

Generative AI for Government

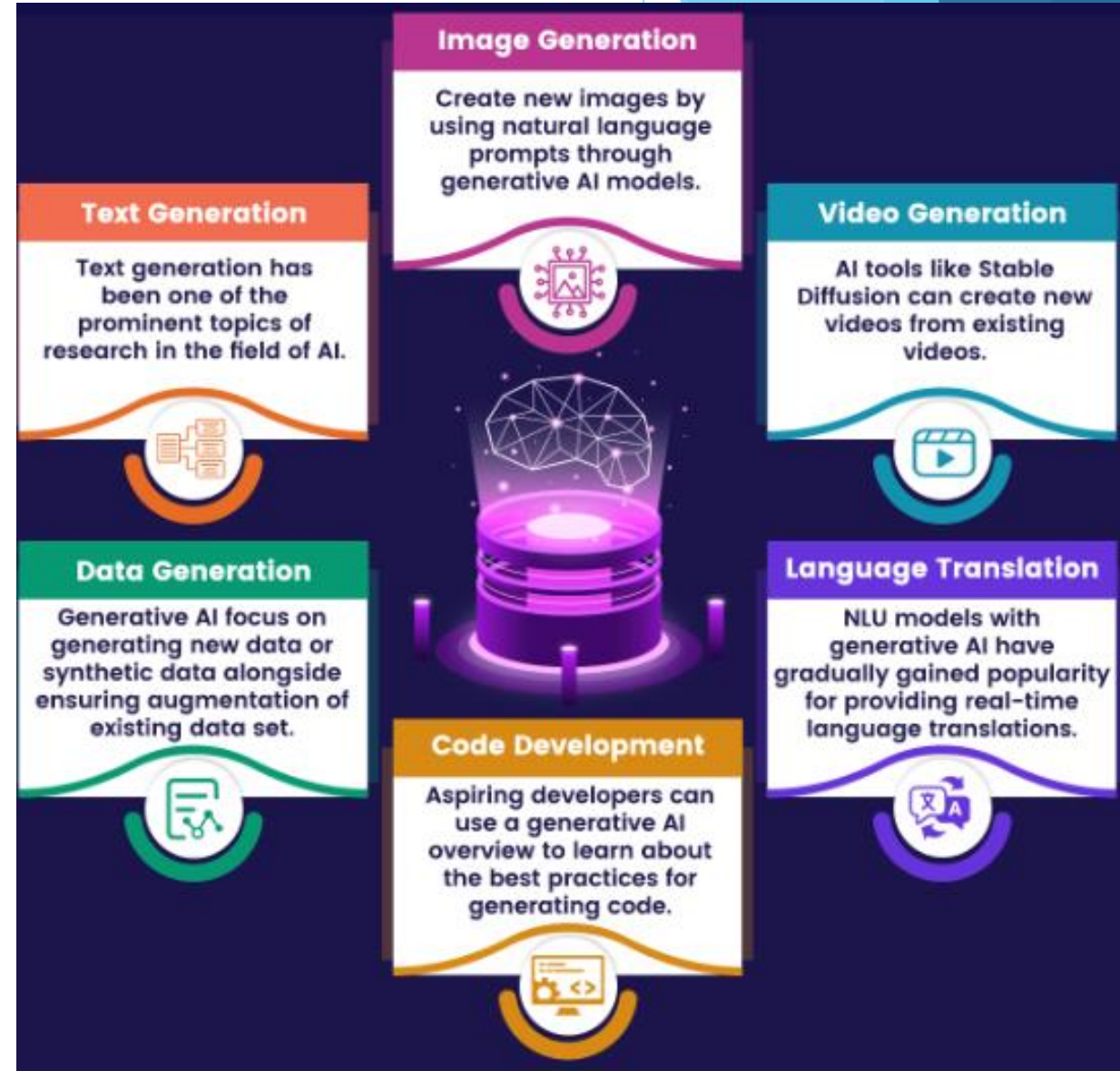
Conner Lawston

Summit2Sea, a cBEYONData Company



Generative AI Overview

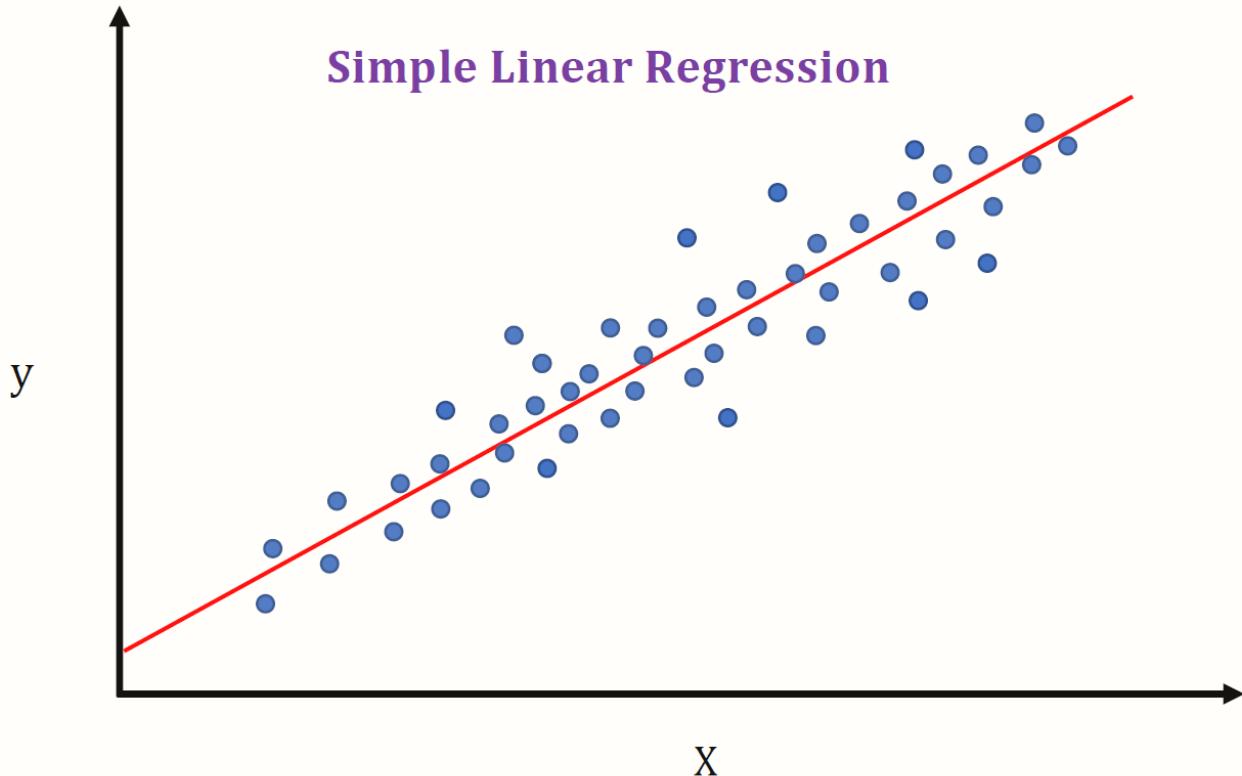
- ▶ “In summary, generative AI is primarily concerned with learning and generating new data samples, while traditional statistical learning focuses on making predictions or drawing insights from existing data.”
 - ChatGPT
- ▶ Linear Regression, MUPE, Decision Trees, etc, are not Generative Models- they are used to describe historical patterns.
- ▶ Generative AI is a very broad field encompassing many use cases
- ▶ It generally uses vast amounts of data (think in terms of billions and trillions of examples)



Comparison- Building Traditional Statistical Models

- ▶ Traditional Statistical modeling involves fitting a model to historical data, or ‘Tokens’
- ▶ By doing this we optimize the model Coefficients, or ‘Parameters’
- ▶ In ICEAA applications, this parameter optimization is usually done in milliseconds

Simple Linear Regression



CER 1: Statistics

SCOPE			
Primary Methodology	T1, \$K	Bus	Released: November 2020
This CER estimates the T1 cost of a Spacecraft Bus. It does not address the costs for Bus level SEITPM. This CER differs from the other Bus T1 CERs by including as many data points across different types of systems.			
CER			UNITS
$y = 145.63x_1^{0.77} \cdot 0.7^{x_2}$			\$K, FY16
VARIABLES RANGES			
	MIN	MAX	STD DEV
x1: Weight (lbs)	260.00	4,900.00	1,397.94
x2: Agency (1 = Commercial, 0 = Military)	0.00	1.00	0.50
STATS			
PEARSONS R^2			^2 MUPE
0.6892			.7438

USCM Model:
2 Parameters (Weight, Agency)
~100 data examples (Satellites)

Comparison- Building Generative AI Models

- ▶ Generative AI models can have millions or billions of Parameters to optimize, requiring billions or trillions of input data tokens, taking months and \$M to compute!

