

GPT AND THE ACTUARIAL LANDSCAPE

An Overview of Large Language Models and Applications

CAS Spring Meeting
May 2023

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MEET THE SPEAKERS



Hugo Latendresse, FCAS

P&C Insurance Practice: Senior Manager
Hugo.Latendresse@oliverwyman.com

Hugo Latendresse is a Senior Manager in Oliver Wyman's Actuarial practice. He specializes in machine learning and automation solutions designed to improve insurance processes. Hugo has seven years of predictive analytics experience in pricing, reserving, claims, and underwriting.



Sabrina Tan, ACAS

P&C Insurance Practice: Consultant
Sabrina.Tan@oliverwyman.com

Sabrina Tan is a Consultant in Oliver Wyman's Actuarial practice. She provides P&C actuarial consulting services to a variety of insurance organizations. She has worked on various projects in predictive analytics, process improvement, pricing, and reserving.



Adam Lewis, FCAS, MAAA

P&C Insurance Practice: Partner
Adam.Lewis@oliverwyman.com

Adam Lewis is a Partner and P&C Southeast Region Leader of Oliver Wyman Actuarial practice. Adam has presented at various risk management conferences on actuarial topics, with a recent focus in data analytics. He specializes in unpaid claim (i.e., reserving) analyses of commercial property and casualty lines and leads a team that has expertise in pricing, data transformation, and capital modeling, among other capabilities.



OVERVIEW

1

Intro to Natural
Language Processing

2

The Building
Blocks of GPT

3

Actuarial Applications

4

Recap

1

INTRO TO NATURAL LANGUAGE PROCESSING



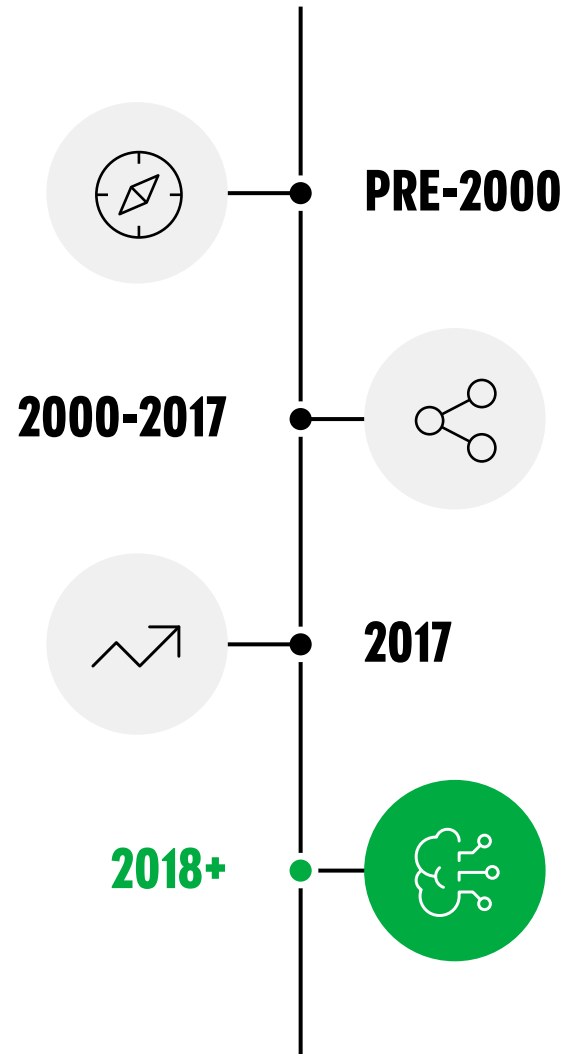
RECENT KEY INNOVATIONS HAVE ACCELERATED ADVANCEMENTS IN NLP

Rule-based systems to simple statistical models

- First application of natural language processing (NLP) was for machine translation
- Initial rule-based models required significant manual coding
- Machine learning and statistical models (N-grams, Markov models) and the first recurrent neural networks such as long short-term memory models replaced hard-coded rules.

Self-attention, transformers, and large language models

- The self-attention mechanism along with transformer architecture enable state-of-the-art performance on language tasks and efficient process of large datasets
- Ability to consider context in texts increased the ability to produce human-like texts



PRE-2000

Use of neural networks for language modeling

- Initial uses of neural networks for next word prediction
- First representations of words with dense vectors called *word embeddings* and algorithms capable of learning them efficiently (Word2Vec)

2017

Generative pre-trained transformers (GPT)

- OpenAI releases first version of GPT language model (2018), with GPT-2 and GPT-3 released each year thereafter
- ChatGPT, fined-tuned with Reinforcement Learning from Human Feedback on GPT-3.5, launched in 2022
- Chat GPT-4 took incorporates more Reinforcement Learning from Human Feedback

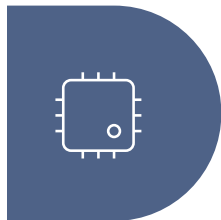
Source: <https://medium.com/nlplanet/a-brief-timeline-of-nlp-bc45b640f07d>

ACCESS TO POWERFUL RESOURCES ENABLE LARGE LANGUAGE MODELS

NLP has achieved groundbreaking results through LLMs, enabled by various modern technology



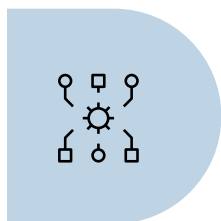
Increasing **availability of text data** from the internet



Development of powerful **computational resources** (GPUs and TPUs)



Frameworks for developing neural networks (TensorFlow and PyTorch)

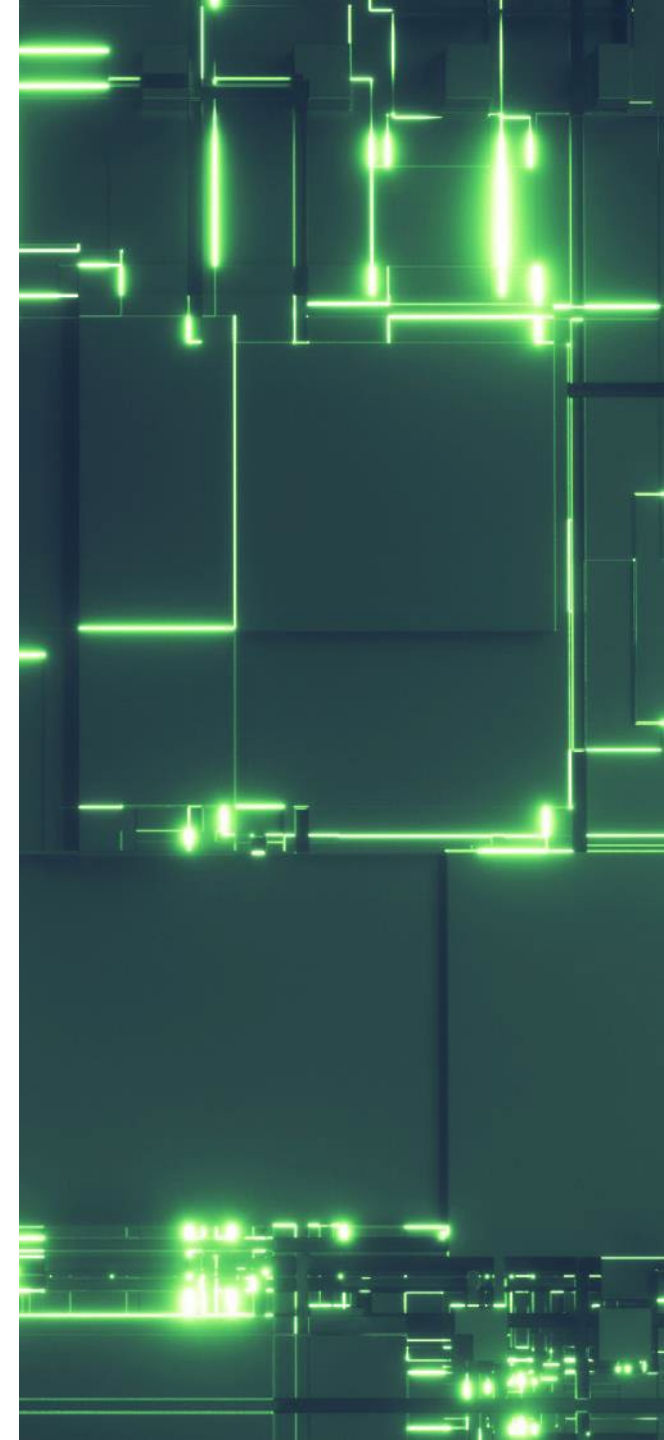


Advances in **ML algorithms** (transformers and self-attention)

