users\dstutz>
```

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Agenda

- Introduction and Context
- Data Scrubbing & Anonymization
- Embeddings
- K-means Clustering
- The Centroid
- Getting the Topic (or Category/Theme)
- Code Review
- Demo
- Q&A

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Introduction and Context

Why is it difficult to analyze free response/text data?

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Introduction and Context

Why is it difficult to analyze free response/text data?

- Inherently unstructured
- Typos/misspellings/l33t
- Inconsistent from person to person
- Difficult to categorize/organize
- Differences in language/dialect
- Data privacy
- Context/ambiguity
- People writing novels when asked for a 1-2 sentence response

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Introduction and Context

Why is it difficult to analyze free response/text data?

Sure, it’s difficult – but we still need to do it!

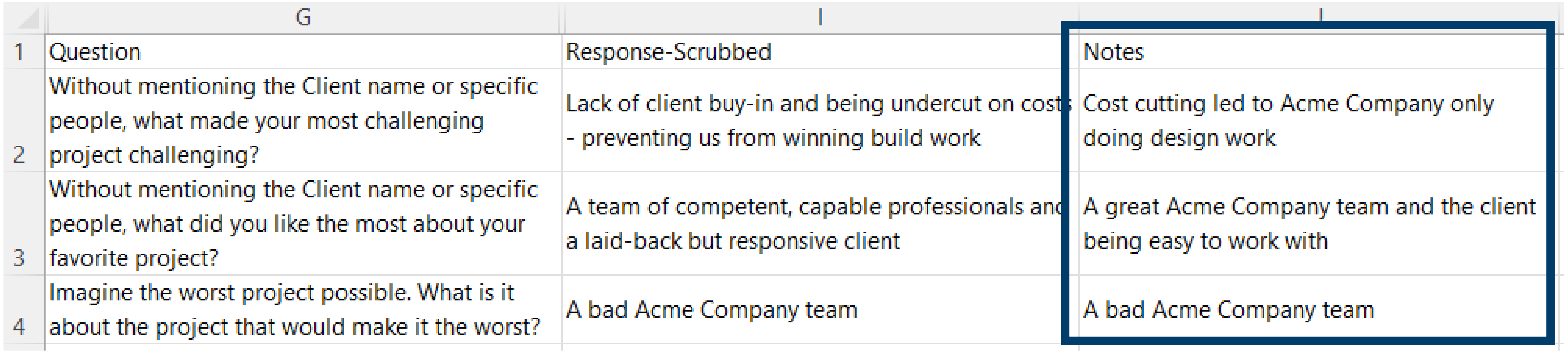
- Survey responses
- Service desk ticket analysis
- Restaurant/product reviews
- Any other use cases?

Introduction and Context

Why is it difficult to analyze free response/text data?

Sure, it's difficult – but we still need to do it!

So, how might we do this **manually**? 🤮



	G	I	J
1	Question	Response-Scrubbed	Notes
2	Without mentioning the Client name or specific people, what made your most challenging project challenging?	Lack of client buy-in and being undercut on costs - preventing us from winning build work	Cost cutting led to Acme Company only doing design work
3	Without mentioning the Client name or specific people, what did you like the most about your favorite project?	A team of competent, capable professionals and a laid-back but responsive client	A great Acme Company team and the client being easy to work with
4	Imagine the worst project possible. What is it about the project that would make it the worst?	A bad Acme Company team	A bad Acme Company team

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Scenario We Solve For

Comments on an employee survey – need to categorize them

Product reviews

Any free response/text data that needs to be categorize

Service desk tickets

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Building Context

There’s a big difference between:

“Twice a week” (lack of any context)

“Question: How often do you exercise?
Answer: Twice a week”

“Question: How often do you want to quit your job?
Answer: Twice a week”

Sometimes, including context in our analysis is important!

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Data Scrubbing + Anonymization

Spoiler alert: we will be calling some large language model (LLM) APIs to help with our analysis

Azure OpenAI
- Dedicated instance – no privacy concerns
- Model availability sometimes lags

Public OpenAI
- Data submitted used for training (becomes public!)
- Models so fresh

Data Scrubbing + Anonymization

Spoiler alert: we will be calling some large language model (LLM) APIs to help with our analysis

We'll be using the Azure OpenAI APIs in this talk as an update to previous iterations of these scripts, however it's always best practice to scrub your data before you submit it to any LLM, even if it's your own instance of Azure OpenAI

If we were calling the public OpenAI endpoints we need a way to "scrub" the data before making it effectively public domain

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Data Scrubbing + Anonymization

Spoiler alert: we will be calling some large language model (LLM) APIs to help with our analysis

Depending on what you are doing, jargon can also be a problem

"Everyone I worked with in ET is great! Especially C-SC and PAMs"

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Disclaimer: we are not data scientists

But we try our best ☺

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Embeddings

Embeddings are like GPS coordinates

- But instead of three numbers representing an X-Y position on the Earth and an altitude, we have numbers that represent a piece of text
- …but instead of three dimensions, the text-embedding-3-large model has **3072**!

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Embeddings

Embeddings are like GPS coordinates

- But instead of three numbers representing an X-Y position on the Earth and an altitude, we have numbers that represent a piece of text
- …but instead of three dimensions, the text-embedding-3-large model has 3072!
- In our case, we are “embedding” text – but you can also embed images

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Embeddings

Embeddings are like GPS coordinates

- Similar text (words, ideas, themes, etc.) have similar embeddings
- The dimensions are not public information; they mean something to the robots but are meaningless to flesh bags like us