Model	Billions of Tokens (Compute-optimal)	Days to Train on MosaicML Cloud	Approx. Cost on MosaicML Cloud
GPT-1.3B	26B	0.14	\$2,000
GPT-2.7B	54B	0.48	\$6,000
GPT-6.7B	134B	2.32	\$30,000
GPT-13B	260B	7.43	\$100,000
GPT-30B *	610B	35.98	\$450,000
GPT-70B **	1400B	176.55	\$2,500,000

Generative AI Applications: Text

- ▶ Probably the most famous use case of Generative AI
- ▶ ChatGPT has gained worldwide attention, but there are hundreds of competing models
- ▶ Also known as ‘Large Language Models (LLM)’

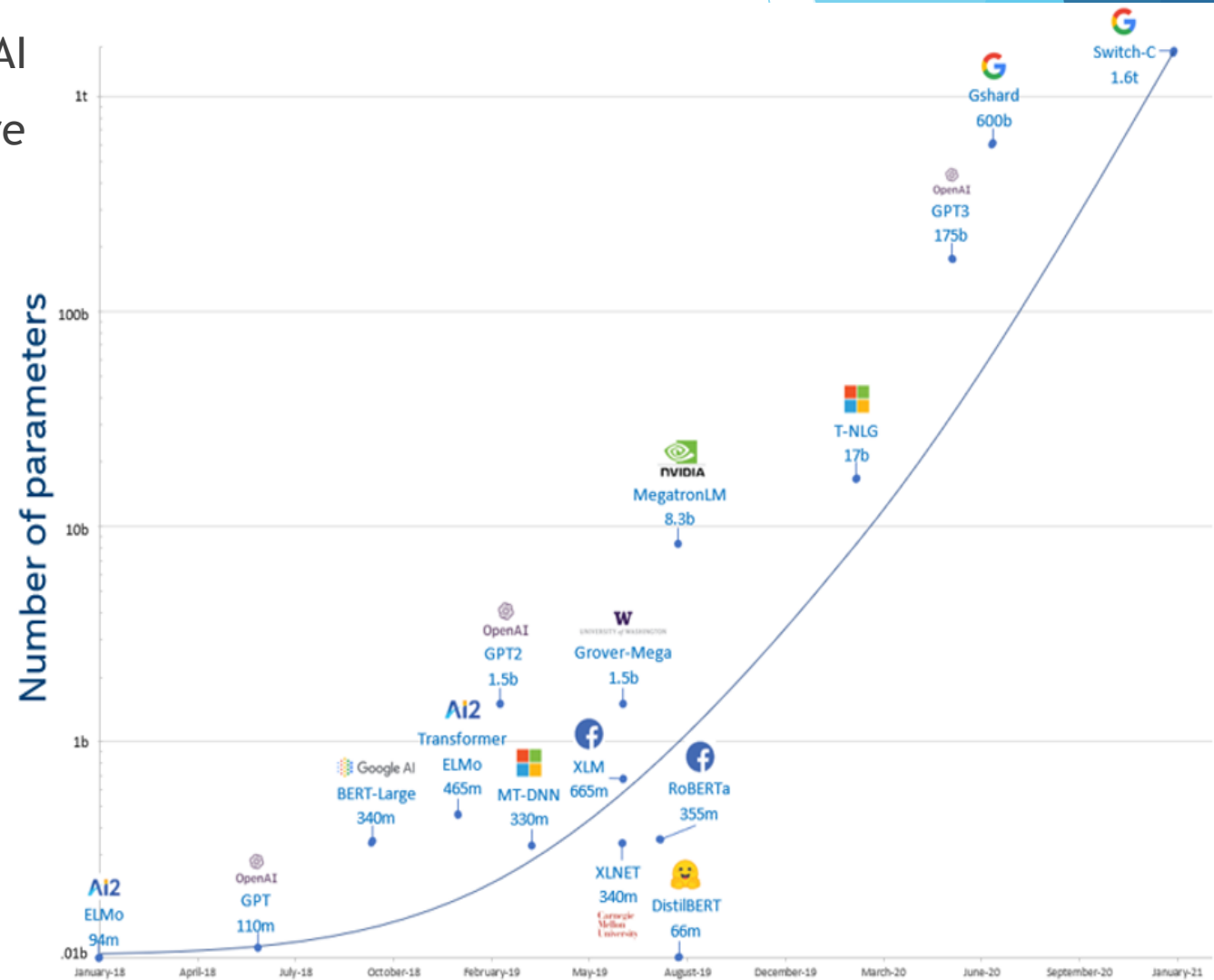


Figure 1: Exponential growth of number of parameters in DL models

Generative AI Applications: Text

-GPT is capable of text understanding and cognitive reasoning, passing the SAT (93rd% on reading/writing, 89th% math), the BAR Exam (90th%), Introductory Wine Sommelier Exam (92%), and Scored 5 on 10 AP tests

What is the diameter of an apple divided by the thickness of an apple peel?



The diameter of an apple can vary depending on the variety, but on average it's about 7-10 cm. The thickness of an apple peel is around 1-2 mm.

Dividing the diameter of an apple by the thickness of the peel, we get:

$$7 \text{ cm} / 0.1 \text{ cm} = 70$$

So, the diameter of an apple divided by the thickness of an apple peel is approximately 70.