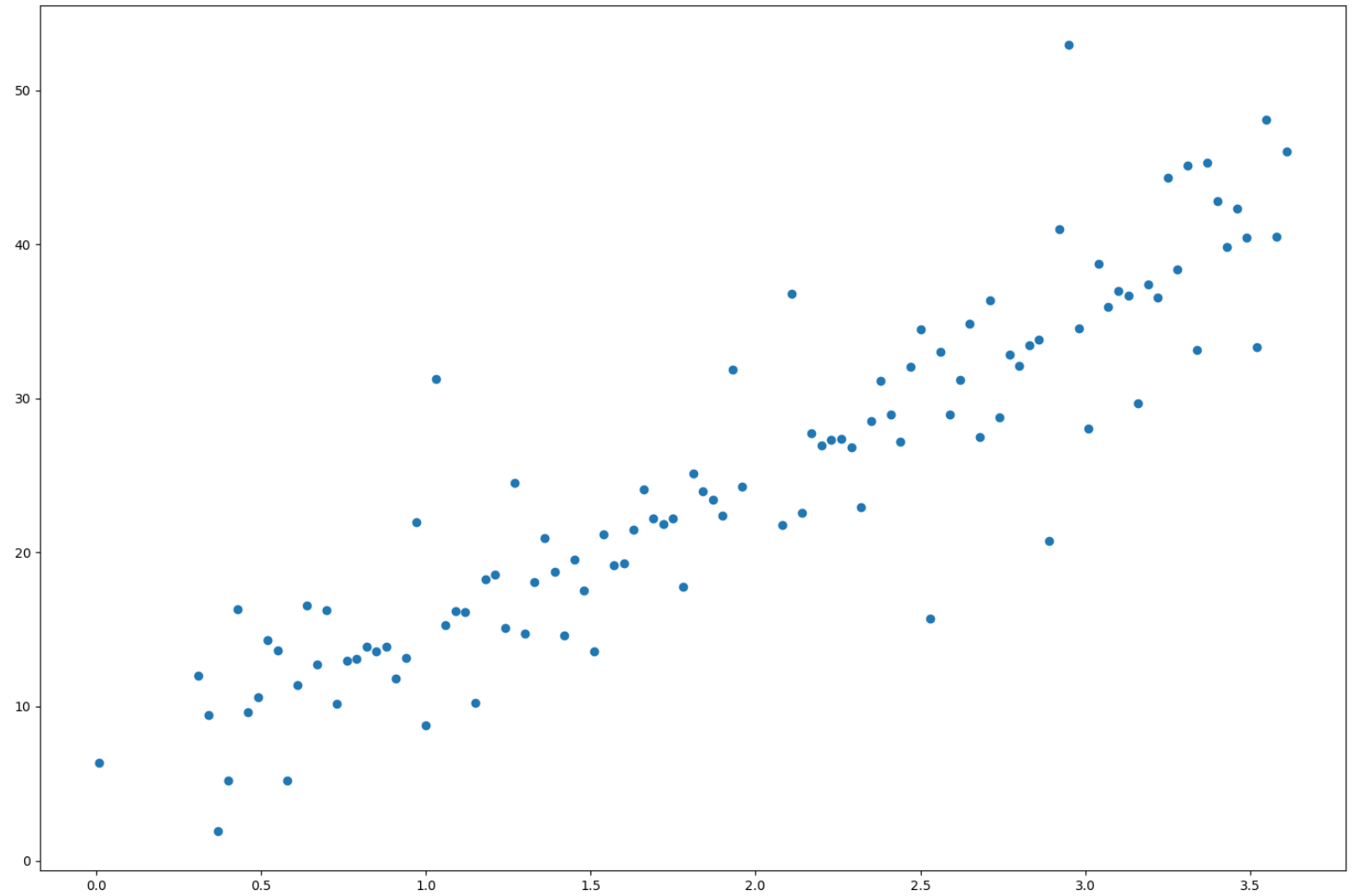
		Number of parameters	Size of training dataset (Quantity of text)	Compute resources used for training
BERT		110M	16GB	
GPT		117M	40GB	
ROBERTA		125M	160GB	
GPT-2		1.5B	800GB	
GPT-3		175B	45TB	3,600+ GPU days 330+ MWh
GPT-4		Proprietary	Proprietary	Proprietary

2

THE BUILDING BLOCKS OF GPT



MACHINE LEARNING 101: GRADIENT DESCENT



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Formulas

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2$$

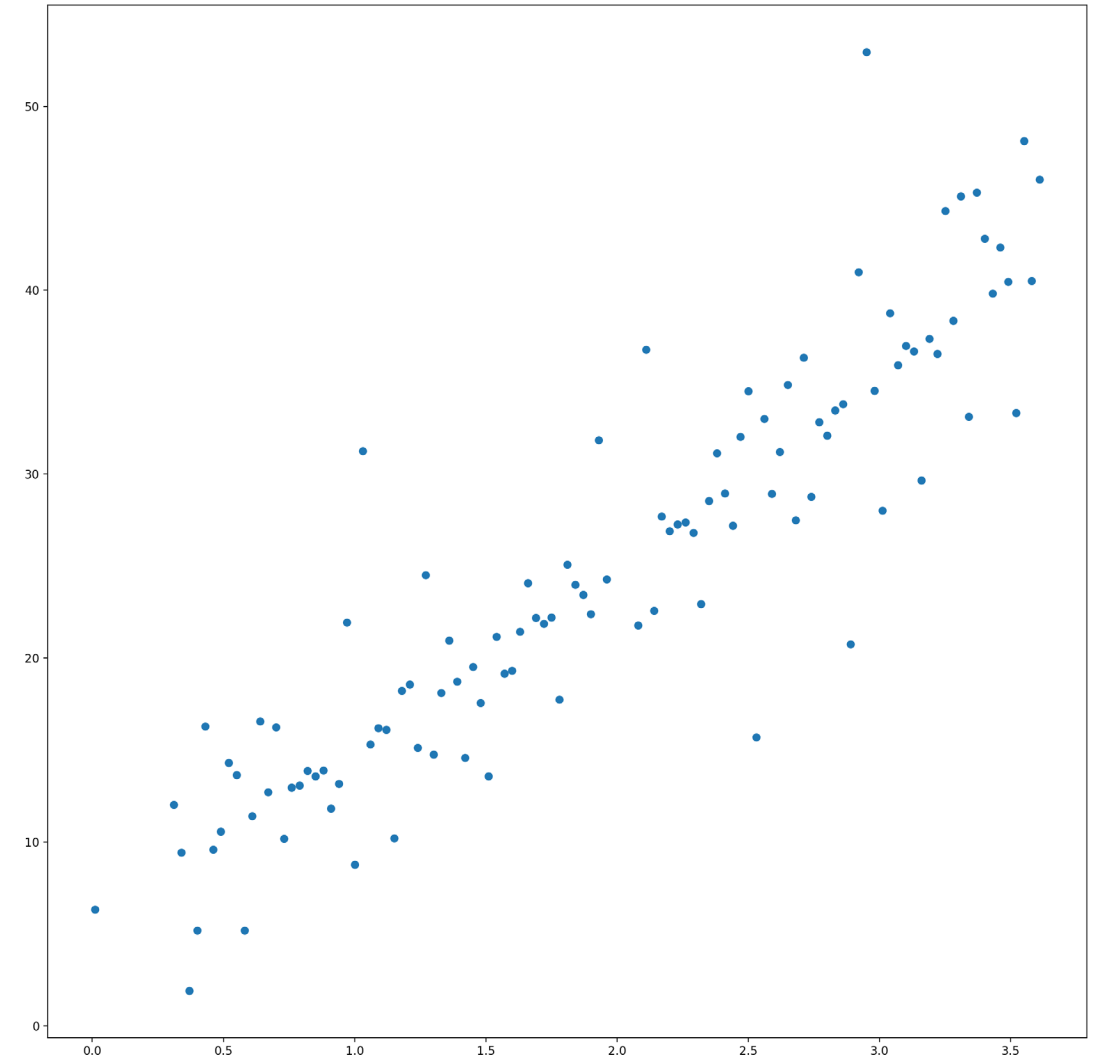
FORMULAS FOR β COEFFICIENTS

Slope

$$\beta_1 = (n * \sum(x*y) - \sum(x) * \sum(y)) / (n * \sum(x^2) - (\sum(x))^2)$$