- Nevertheless, we know thanks to the data scientists that similar text will have similar "coordinates"

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Embeddings

Embeddings are like GPS coordinates

Similar text (words, ideas, themes, etc.) have similar embeddings

Embeddings cost money and take time to generate

- The text-embedding-3-large model costs $0.13/1M tokens
- Each word is typically 2-4 tokens
- For small pieces of text, storing 3072 floating-point numbers (coordinates) may take up more memory than storing the text itself
- The size difference is very pronounced if we write the floating-point numbers to CSV

Embeddings

Embeddings are like GPS coordinates

Similar text (words, ideas, themes, etc.) have similar embeddings

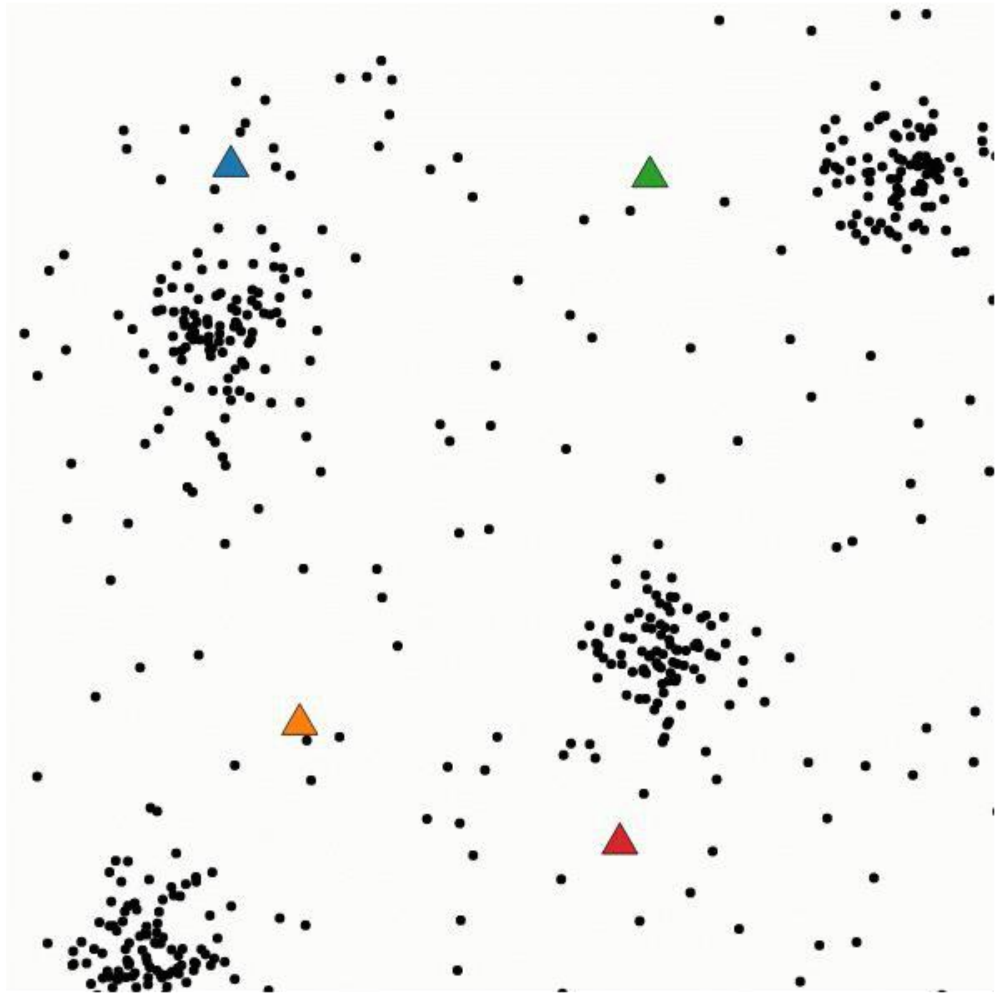
Embeddings cost money and take time to generate

OpenAI is not the only game in town:

- Google's BERT and its variants
- Facebook's FastText
- GloVe (Global Vectors for Word Representation)
- ELMo (Embeddings from Language Models)

K-means Clustering

K-means Clustering is an algorithm that partitions data points (embeddings) into K distinct, non-overlapping clusters (think of clusters as categories)



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K-means Clustering

There are many alternative algorithms to K-means Clustering

- DBSCAN (Density-Based Spatial Clustering of Applications with Noise)
- Gaussian Mixture Models (GMM)
- Hierarchical Clustering
- Spectral Clustering
- OPTICS (Ordering Points To Identify the Clustering Structure)

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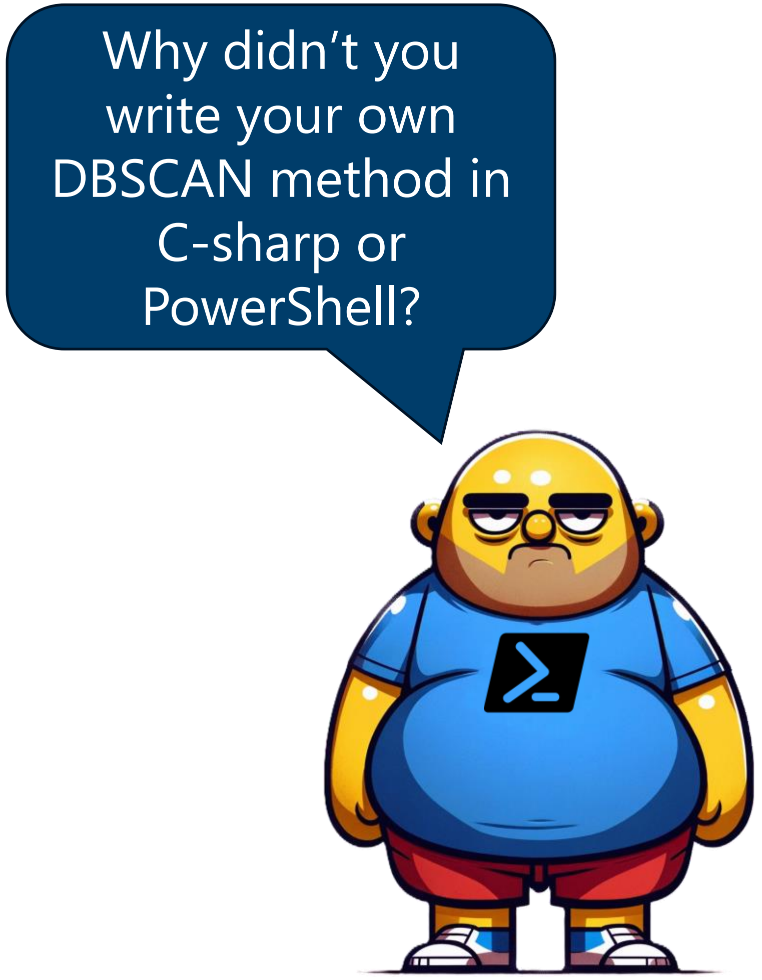
Why didn't you write your own DBSCAN method in C-sharp or PowerShell?

K-means Clustering

There are many alternative algorithms to K-means Clustering

- DBSCAN (Density-Based Spatial Clustering of Applications with Noise)
- Gaussian Mixture Models (GMM)
- Hierarchical Clustering
- Spectral Clustering
- OPTICS (Ordering Points To Identify the Clustering Structure)

We use K-means Clustering in our process mainly because K-means Clustering is the most available clustering method available in PowerShell (okay, .NET). While other clustering methods have their advantages and disadvantages, for simplicity and ease of integration, we decided to roll with K-means Clustering

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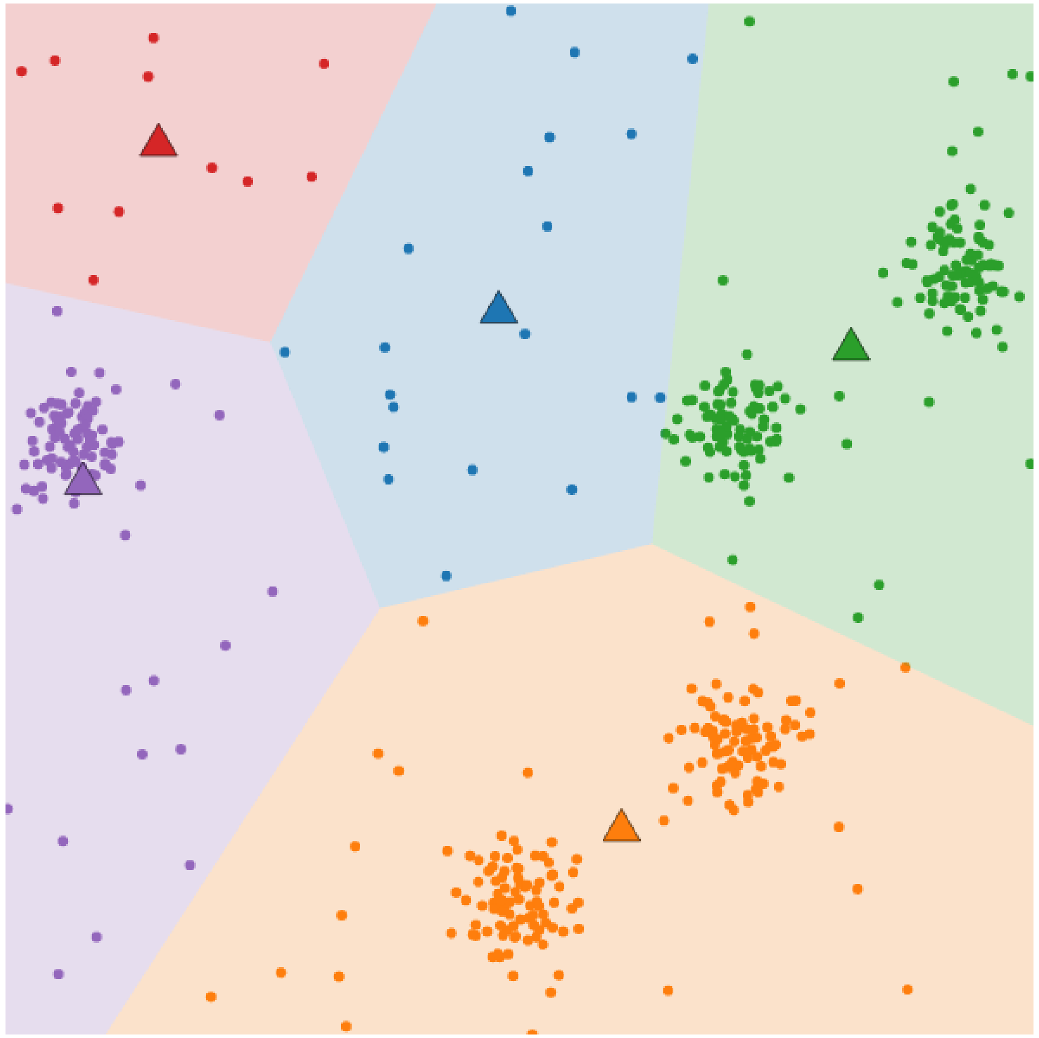
The Centroid

Once we've created our clusters, all we've done is grouped similar ideas together

- Essentially, we've categorized the comments without knowing what the categories are

Each cluster has a specific coordinate known as the "centroid" (▲) , which is reported to us as part of the algorithm



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The Centroid

Since we have the embeddings (coordinates) for each item in the cluster and the centroid's "coordinates," we can find the item closest to the centroid.

This closest item *should* be most representative of the cluster

The Centroid

Since we have the embeddings (coordinates) for each item in the cluster and the centroid's "coordinates," we can find the item closest to the centroid.

This closest item *should* be most representative of the cluster

You might be more confident if you listened and used DBSCAN

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The Centroid

Since we have the embeddings (coordinates) for each item in the cluster and the centroid's "coordinates," we can find the item closest to the centroid.

This closest item *should* be most representative of the cluster

We can also select the *n*-most central items in the cluster and treat those as a set

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Getting the Topic

We have our data grouped and know the “most representative” data point(s) in each group, but we still haven’t surfaced the topic or summary of each cluster!

To do this programmatically, we can take the most representative comment(s) and ask ChatGPT for help.

End to End Process

1. Add context to the data, if necessary
2. Remove company-specific jargon and identifiable information
3. Pull down the embeddings for the dataset from Azure OpenAI
4. Then, using the local embeddings file, invoke K-means Clustering on the dataset to cluster data points together
5. Identify the "most representative" data point(s) for each cluster
6. Submit the "most representative" data point(s) to Azure OpenAI chat completions to define the categories for each cluster
7. Output the categories and their respective comments for a full view of the insights!

Code Review

Follow along in our repo on GitHub: https://github.com/franklesniak/AutoCategorizerPS

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Add-ContextToDataset.ps1

Parameterized string concatenation – nothing too fancy!