Note: The above numbers are estimates and the exact numbers may vary depending on the apple being considered.

Model: Browsing ALPHA



Summarize <https://simonwillison.net/2023/Apr/4/substack-observable/>



Finished browsing

Clicked on: [Semi-automating a Substack newsletter with an Obse...](#)

Reading content

Finished browsing

In the article "Semi-automating a Substack newsletter with an Observable notebook," Simon Willison discusses how he has semi-automated the process of sending out a weekly-ish email newsletter that consists of content from his blog. To achieve this automation, he uses an Observable Notebook to generate the HTML content for the newsletter.

Generative AI Applications: Images

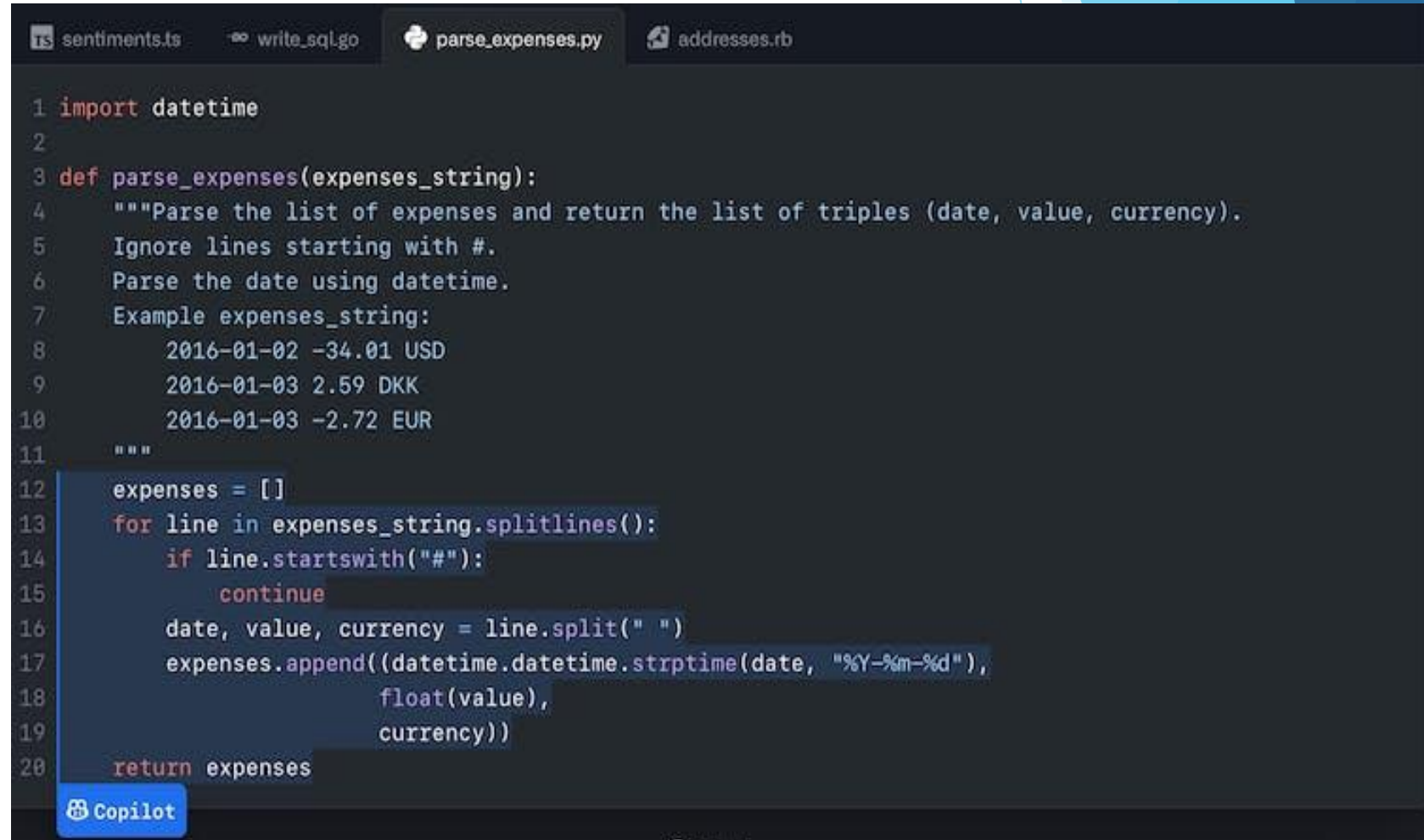
- ▶ DALL-E (2021): ‘Text To Image’ model developed by OpenAI
- ▶ DALL-E 2 (2022): “can combine concepts, attributes, and styles”
- ▶ DALL-E 3 (2023): “significantly more nuance and detail”
- ▶ Trained on 400 million pairs of images with text captions scraped from the Internet. Its role is to "understand and rank" DALL-E's output by predicting which caption from a list of 32,768 captions randomly selected from the dataset (of which one was the correct answer) is most appropriate for an image.
- ▶ DALL-E2 has 3.5 billion parameters that have been optimized through its 3 day long training computation (costing ~\$300K)