Intercept

$$\beta_0 = (\sum(y) - \beta_1 * \sum(X)) / N$$



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Formulas

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2 = 10.7476$$

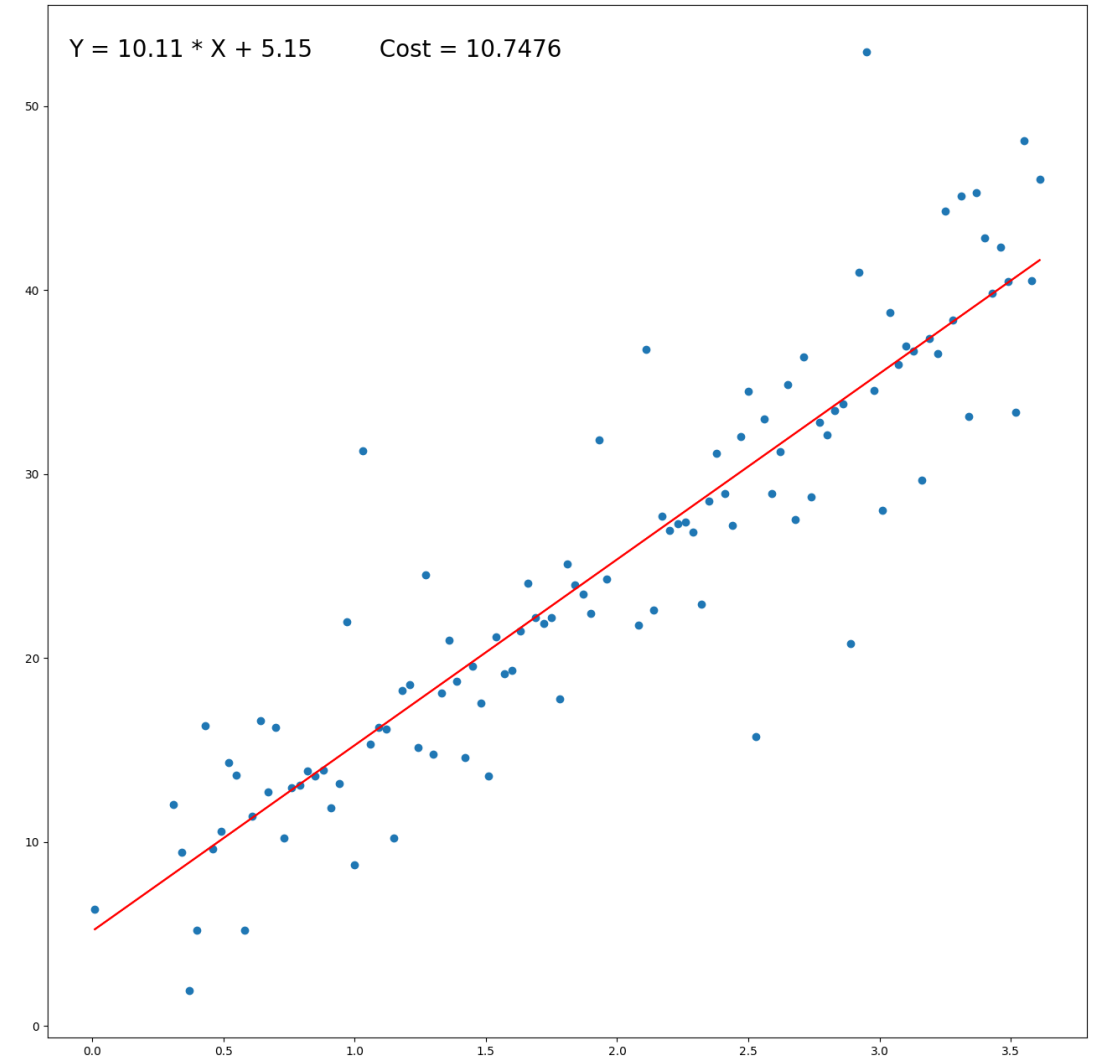
FORMULAS FOR β COEFFICIENTS

Slope

$$\beta_1 = (n * \sum(x*y) - \sum(x) * \sum(y)) / (n * \sum(x^2) - (\sum(x))^2) = 10.11$$

Intercept

$$\beta_0 = (\sum(y) - \beta_1 * \sum(X)) / N = 5.15$$



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Formulas

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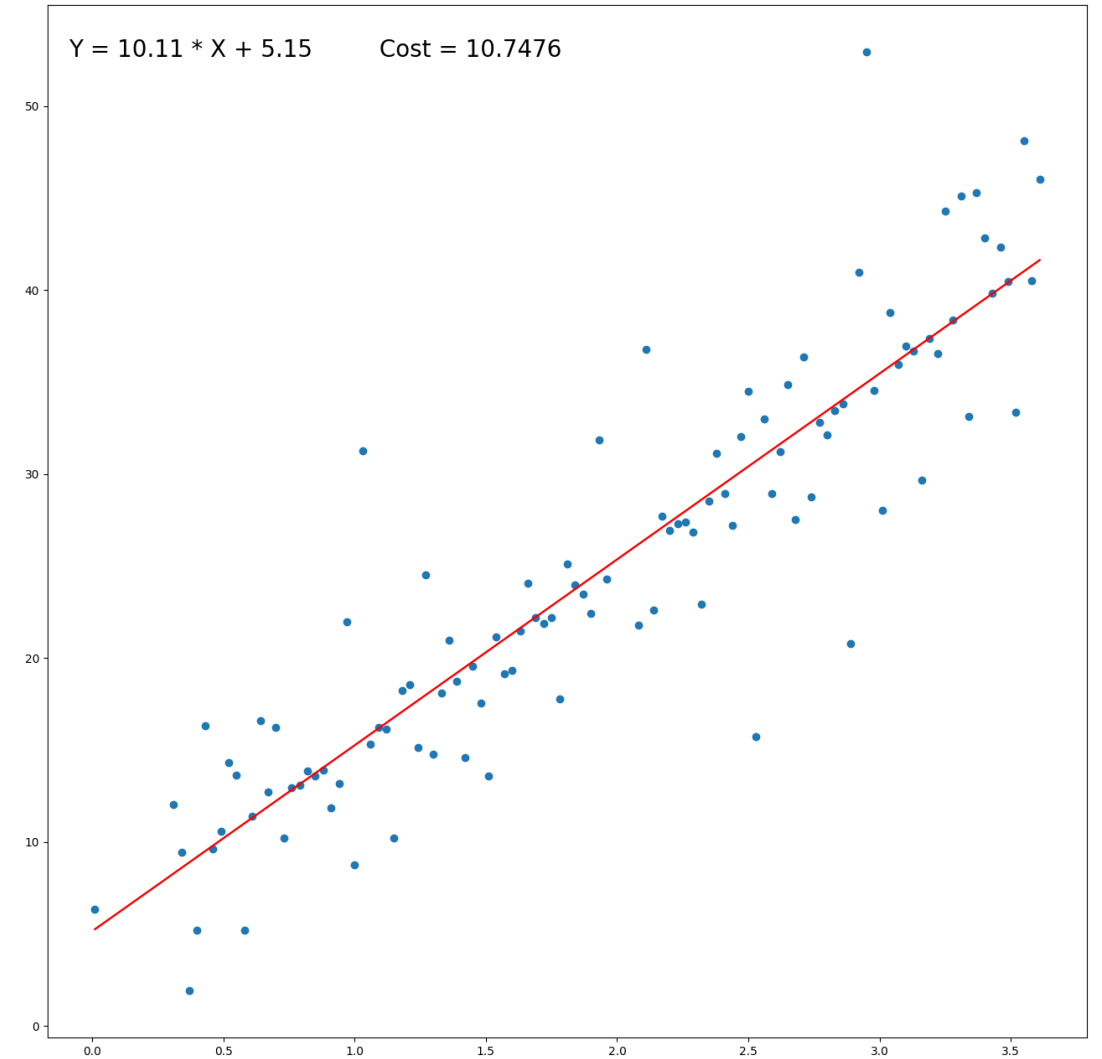
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Intercept
$$\beta_0 = (\sum(y) - \beta_1 * \sum(X)) / N = 5.15$$

RESULTING MODEL

$$Y = 10.11 * X + 5.15$$



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Formulas

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2 = 10.7476$$

FORMULAS FOR β COEFFICIENTS

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Intercept
$$\beta_0 = (\sum(y) - \beta_1 * \sum(X)) / N = 5.15$$

RESULTING MODEL

$$Y = 10.11 * X + 5.15$$

Without those formulas,

How can we find the coefficients?

MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Gradient Descent

MODEL STRUCTURE

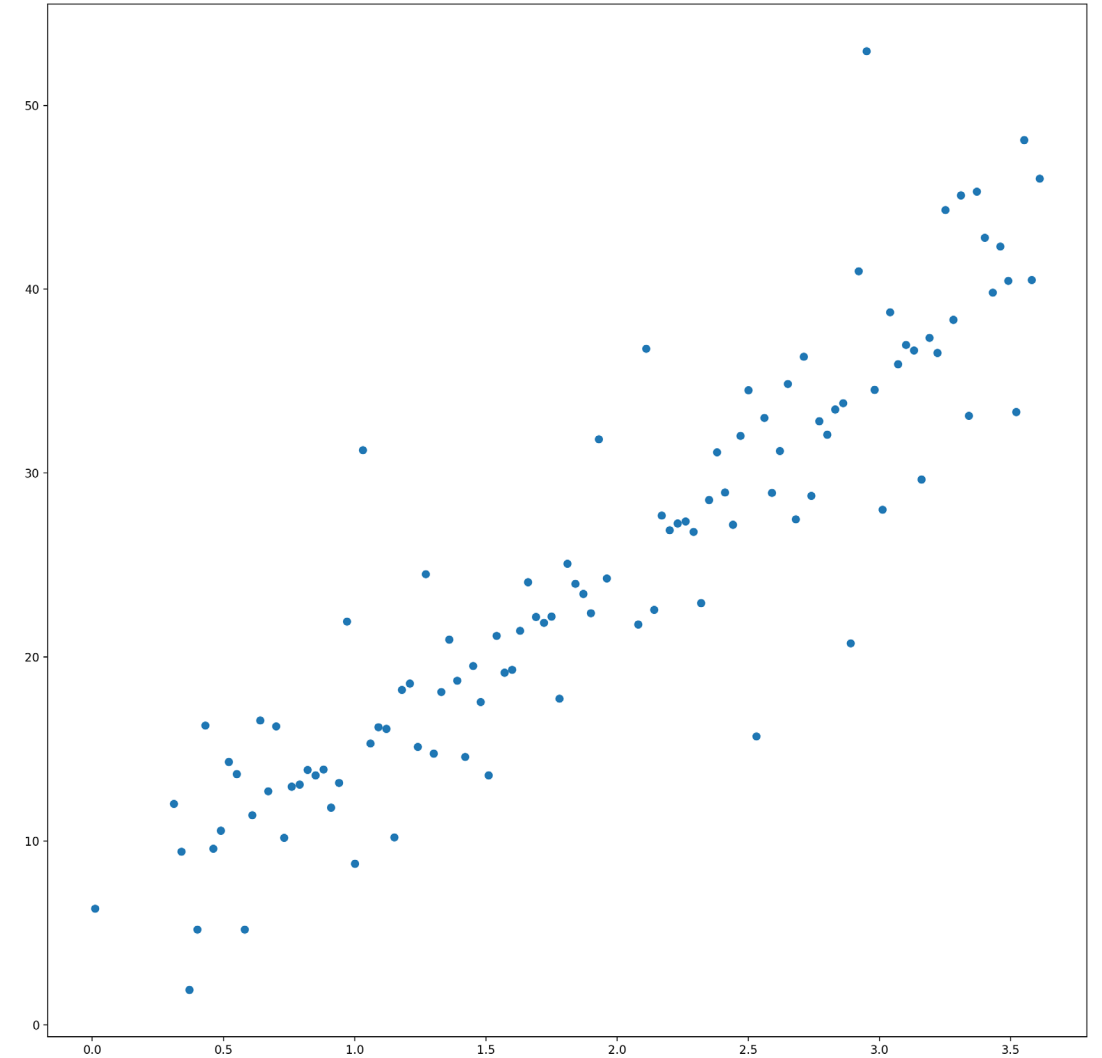
$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2$$

FORMULAS FOR β COEFFICIENTS

None!



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Gradient Descent

MODEL STRUCTURE

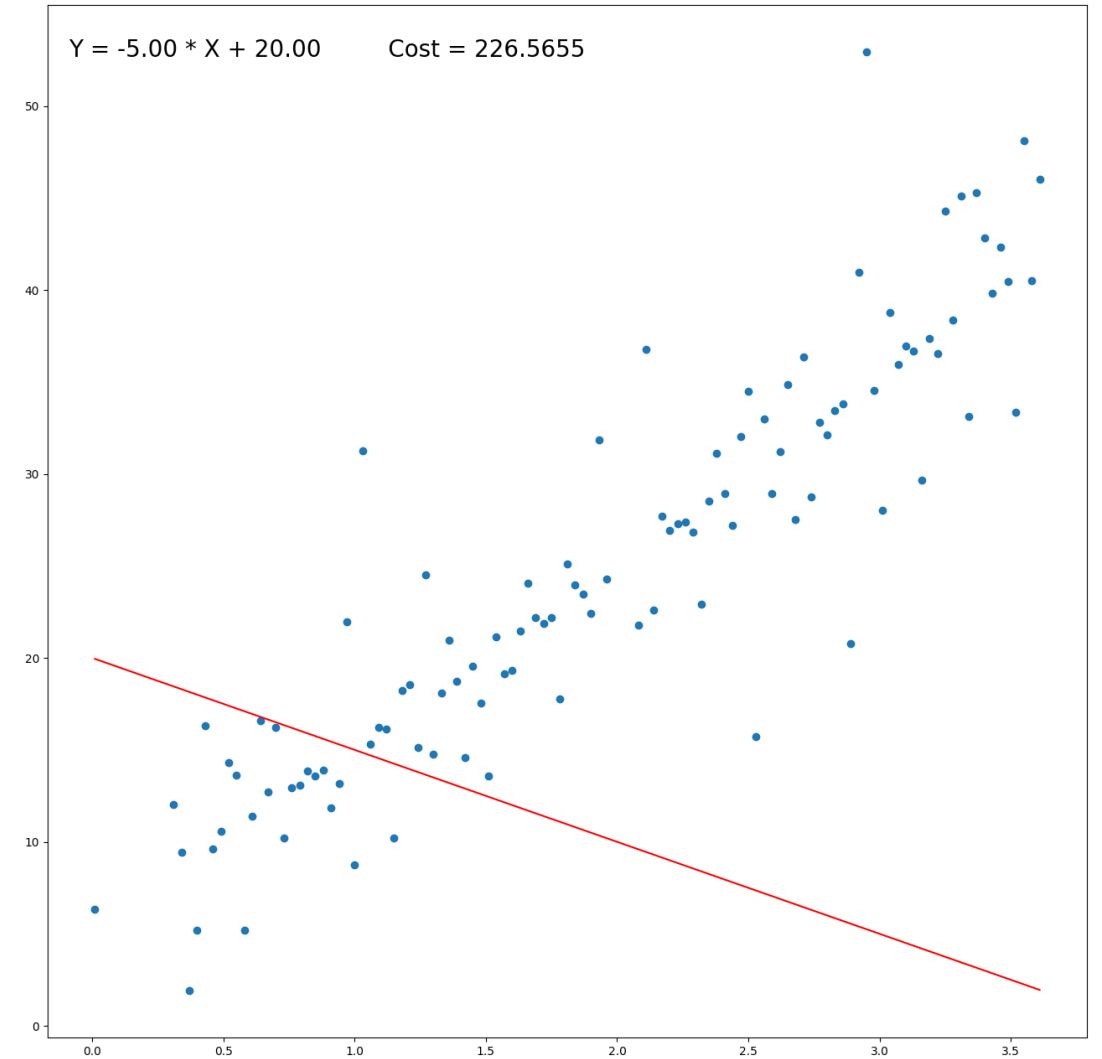
$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2$$

FORMULAS FOR β COEFFICIENTS

None!