```
.\Add-ContextToDataset.ps1
   -InputCSVPath 'C:\Users\jdoe\Documents\Contoso Employee Survey
Comments Aug 2021.csv'
   -TextBeforeFieldName1 'On an employee engagement survey, a question
was asked: '
   -FieldName1 'Question'
   -TextBeforeFieldName2 ' #### In response, the employee wrote the
following comment: '
   -FieldName2 'Comment'
   -AdditionalContextDataFieldName 'AdditionalContext'
   -OutputCSVPath 'C:\Users\jdoe\Documents\Contoso Employee Survey
Comments Aug 2021 - With Additional Context.csv'
```

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Add-ContextToDataset.ps1

Parameterized string concatenation –

```
.\Add-ContextToDataset.ps1
    -InputCSVPath 'C:\Users\jdo
Comments Aug 2021.csv'
    -TextBeforeFieldName1 'On a
was asked: '
    -FieldName1 'Question'
    -TextBeforeFieldName2 '  ###
following comment: '
    -FieldName2 'Comment'
    -AdditionalContextDataFieldName 'AdditionalContext'
    -OutputCSVPath 'C:\Users\jdoe\Documents\Contoso Employee Survey
Comments Aug 2021 - With Additional Context.csv'
```

We use PSObject Properties to dynamically access CSV column names. For example:

```
($RowInCSV.PSObject.Properties |
Where-Object {$_.MemberType -eq
'NoteProperty' -and $_.Name -eq
$FieldName1 }).Value
```

D

Add-ContextToDataset.ps1

Parameterized string concatenation –

```
.\Add-ContextToDataset.ps1
   -InputCSVPath 'C:\Users\jdo
Comments Aug 2021.csv'
   -TextBeforeFieldName1 'On a
was asked: '
   -FieldName1 'Question'
   -TextBeforeFieldName2 ' ###
following comment: '
   -FieldName2 'Comment'
   -AdditionalContextDataField
   -OutputCSVPath 'C:\Users\jd
Comments Aug 2021 - With Additional Context.csv'
```

In this specific example, the contents of the "Question" field and the "Comment" field are concatenated into a new column ("AdditionalContext"). Based on the supplied parameters, the resulting field is structured like:

```
On an employee engagement survey, a
question was asked: <Question> #### In
response, the employee wrote the following
comment: <Comment>
```

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```
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```

BUT WAIT, THERE'S MORE!:

Things we wish we could talk about, but don't have time to:

- Primitive vs. complex object types
- Shallow-cloning vs. deep cloning
- Serialization techniques; imperfections
- PowerShell forward and backward compatibility
- Security concerns with serialization
- Serialization performance
- Copy-Object

(if these are interesting, come find us later, or tell everyone how great this talk was so that we get invited back next year 😁)

Convert-DataToAnonymizeAndRemoveJargon.ps1

Simple “find and replace” operation, with find and replace text supplied via CSVs:

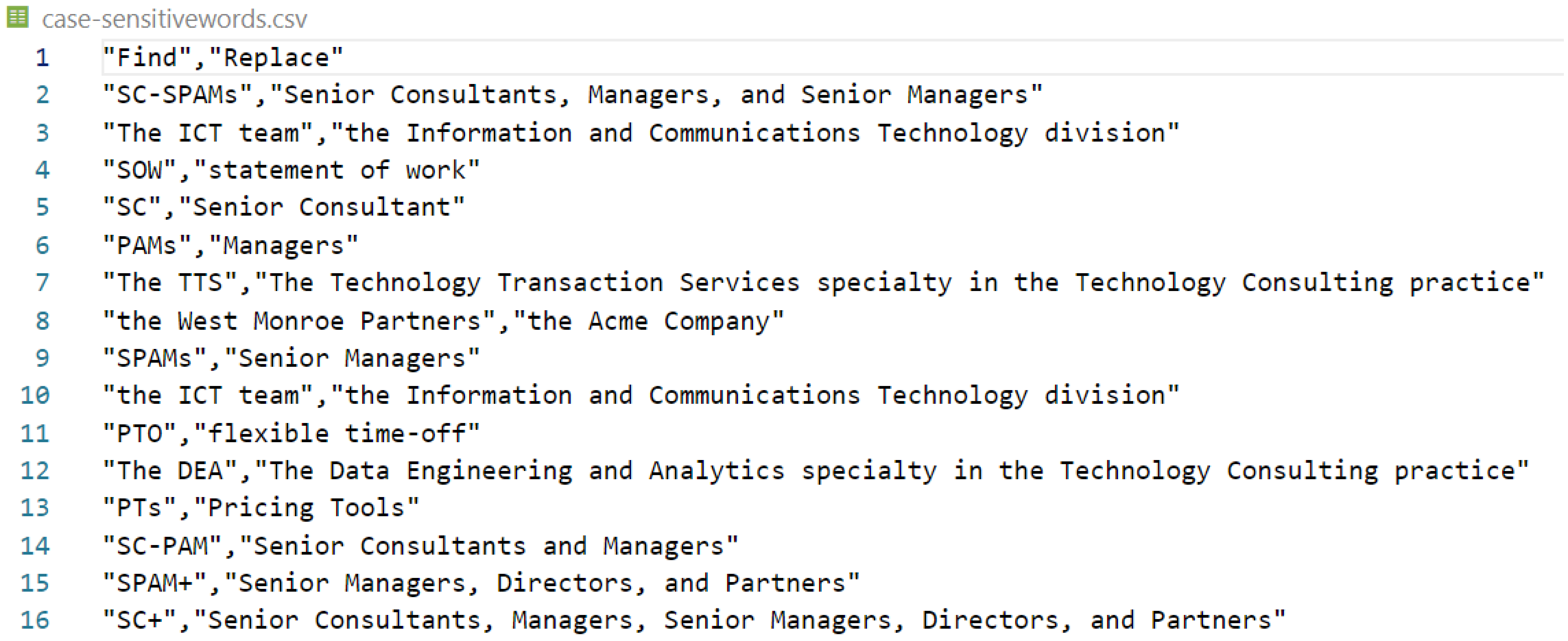
- One for case-sensitive replacement
- One for case-insensitive replacement

“West Monroe” becomes “Acme Company”

“SS team” becomes “Shared Services divisions”

Follow along in our repo on GitHub: https://github.com/franklesniak/AutoCategorizerPS

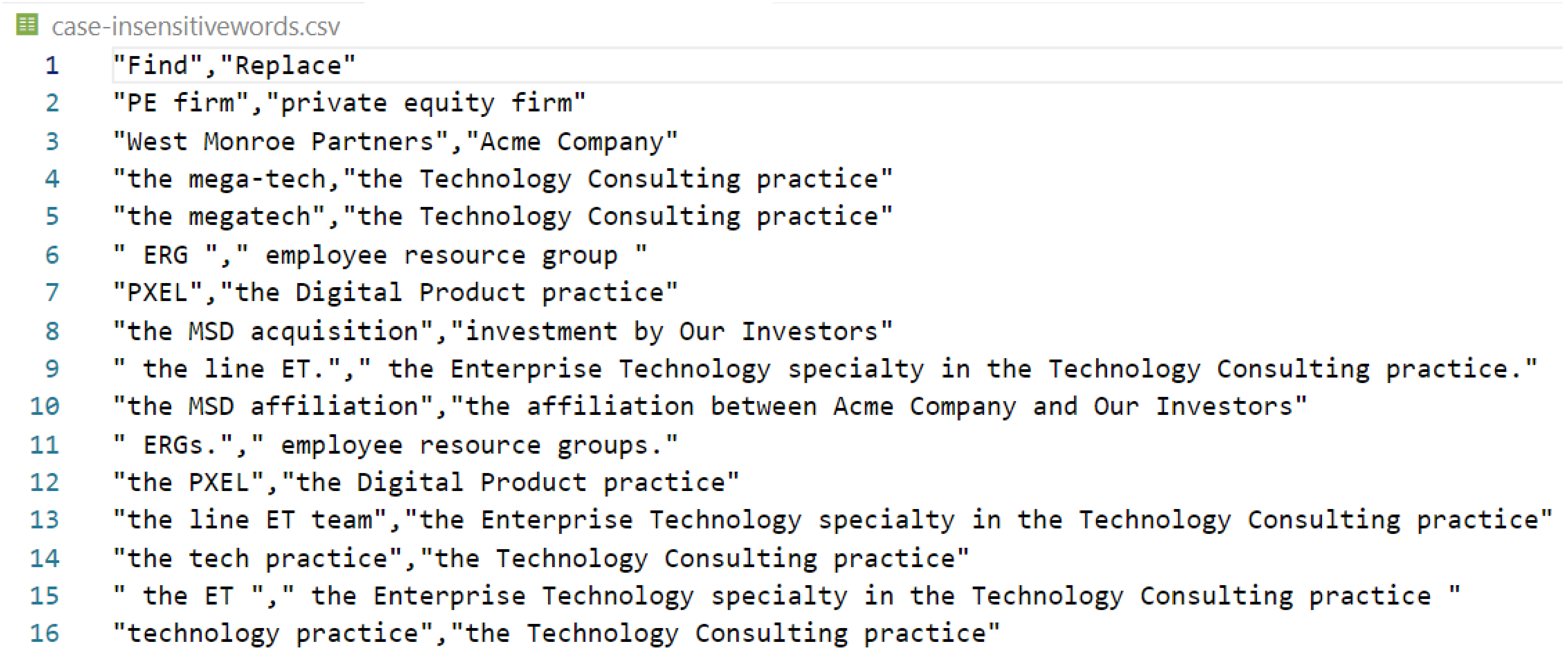
Convert-DataToAnonymizeAndRemoveJargon.ps1



case-sensitivewords.csv

```
"Find","Replace"
"SC-SPAMs","Senior Consultants, Managers, and Senior Managers"
"The ICT team","the Information and Communications Technology division"
"SOW","statement of work"
"SC","Senior Consultant"
"PAMs","Managers"
"The TTS","The Technology Transaction Services specialty in the Technology Consulting practice"
"the West Monroe Partners","the Acme Company"
"SPAMs","Senior Managers"
"the ICT team","the Information and Communications Technology division"
"PTO","flexible time-off"
"The DEA","The Data Engineering and Analytics specialty in the Technology Consulting practice"
"PTs","Pricing Tools"
"SC-PAM","Senior Consultants and Managers"
"SPAM+","Senior Managers, Directors, and Partners"
"SC+","Senior Consultants, Managers, Senior Managers, Directors, and Partners"
```

Convert-DataToAnonymizeAndRemoveJargon.ps1



case-insensitivewords.csv