Generative AI Applications: Code

▶ Github Copilot

- ▶ Also made by OpenAI
- ▶ It can generate code from English description, or complete half-done code
- ▶ Trained on 159 gigabytes of Python code sourced from 54 million public GitHub repositories



```
sentiments.ts  write_sql.go  parse_expenses.py  addresses.rb

1 import datetime
2
3 def parse_expenses(expenses_string):
4     """Parse the list of expenses and return the list of triples (date, value, currency).
5     Ignore lines starting with #.
6     Parse the date using datetime.
7     Example expenses_string:
8         2016-01-02 -34.01 USD
9         2016-01-03 2.59 DKK
10        2016-01-03 -2.72 EUR
11    """
12    expenses = []
13    for line in expenses_string.splitlines():
14        if line.startswith("#"):
15            continue
16        date, value, currency = line.split(" ")
17        expenses.append((datetime.datetime.strptime(date, "%Y-%m-%d"),
18                        float(value),
19                        currency))
20    return expenses

Copilot
```

ChatGPT Can also be used to generate Code

CO write me sql code to join two databases

To join tables from two different databases in SQL, you typically need to qualify the table names with the database names. The exact SQL syntax may vary depending on the database management system (DBMS) you are using, but I'll provide a generic example that should work in many systems. In this example, we'll join two tables, one from the "Database1" and the other from "Database2."

```
sql Copy code
SELECT
    db1.table1.column1 AS alias1,
    db2.table2.column2 AS alias2
FROM
    Database1.schema1.table1 AS db1
INNER JOIN
    Database2.schema2.table2 AS db2
ON
    db1.common_column = db2.common_column;
```

CO Write Power BI DAX code to calculate a 30 day moving average

To calculate a 30-day moving average in Power BI using Data Analysis Expressions (DAX), you can use the `AVERAGEX` function in combination with the `DATESINPERIOD` and `FILTER` functions. Here's the DAX code to achieve this:

```
DAX Copy code
30-Day Moving Average =
AVERAGEX(
    FILTER(
        ALL('YourTable'),
        'YourTable'[Date] >= MAX('YourTable'[Date]) - 30
        && 'YourTable'[Date] <= MAX('YourTable'[Date])
    ),
    'YourTable'[Value]
)
```