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Gradient Descent

MODEL STRUCTURE

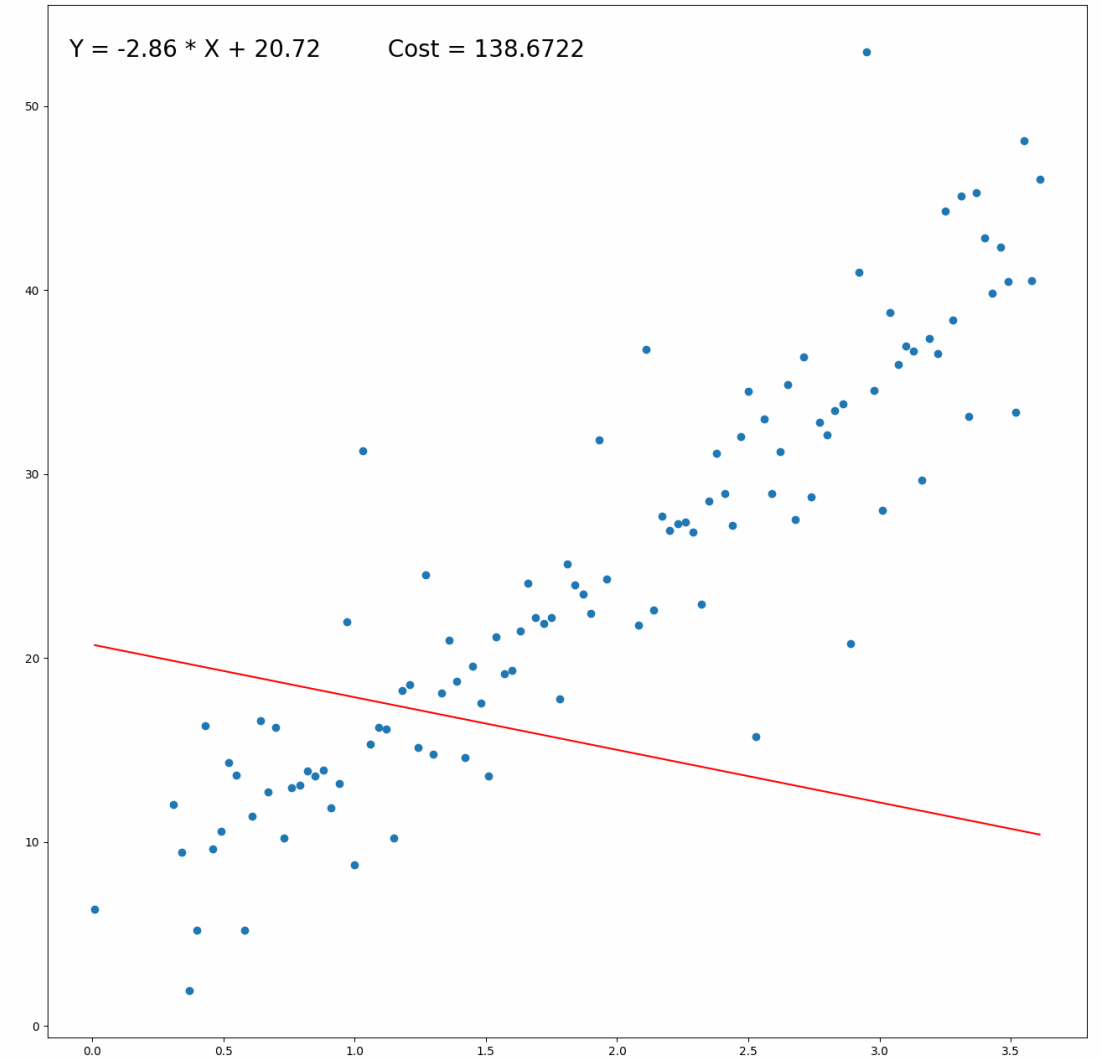
$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

$$\text{Cost} = \sum(\text{predicted} - \text{actual})^2$$

FORMULAS FOR β COEFFICIENTS

None!



MACHINE LEARNING 101: GRADIENT DESCENT

Linear Regression Model Using Gradient Descent

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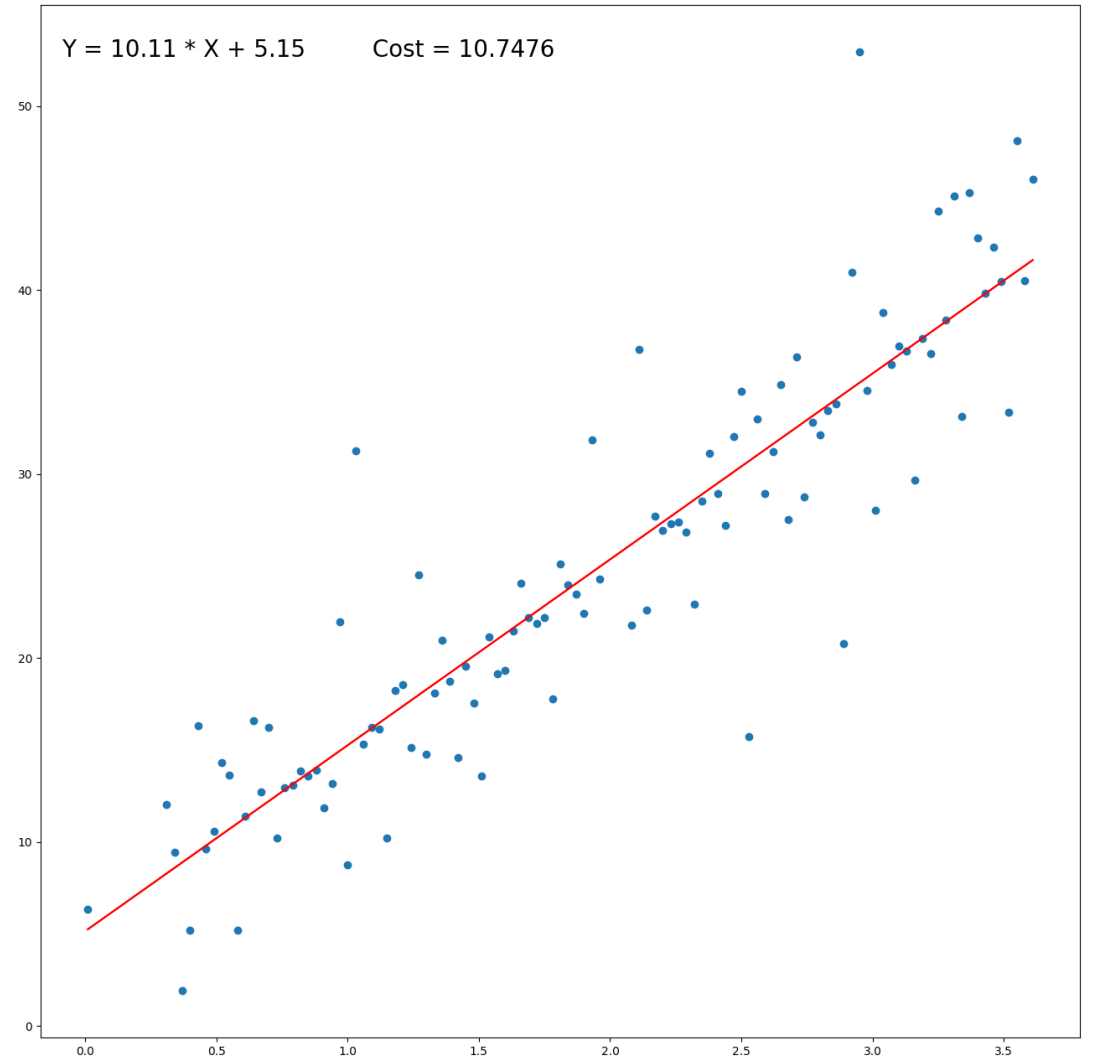
FORMULAS FOR β COEFFICIENTS

None!

RESULTING MODEL

$$Y = 10.11 * X + 5.15$$

Through the two coefficients, the model “remembers” the data.



REGRESSION VS CLASSIFICATION

Linear Regression

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X$$

COST FUNCTION

Sum of squared error
 $\Sigma(\text{predicted} - \text{actual})^2$

Prediction Y can be any number

Example: predict the sell price of a house using one variable (such as square footage)

Multivariate Linear Regression

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \beta_2 * X_2 + \beta_3 * X_3 + \dots$$

COST FUNCTION

Sum of squared error
 $\Sigma(\text{predicted} - \text{actual})^2$

Prediction Y can be any number

Example: predict the sell price of a house using multiple variables (square footage, year of construction, etc.)