```
"Find","Replace"
"PE firm","private equity firm"
"West Monroe Partners","Acme Company"
"the mega-tech,"the Technology Consulting practice"
"the megatech","the Technology Consulting practice"
" ERG "," employee resource group "
"PXEL","the Digital Product practice"
"the MSD acquisition","investment by Our Investors"
" the line ET."," the Enterprise Technology specialty in the Technology Consulting practice."
"the MSD affiliation","the affiliation between Acme Company and Our Investors"
" ERGs."," employee resource groups."
"the PXEL","the Digital Product practice"
"the line ET team","the Enterprise Technology specialty in the Technology Consulting practice"
"the tech practice","the Technology Consulting practice"
" the ET "," the Enterprise Technology specialty in the Technology Consulting practice "
"technology practice","the Technology Consulting practice"
```

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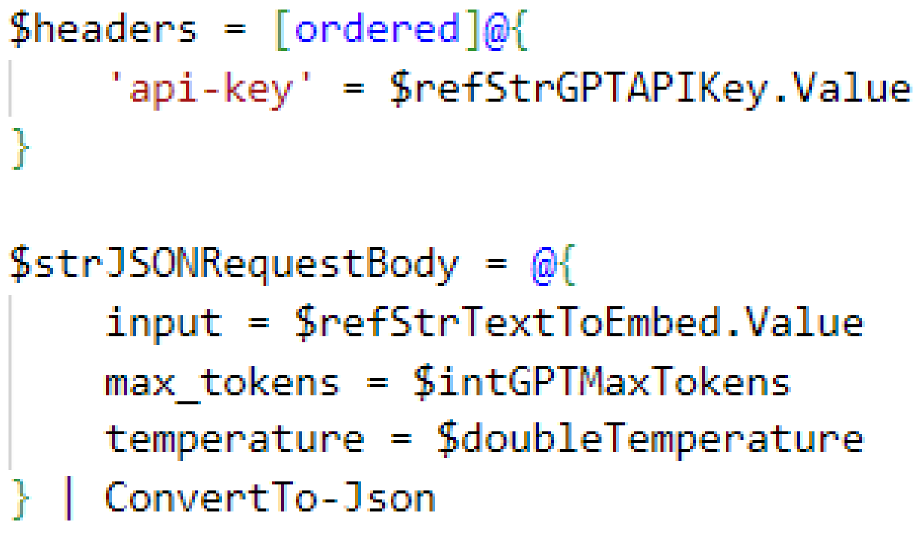
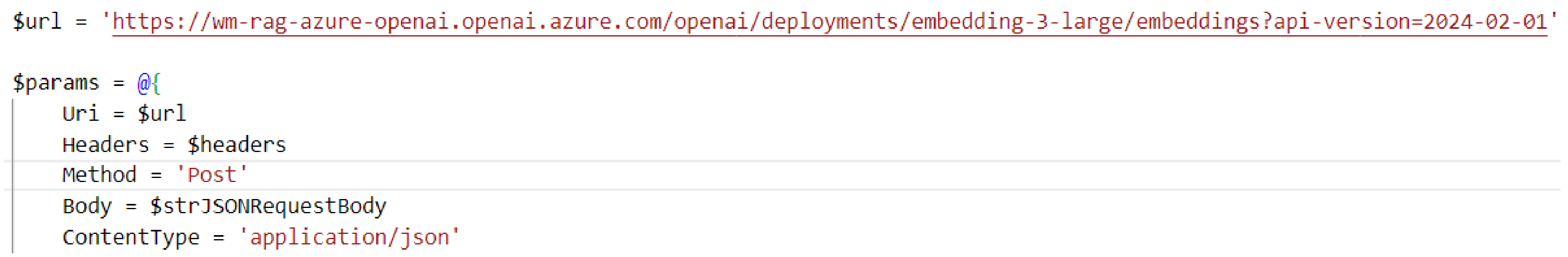
Get-TextEmbeddingsUsingAzureOpenAI.ps1

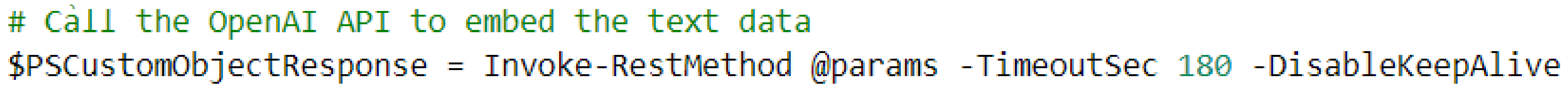
A simple API call…



```powershell
$headers = [ordered]@{
    'api-key' = $refStrGPTAPIKey.Value
}

$strJSONRequestBody = @{
    input = $refStrTextToEmbed.Value
    max_tokens = $intGPTMaxTokens
    temperature = $doubleTemperature
} | ConvertTo-Json
```



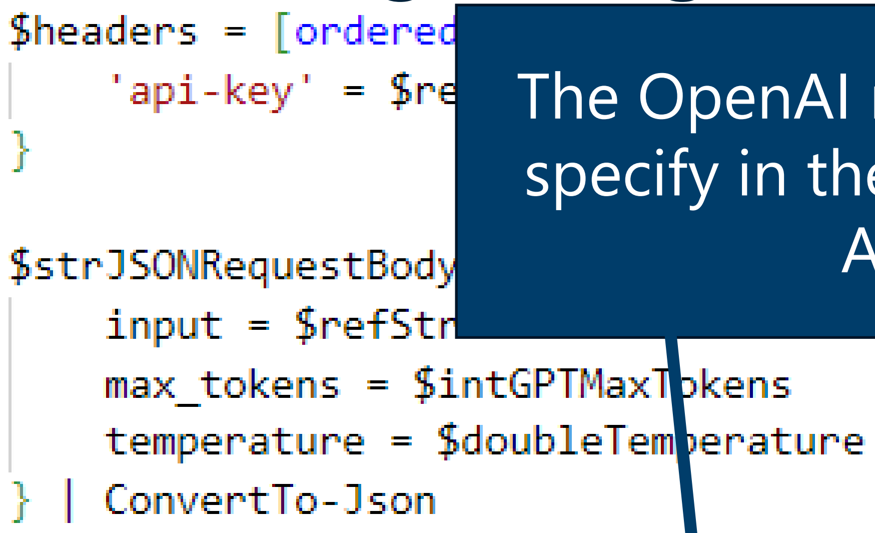
```powershell
$url = 'https://wm-rag-azure-openai.openai.azure.com/openai/deployments/embedding-3-large/embeddings?api-version=2024-02-01'

$params = @{
    Uri = $url
    Headers = $headers
    Method = 'Post'
    Body = $strJSONRequestBody
    ContentType = 'application/json'
```



```powershell
# Call the OpenAI API to embed the text data
$PSCustomObjectResponse = Invoke-RestMethod @params -TimeoutSec 180 -DisableKeepAlive
```

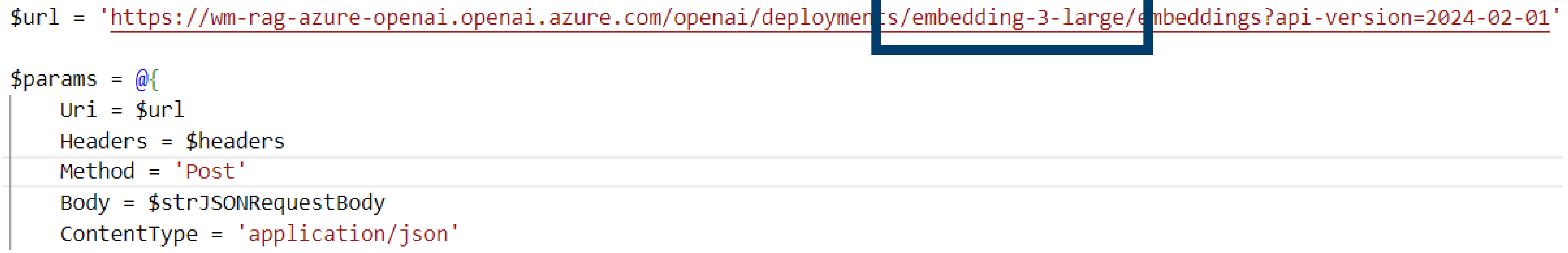
Get-TextEmbeddingsUsingAzureOpenAI.ps1

A simple API call…