Continued



write a python script to build a linear regression model



Certainly! Below is a simple Python script to build a linear regression model using the popular machine learning library, scikit-learn. This script assumes you have your dataset with features and target variable ready. You can replace `X` and `y` with your actual data.

```
# Import the necessary libraries
import numpy as np
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score

# Sample data (replace with your own dataset)
# X should be your feature matrix, and y should be the target variable.
X = np.array([[1.0], [2.0], [3.0], [4.0], [5.0]])
y = np.array([2.0, 3.0, 4.0, 4.5, 5.5])

# Split the data into training and testing sets (you can adjust the test_size)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create a Linear Regression model
model = LinearRegression()

# Fit the model to the training data
model.fit(X_train, y_train)

# Make predictions on the test data
y_pred = model.predict(X_test)

# Evaluate the model
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)

print("Mean Squared Error:", mse)
print("R-squared:", r2)

# Coefficients and intercept of the linear regression model
print("Coefficients:", model.coef_)
print("Intercept:", model.intercept_)
```

Continued

CO

Write code in base R without using any packages, to perform an iteratively reweighted least squares regression



Performing an Iteratively Reweighted Least Squares (IRLS) regression in base R without any additional packages is possible, but it's important to note that IRLS is most commonly used for generalized linear models (GLMs) with specific link functions. In this example, I'll demonstrate how to perform IRLS for a simple linear regression. Please keep in mind that for basic linear regression, the standard least squares approach is generally more appropriate.

Here's how you can perform IRLS for simple linear regression in base R:

R

Copy code

```
# Generate some sample data
set.seed(123)
x <- rnorm(100)
y <- 2 * x + rnorm(100)

# Initial values for the regression coefficients
beta0 <- 1
beta1 <- 1

# Define the model
model <- function(x, beta0, beta1) {
  beta0 + beta1 * x
}

# Perform IRLS
for (iteration in 1:100) { # Maximum number of iterations
  # Calculate the predicted values
  y_pred <- model(x, beta0, beta1)

  # Calculate the residuals
  residuals <- y - y_pred

  # Calculate the weights (inverse of the squared residuals)
  weights <- 1 / (residuals^2)

  # Update the regression coefficients
  beta1_new <- sum(weights * x * residuals) / sum(weights * x^2)
  beta0_new <- mean(weights * residuals)

  # Check for convergence
  if (abs(beta0_new - beta0) < 1e-6 && abs(beta1_new - beta1) < 1e-6) {
    break
  }

  beta0 <- beta0_new
  beta1 <- beta1_new
}

# Estimated coefficients
cat("Intercept (beta0):", beta0, "\n")
cat("Slope (beta1):", beta1, "\n")
```

Generative AI for Government- GURU

- LLM Specifically trained for use in Federal Contracting- developed by Summit2Sea Consulting
- Input sources include 2,000 + pages of FAR & DFARS, as well as Audio Interviews with Summit2Sea Acquisition SME's
- Data is encapsulated within our cybersecurity protocols and user prompts are not kept (unlike ChatGPT)

Introducing S2S's AI solution

GURU

Based on the FAR and DFAR pdf booklets, GURU will answer any questions you have about
Federal Regulation Acquisition

Ask any question and see if the AI can find the correct answer!
You can use keywords or full-fledged questions, and the AI will respond in complete sentences

 How may I help you with Federal Regulation Acquisition?

Your message



GURU Example Output



What is a firm fixed price contract?



A price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract.

Source:

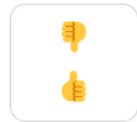
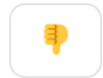
Firm-fixed-price contracts. 16.202-1 Description. A firm-fixed-price contract provides for a price that is not subject to any adjustment on the basis of the contractor's cost experience in performing the contract. This contract type places upon the contractor maximum risk and full responsibility for all costs and resulting profit or loss. It provides maximum incentive for the contractor to control costs and perform effectively and imposes a minimum administrative burden upon the contracting parties. The contracting officer may use a firm-fixed-price contract in conjunction with an award-fee incentive (see 16.404) and performance or delivery incentives (see 16.402-2 and 16.402-3) when the award fee or incentive is based solely on factors other than cost. The contract type remains firm-fixed-price when used with these incentives. 16.202-2 Application.

FAR.pdf, page 476

Source is provided by GURU- where it got its answer from

Run

Results:




Users are able to provide feedback to further improve GURU

A cost-plus-fixed-fee contract is a cost-reimbursement contract that provides for payment to the contractor of a negotiated fee that is fixed at the inception of the contract. The fixed fee does not vary with actual cost, but may be adjusted as a result of changes in the work to be performed under the contract. This contract type permits contracting for efforts that might otherwise present too great a risk to contractors, but it provides the contractor only a minimum incentive to control costs. (b) Application. (1) A cost-plus-fixed-fee contract is suitable for use when the conditions of 16.301-2 are present and, for example- (i) The contract is for the performance of research or preliminary exploration or study, and the level of effort required is unknown; or (ii) The contract is for development and test, and using a cost-plus-

GURU Examples Continued

 What is earned value management?