Logistic Regression

MODEL STRUCTURE

$$Y = 1 / (1 + \exp(-(\beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \dots)))$$
$$Y = \text{sigmoid}(\beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \dots)$$

COST FUNCTION

Cross-entropy
 $\Sigma(-\text{actual} * \log(\text{predicted}) + (1 - \text{actual}) * \log(1 - \text{predicted}))$

Prediction Y is between 0 and 1

Example: predict whether a flower is of a certain species based on petal length and width

REGRESSION VS CLASSIFICATION

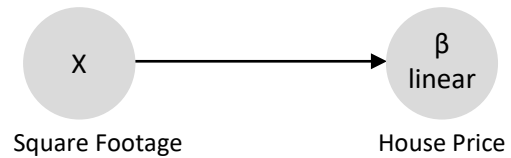
Linear Regression

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X$$

Input

Output



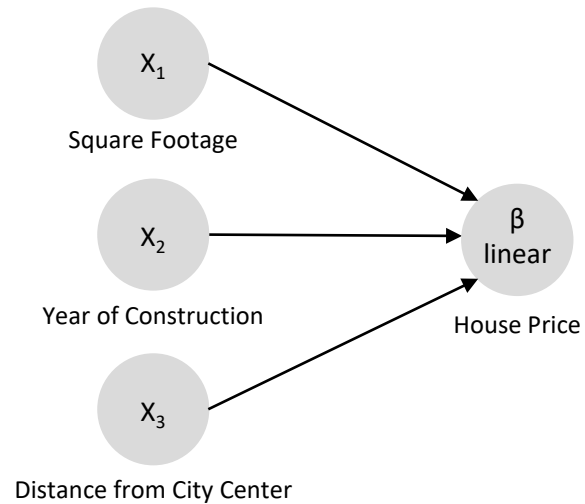
Multivariate Linear Regression

MODEL STRUCTURE

$$Y = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \beta_2 * X_2 + \beta_3 * X_3 + \dots$$

Input Layer

Output



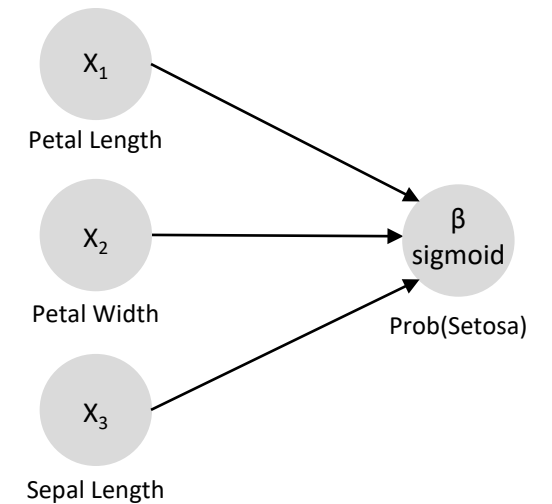
Logistic Regression

MODEL STRUCTURE

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$$Y = \text{sigmoid}(\beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \dots)$$

Input Layer

Output

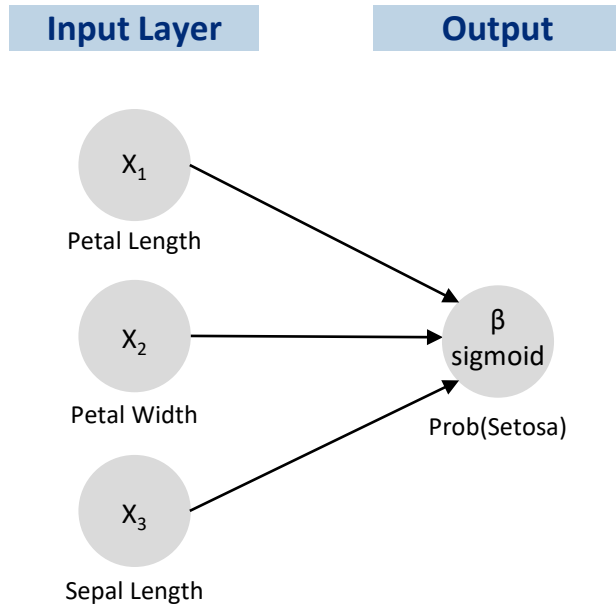


SINGLE-LABEL VS MULTI-LABEL CLASSIFICATION

Single-Label Classification

MODEL STRUCTURE

$$Y = \text{sigmoid}(\beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \dots)$$



Multi-Label Classification Training Data Example

Petal Length	Petal Width	Sepal Length	Species
5.4	3.9	1.3	Setosa
4.5	2.3	1.3	Setosa
4.4	3.2	1.3	Setosa
4.8	3.0	1.4	Setosa
5.1	3.8	1.6	Setosa
4.6	3.2	1.4	Setosa
5.3	3.7	1.5	Setosa
5.0	3.3	1.4	Setosa
7.0	3.2	4.7	Versicolor
6.4	3.2	4.5	Versicolor
6.9	3.1	4.9	Versicolor
5.6	2.7	4.2	Versicolor
5.7	3.0	4.2	Versicolor
5.7	2.9	4.2	Versicolor
6.2	2.9	4.3	Versicolor
5.1	2.5	3.0	Versicolor
5.7	2.8	4.1	Versicolor
6.3	2.5	5.0	Virginica
6.5	3.0	5.2	Virginica
6.2	3.4	5.4	Virginica
...
5.9	3.0	5.1	Virginica

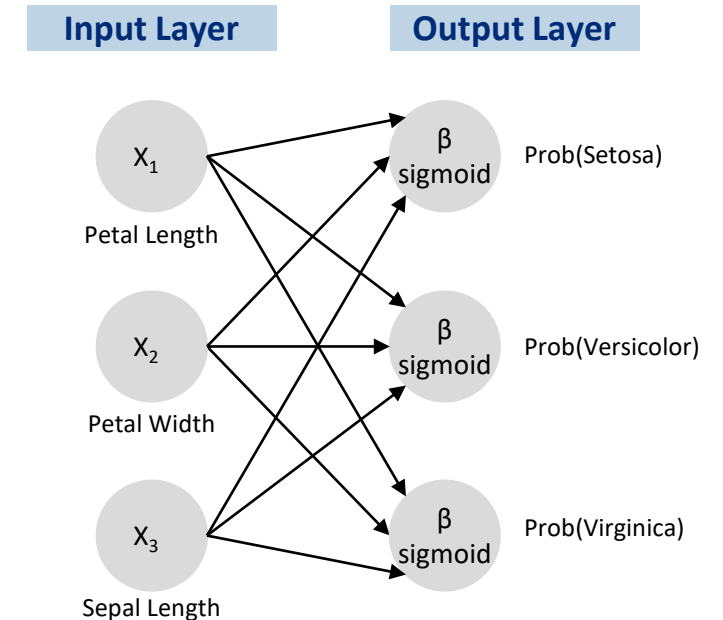
Multi-Classification Training Data Example

MODEL STRUCTURE

$$Y_1 = \text{sigmoid}(\beta_{10} + \beta_{11} * X_1 + \beta_{12} * X_2 + \dots)$$

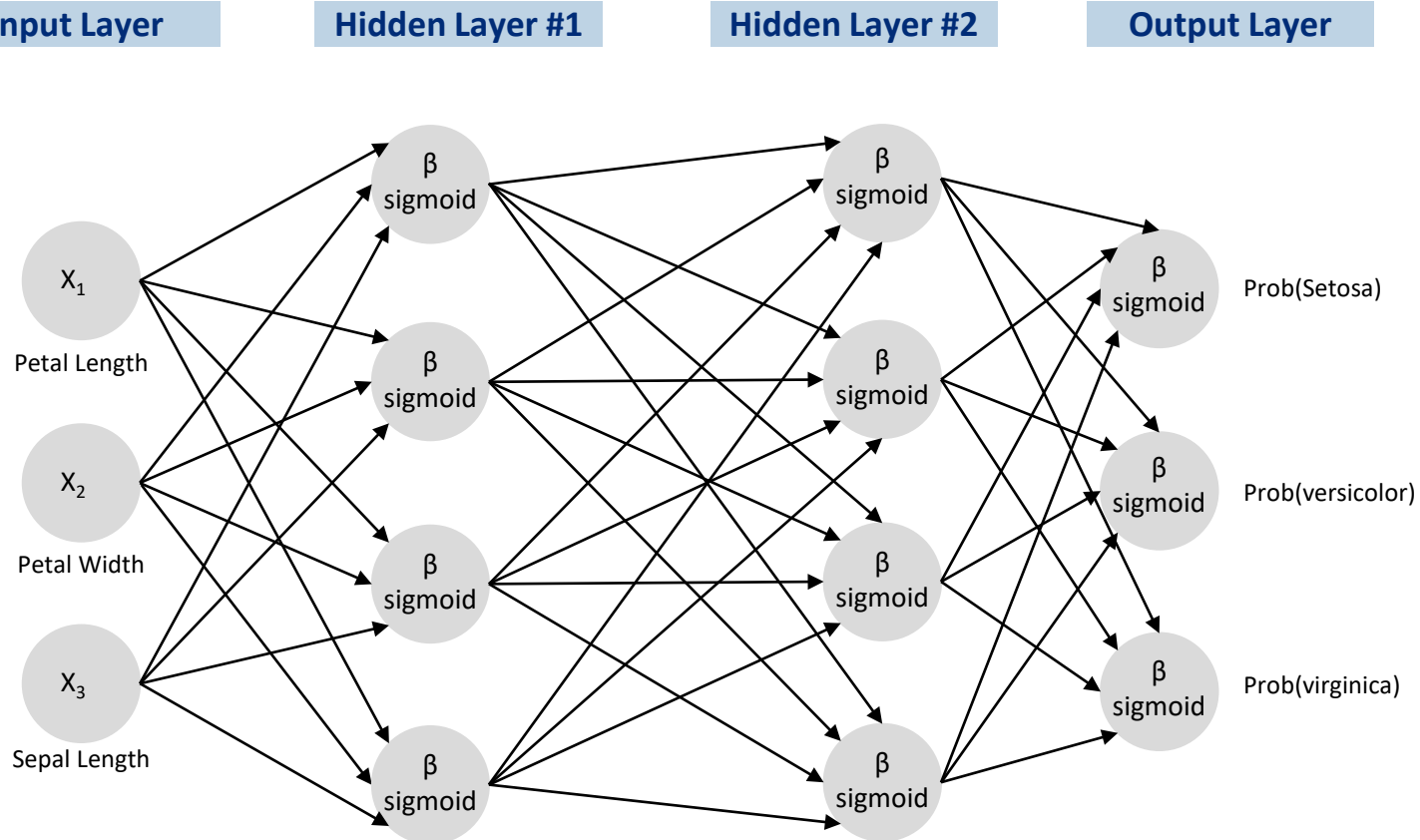
$$Y_2 = \text{sigmoid}(\beta_{20} + \beta_{21} * X_1 + \beta_{22} * X_2 + \dots)$$