```
$headers = [ordered
    'api-key' = $re
}

$strJSONRequestBody
    input = $refStr
    max_tokens = $intGPTMaxTokens
    temperature = $doubleTemperature
} | ConvertTo-Json
```

The OpenAI model used will be the one you specify in the Deployment that is created in Azure OpenAI Studio



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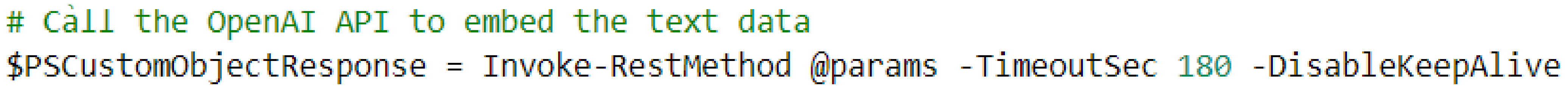

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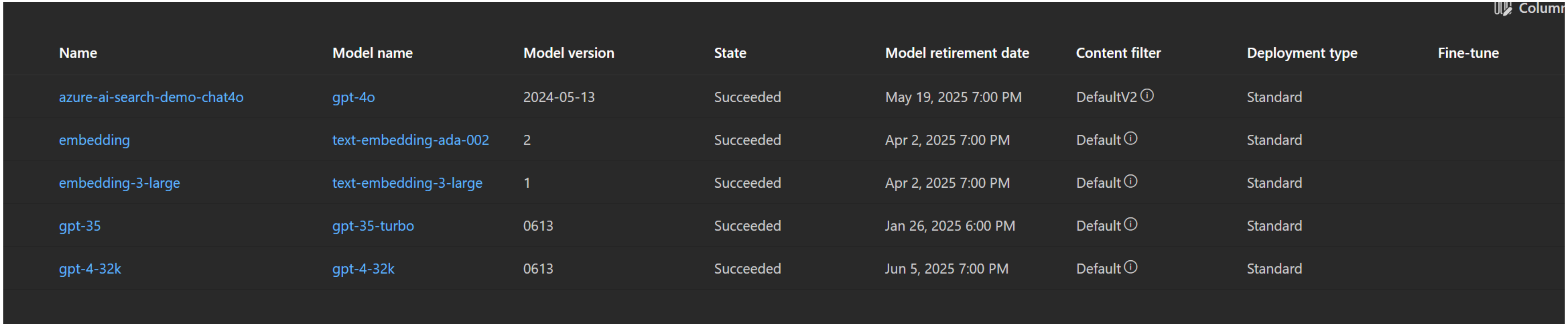

Colum

Name	Model name	Model version	State	Model retirement date	Content filter	Deployment type	Fine-tune
azure-ai-search-demo-chat4o	gpt-4o	2024-05-13	Succeeded	May 19, 2025 7:00 PM	DefaultV2 ⓘ	Standard	
embedding	text-embedding-ada-002	2	Succeeded	Apr 2, 2025 7:00 PM	Default ⓘ	Standard	
embedding-3-large	text-embedding-3-large	1	Succeeded	Apr 2, 2025 7:00 PM	Default ⓘ	Standard	
gpt-35	gpt-35-turbo	0613	Succeeded	Jan 26, 2025 6:00 PM	Default ⓘ	Standard	
gpt-4-32k	gpt-4-32k	0613	Succeeded	Jun 5, 2025 7:00 PM	Default ⓘ	Standard	

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Get-TextEmbeddingsUsingAzureOpenAI.ps1

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```
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```
$url = 'https://wm-rag-azure-openai.openai.azure.com/openai/deployments/embedding-3-large/embeddings?api-version=2024-0

$params = @{
    Uri = $url
    Headers = $headers
    Method = 'Post'
    Body = $strJSONRequestBody
    ContentType = 'application/json'
# Call the OpenAI API to embed the text data
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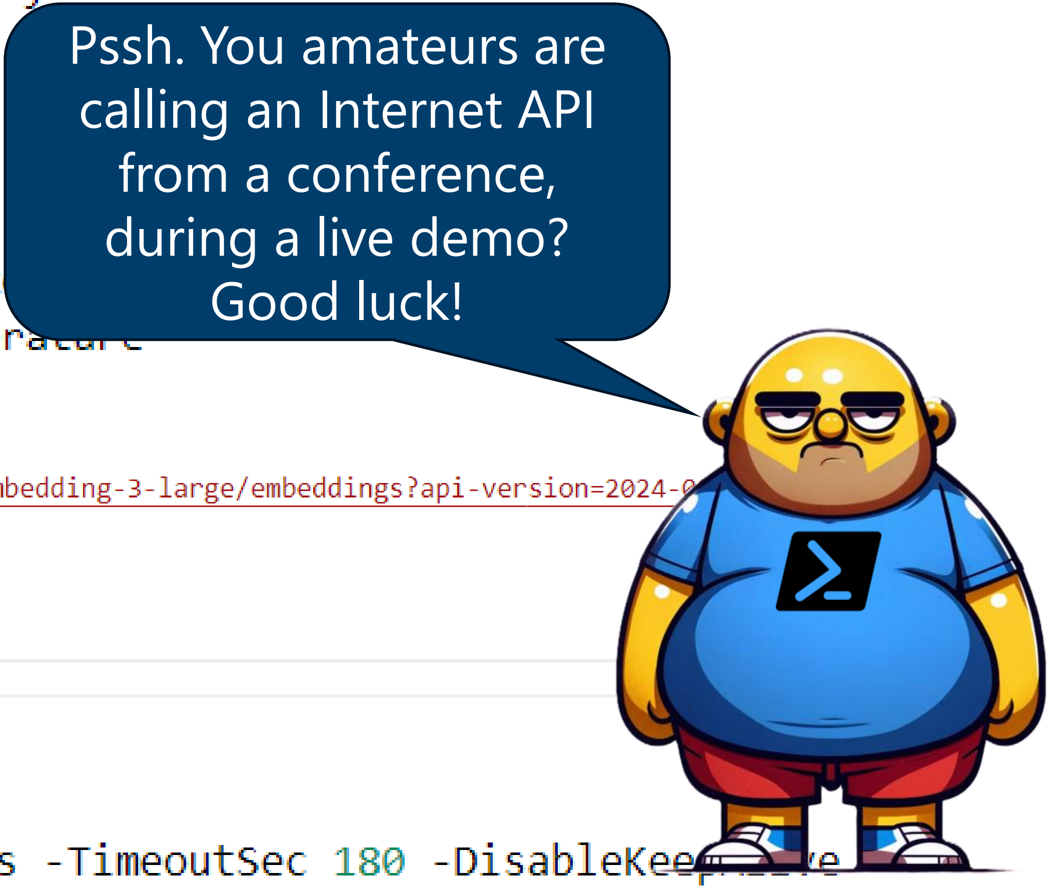
Pssh. You amateurs are calling an Internet API from a conference, during a live demo? Good luck!

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Get-TextEmbeddingsUsingAzureOpenAI.ps1

A simple API call… with lots of goodies!

- Automatic retries via error handling, automatic recursion, and exponential back-off timer
- Checks for PowerShell modules; provides helpful install commands if any are missing
- Checks to see if PowerShell modules are up to date; provides helpful warning message if modules are out of date but does not block execution (check can be suppressed)

Get-TextEmbeddingsUsingAzureOpenAI.ps1

A simple API call… with lots of goodies!

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You don’t need modules to call an API.

Get-TextEmbeddingsUsingAzureOpenAI.ps1

A simple API call… with lots of goodies!

- Automatic retries via error handling, automatic recursion, and exponential back-off timer
- Checks for PowerShell modules; provides helpful install commands if any are missing
- Checks to see if PowerShell modules are up to date; provides helpful warning message if modules are out of date but does not block execution (check can be suppressed)
- We use the SecretManagement module to securely store and retrieve the OpenAI API key from an Azure Key Vault

(pls don't store your API keys in your code, pls we beg of you)

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Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering

Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering

Accord.NET is end of life. Why are you continuing to use it?

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Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering

- We use Accord.NET because it's compatible with "full diesel" .NET Framework 4.x as well as .NET Standard 2.0
- This means we can run it on Windows PowerShell 5.1 as well as newer PowerShell 7.x without any trouble

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Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering

Lots of goodies in this script!

- Split strings without RegEx!

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Uses the Accord.NET NuGet package to perform K-means Clustering

Lots of goodies in this script!

- Split strings without RegEx!

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Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering

Lots of goodies in this script!

- Split strings without RegEx!
- Checks for registration of nuget.org as a package provider; helpful warning message if not registered
- Checks to see if required NuGet packages are "installed"; provides a helpful warning message if not
- Dynamically locates the "installed" NuGet package DLL file(s) and loads them into memory

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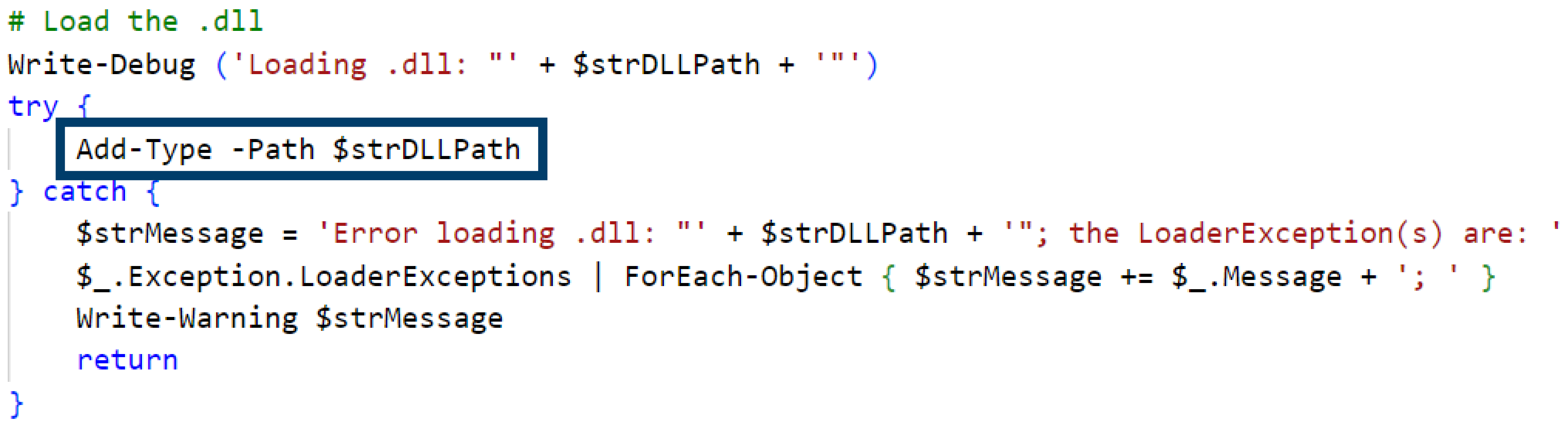
Invoke-KMeansClustering.ps1

Uses the Accord.NET NuGet package to perform K-means Clustering



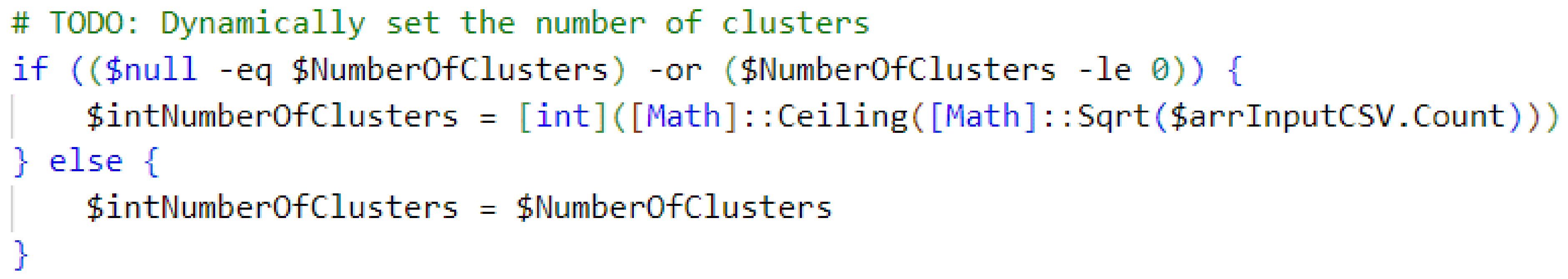
```
# Load the .dll
Write-Debug ('Loading .dll: "' + $strDLLPath + '"')
try {
    Add-Type -Path $strDLLPath
} catch {
    $strMessage = 'Error loading .dll: "' + $strDLLPath + '"; the LoaderException(s) are: '
    $_.Exception.LoaderExceptions | ForEach-Object { $strMessage += $_.Message + '; ' }
    Write-Warning $strMessage
    return
}
```

if

Invoke-KMeansClustering.ps1

How many clusters is the right number?

- The square root of the number of items is a good guess