 **Earned value management system means a project management tool that effectively integrates the project scope of work with cost, schedule and performance elements for optimum project planning and control.**

(iii) For cost or incentive contracts and subcontracts valued at less than \$20,000,000— (A) The application of earned value management is optional and is a risk-based decision; (B) A decision to apply earned value management shall be documented in the contract file; and (C) Follow the procedures at PGI 234.201 (1)(iii) for conducting a cost-benefit analysis. (iv) For firm-fixed-price contracts and subcontracts of any dollar value— (A) The application of earned value management is discouraged; and (B) Follow the procedures at PGI 234.201 (1)(iv) for obtaining a waiver before applying earned value management. (2) When an offeror proposes a plan for compliance with the earned value management system guidelines in ANSI/ EIA-748, follow the review procedures at PGI 234.201 (2). (3) The Defense Contract Management Agency is responsible for determining earned value management system compliance when DoD is the cognizant Federal agency.

GURU Examples Continued



Explain the government PPBE process




Dod 7045.14

Source:

Period of Availability The period of time in which budget authority is available for original obligation. [↑DoD 7000.14-R Financial Management Regulation Glossary](#)

- September 2021 Planning, Programing, Budgeting, and Execution (PPBE) A cyclic process containing four distinct, but interrelated phases: planning, programing, budgeting, and execution. In addition to establishing the framework and process for decision making on future programs, the process permits prior decisions to be examined and analyzed from the viewpoint of the current environment (threat, political, economic, technological, and resources) and for the time period being addressed. The ultimate objective of PPBE is to provide operational commanders the best mix of forces, equipment, and support attainable within fiscal constraints. Political Subdivision of Local Government A local unit of government, including specifically a county, municipality, city, town, township, school district, or other special district created by State law, or combination of these units.

GURU Examples Continued

 explain appropriations

 Appropriations used

Source:

Appropriations represent legal authority granted by Congress to incur obligations (see subparagraph 3.2.1.5 for an exception), and to make payments from the Treasury for specified purposes. An appropriations act is the most common form of budget authority; and the making of an appropriation must be expressly stated and may not be inferred or made by implication. Appropriations are available for obligation based on varying characteristics specific to periods of availability, phases of availability, and amounts. 3.2.1.1. Period of Availability. The period of time in which budget authority is available to incur new obligations. Congress establishes the period of availability. [▲]DoD 7000.14-R Financial Management Regulation Volume 3, Chapter 13

- February 2022 3.2.1.1.1. One-Year (Annual) Authority. Budget authority that is available for obligation only during a specified fiscal year and expires at the end of that period. For example, most Operations and Maintenance (O&M) and Personnel appropriations. 3.2.1.1.2.

Combined_Volume1-16.pdf, page 1549

GURU Examples Continued



What does DCMA do?



Provides centralized, cost-effective, automated debt servicing and collection assistance to dcos on delinquent debts owed to dod by individuals who are no longer paid by dod

Source:

Defense Contract Management Agency (DCMA) insurance/pension specialists and Defense Contract Audit Agency (DCAA) auditors assist ACOs in making these determinations, conduct CIPRs when needed, and perform other routine audits as authorized under FAR 42.705 and 52.215-2. A CIPR is a DCMA/DCAA joint review that— (1) Provides an in-depth evaluation of a contractor's— (i) Insurance programs; (ii) Pension plans; (iii) Other deferred compensation plans; and (iv) Related policies, procedures, practices, and costs; or (2) Concentrates on specific areas of the contractor's insurance programs, pension plans, or other deferred compensation plans. (b) DCMA is the DoD Executive Agent for the performance of all CIPRs. (c) DCAA is the DoD agency designated for the performance of contract audit responsibilities related to Cost Accounting Standards administration as described in FAR subparts 30.2 and 30.6 as they relate to a contractor's insurance programs, pension plans, and other deferred compensation plans. 242.7302 Requirements.

DFARS.pdf, page 717

GURU Live Q&A Session

- ▶ Please ask questions and GURU will attempt to answer them