$$Y_3 = \text{sigmoid}(\beta_{30} + \beta_{31} * X_1 + \beta_{32} * X_2 + \dots)$$



NEURAL NETWORKS

Multi-Layer Perceptron



MODEL STRUCTURE

The number of nodes in the hidden layer is chosen by the modeler.

COST FUNCTION

Cross-entropy
 $\Sigma(-\text{actual} * \log(\text{predicted}) + (1 - \text{actual}) * \log(1 - \text{predicted}))$

MODEL PARAMETERS

All β parameters are initially set a random. The model adjusts those parameters to minimize the cost function.

**BUT WHAT ABOUT
PREDICTING WORDS?**

NEXT WORD PREDICTION

Fundamentally, GPT-3 and ChatGPT are neural networks that constantly give a probability to what should be the next outputted word. That's why ChatGPT types one word at a time!

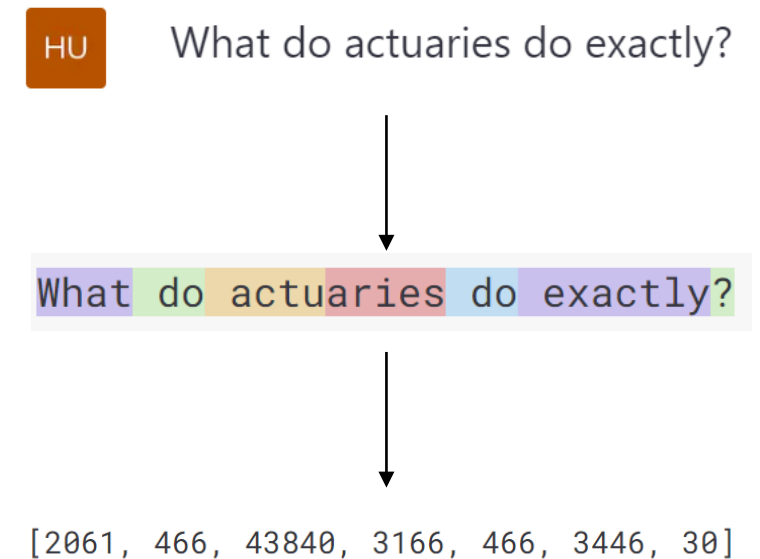
First Step: Tokenization

- First step of NLP any model is to convert text into numbers, or “tokens”.
- GPT-3's tokenizer assign integers to chunks of characters.
- It's a one-to-one mapping, fixed mapping.
 - In the input layer, “exactly” will always be mapped to the number 3446
 - In the output layer, 3446 will always be mapped to “exactly”

Classification Problem

- Next word prediction becomes a classification problem
- Input: series of tokens (a sentence)
- Output: probability distribution over all tokens
- Vocab size of GPT-3 = 50,257
- The problem becomes a classification problem with 50,257 labels

Example: Tokenization of an Input



Source: <https://platform.openai.com/tokenizer>

SUMMARIZING MEANING AND REDUCING DIMENSIONALITY WITH WORD EMBEDDINGS

How to quantify meanings of words?

- Token IDs cannot be used as-is.
- Word Embedding: a large vector assigned to each token
- Values in the vector are initially assigned at random

Word Embedding Examples

Token	Token ID	One-Hot Encoded Vector (50,000 dimensions)	Word Embedding Vector (fewer dimensions)
round	35634	(0, 0, 0, 0, 0, 0, ..., 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, ..., 0, 0, 0, 0, 0)	(0.932, 0.321, 0.456, 0.571, 0.984, ..., 0.654)
ball	1894	(0, 0, 0, 0, 0, 0, ..., 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, ..., 0, 0, 0, 0, 0)	(0.524, 0.329, 0.132, 0.134, 0.952, ..., 0.213)
net	3262	(0, 0, 0, 0, 0, 0, ..., 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, ..., 0, 0, 0, 0, 0)	(0.187, 0.818, 0.118, 0.901, 0.347, ..., 0.221)

REPRESENTING ORDER OF WORDS WITH POSITIONAL ENCODING

Network nodes need to consider multiple tokens at once. How to do that?

A naïve approach of simply taking an average or a sum of all word embedding vectors would be wrong for two reasons.

- First, obvious reason: the order of the tokens need to be considered.

Solution: Positional Encoding (see below)

- Second, less obvious reason: some words “care” more about each other than others.

Solution: Self-Attention (see next slides)

Token	Word Embedding		Positional Encoding		<i>The resulting vectors represent both the meaning and position of tokens.</i>
Name	(0.638, 0.759, 0.905, 0.243, 0.189, ..., 0.900)	+	(0, 1, 0, 1, 0, ..., 0)	=	(0.638, 1.759, 0.905, 1.243, 0.189, ..., 0.900)
the	(0.655, 0.325, 0.599, 0.91, 0.49, ..., 0.726)	+	(0.031, 1.000, 0.003, 1.000, 0, ..., 0)	=	(0.686, 1.324, 0.602, 1.909, 0.490, ..., 0.726)
capital	(0.082, 0.326, 0.622, 0.418, 0.136, ..., 0.344)	+	(0.062, 0.998, 0.000, 1.000, 0, ..., 0)	=	(0.144, 1.324, 0.622, 1.418, 0.136, ..., 0.344)
of	(0.194, 0.294, 0.796, 0.07, 0.726, ..., 0.56)	+	(0.094, 0.995, 0.000, 1.000, 0, ..., 0)	=	(0.288, 1.289, 0.796, 1.07, 0.726, ..., 0.560)
Peru	(0.825, 0.943, 0.828, 0.611, 0.912, ..., 0.962)	+	(0.125, 0.992, 0.000, 1.000, 0, ..., 0)	=	(0.95, 1.935, 0.828, 1.611, 0.912, ..., 0.962)

ATTENTION IS ALL YOU NEED

Self-Attention is the mechanism used by transformer models to weigh the importance of different words in a sentence or piece of text based on their relationships to other words.

Motivation for Self-Attention

“I can enjoy almost any **music** genre, but I was never enthusiastic about **heavy** ____.”

“I run instead of **lifting**, because my apartment building’s gym doesn’t have **heavy** ____.”

In the two sentences above:

- The words “**music**” and “**lifting**” give a lot of meaning to the token “**heavy**”, since those tokens help specify the context.
- The words “enthusiastic” and “apartment”, however are not very useful in finding out what is “**heavy**”.

Therefore, we want the next word predictions to highly depend on “**music**” and “**lifting**” and not so much on “enthusiastic” and “apartment”.