```
# TODO: Dynamically set the number of clusters
if (($null -eq $NumberOfClusters) -or ($NumberOfClusters -le 0)) {
    $intNumberOfClusters = [int]([Math]::Ceiling([Math]::Sqrt($arrInputCSV.Count)))
} else {
    $intNumberOfClusters = $NumberOfClusters
}
```

Invoke-KMeansClustering.ps1

How many clusters is the right number?

- The square root of the number of items is a good guess
- There are algorithms (e.g., “elbow method”) that can programmatically determine the optimal number of clusters

F

Invoke-KMeansClustering.ps1

Because Accord.NET is loaded into memory, and because it's just .NET, we can access it like any other object:

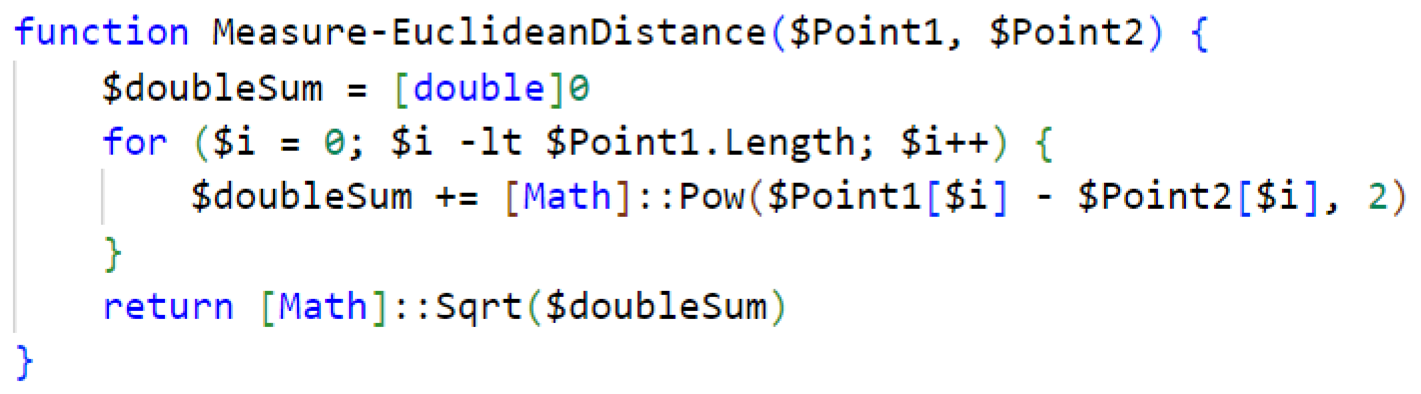
```
$kmeans = New-Object -TypeName 'Accord.MachineLearning.KMeans' -ArgumentList @($intNumberOfClusters)
[void]($kmeans.Learn($arrEmbeddings))
$arrClusterNumberAssignmentsForEachItem = $kmeans.Clusters.Decide($arrEmbeddings)
```

F

Invoke-KMeansClustering.ps1

For each item in each cluster, we calculate its "Euclidian distance" to the centroid of the cluster

- Think of this as the distance between two points on a map



```
function Measure-EuclideanDistance($Point1, $Point2) {
    $doubleSum = [double]0
    for ($i = 0; $i -lt $Point1.Length; $i++) {
        $doubleSum += [Math]::Pow($Point1[$i] - $Point2[$i], 2)
    }
    return [Math]::Sqrt($doubleSum)
}
```

F

Invoke-KMeansClustering.ps1

Finally, we sort the clustered items by their distance, shortest to longest, and generate our output!

Get-TopicForEachCluster.ps1

Again, a simple API call… this time against Azure OpenAI’s chat API

D

Get-TopicForEachCluster.ps1

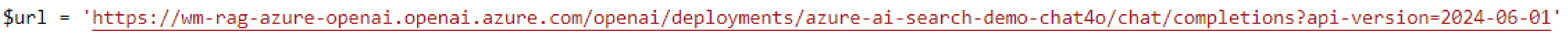
Again, a simple API call… this time against Azure OpenAI's chat API

```
$headers = [ordered]@{
    'api-key' = $refStrGPTAPIKey.Value
}

$arrMessages = @(
    @{
        'role' = 'system'
        'content' = 'You are ChatGPT, a large language model trained by OpenAI.'
    },
    @{
        'role' = 'user'
        'content' = ($refStrTextToSend.Value)
    }
)

$strJSONRequestBody = [ordered]@{
    messages = $arrMessages
    max_tokens = 150
    top_p = 0.5
    temperature = $doubleTemperature
} | ConvertTo-Json
```

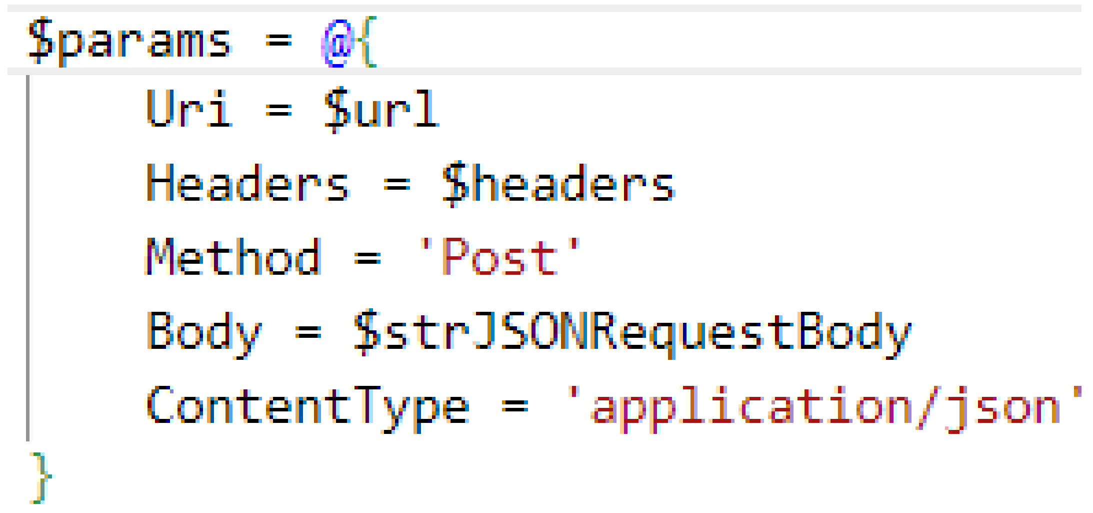
D

Get-TopicForEachCluster.ps1

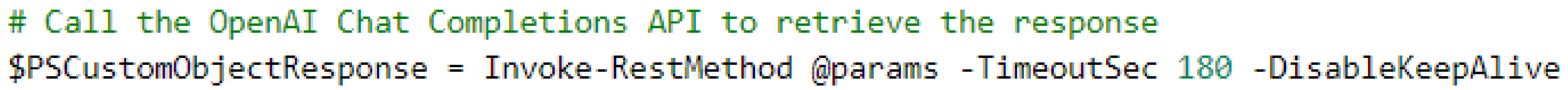
Again, a simple API call… this time against OpenAI's chat API



```powershell
$url = 'https://wm-rag-azure-openai.openai.azure.com/openai/deployments/azure-ai-search-demo-chat4o/chat/completions?api-version=2024-06-01'
```



```powershell
$params = @{
        Uri = $url
        Headers = $headers
        Method = 'Post'
        Body = $strJSONRequestBody
        ContentType = 'application/json'
}
```



```powershell
# Call the OpenAI Chat Completions API to retrieve the response
$PSCustomObjectResponse = Invoke-RestMethod @params -TimeoutSec 180 -DisableKeepAlive
```

westMONROE

D

Get-TopicForEachCluster.ps1

Again, a simple API call… this time against OpenAI’s chat API

We don’t need a “conversation” – a single question/answer exchange will do

D

Get-TopicForEachCluster.ps1

Again, a simple API call… this time against OpenAI's chat API

We don't need a "conversation" – a single question/answer exchange will do

- Here's an example prompt that the script uses:

```
In as few words as possible (certainly no more than 1-3 words),
describe the topic, main idea, or theme of the following five texts,
treated as a set. Each text is separated by three forward slashes
(///): <top five representative texts>
```

D

Get-TopicForEachCluster.ps1

Again, a simple API call… this time against OpenAI's chat API

We don't need a "conversation" – a single question/answer exchange will do

Again, we have automatic retries via error handling, automatic recursion, and exponential back-off timer – to ensure Internet "blips" don't screw us up

Demo

Q+A

THANK YOU