COMBINING KEYS, QUERIES, AND VALUES IN SELF-ATTENTION



Queries: vector describing what each token cares about



Keys: vector describing what each token can inform about

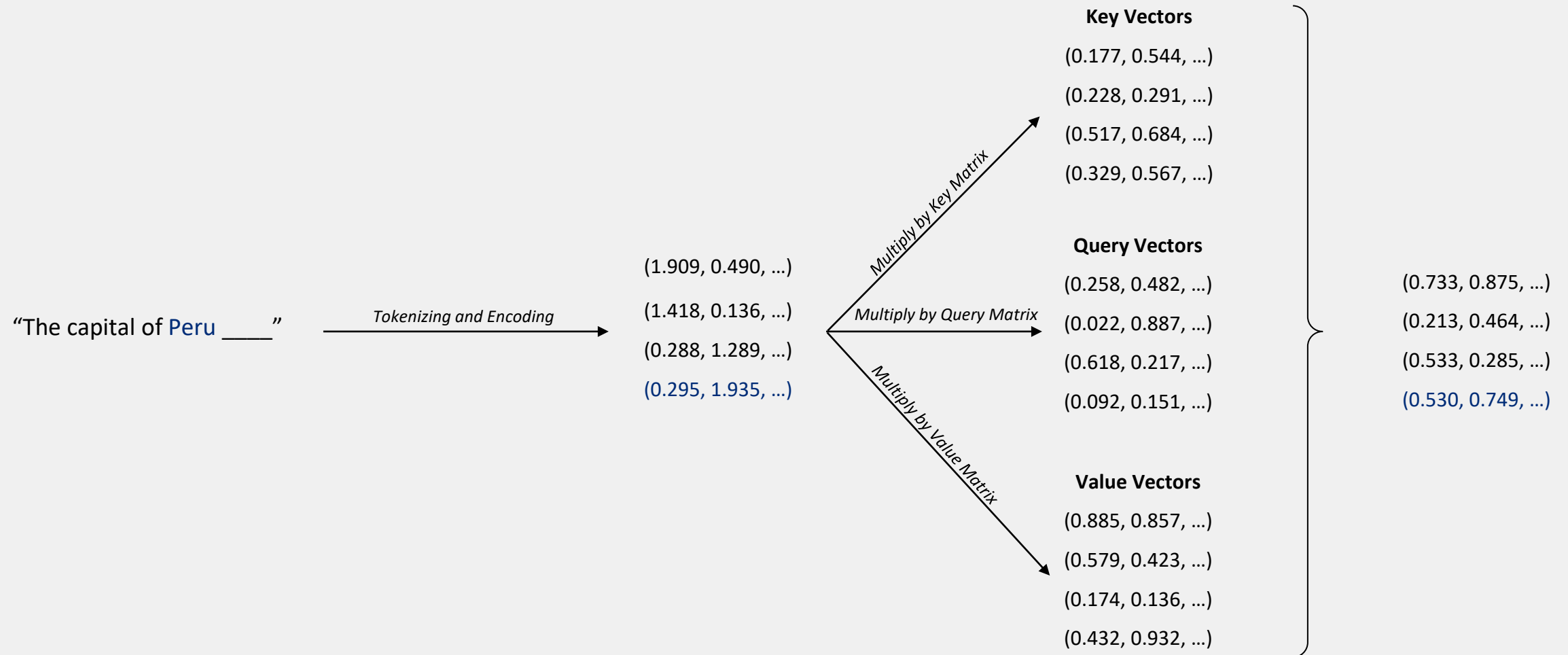


Value: vector describing information each token has to offer

- Matrices used to obtain keys, queries, and values are common to all tokens.
- They are initialized at random and trained using gradient descent.

	A. Key	B. Query	C. Value	D. Unnormalized Weights	E. Normalized Weights	F. New Representation of "Peru"
Preceding Tokens	Key Matrix x Previous Representation	Query Matrix x Previous Representation	Value Matrix x Previous Representation	Key x "Peru" Query	softmax(D.)	weighted average of C.
The	(0.177, 0.544, ...)	(0.258, 0.482, ...)	(0.885, 0.857, ...)	1.798	14%	(0.530, 0.749, ...)
capital	(0.228, 0.291, ...)	(0.022, 0.887, ...)	(0.579, 0.423, ...)	2.501	29%	
of	(0.517, 0.684, ...)	(0.618, 0.217, ...)	(0.174, 0.136, ...)	0.421	4%	
Peru	(0.329, 0.567, ...)	(0.092, 0.151, ...)	(0.432, 0.932, ...)	3.113	53%	

CREATING KEYS, QUERIES, AND VALUES TO ALLOW SELF-ATTENTION CALCULATION



TRANSFORMER ARCHITECTURE EXAMPLE



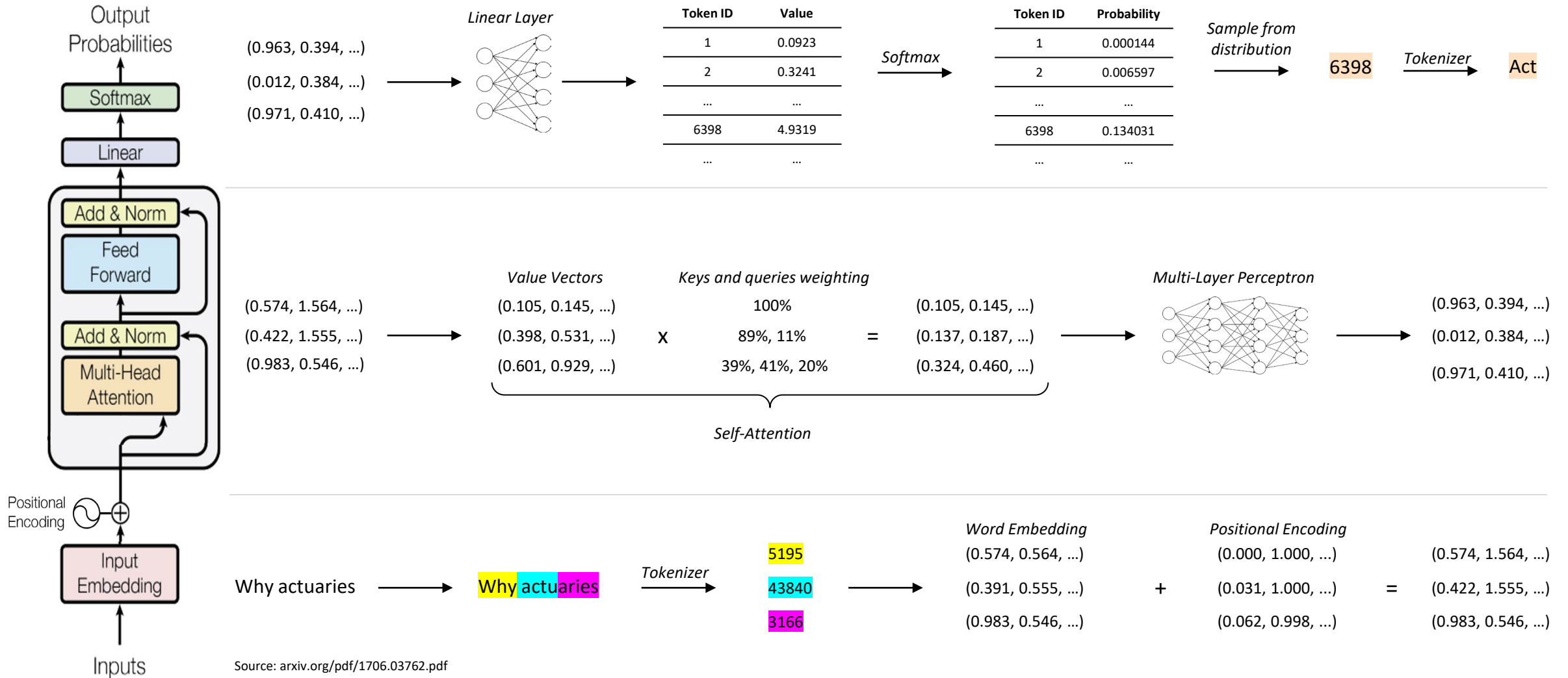
Why actuaries



Actuaries are professionals who use mathematical and statistical techniques to analyze financial risk and uncertainty. They are often employed by insurance companies, pension funds, and other financial institutions to assess the likelihood of future events and the associated financial impact.



TRANSFORMER ARCHITECTURE EXAMPLE



Source: arxiv.org/pdf/1706.03762.pdf

TRANSFORMER ARCHITECTURE EXAMPLE



Why actuaries

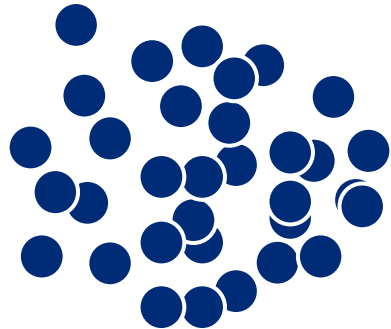


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GPT IS CAPABLE OF ZERO-SHOT LEARNING

FINE-TUNING



Update weights of pre-trained model by training on a dataset specific to the desired task

FEW-SHOT LEARNERS



Model is given a few demonstrations of the task as conditioning, but no weight updates are allowed

ONE-SHOT LEARNERS



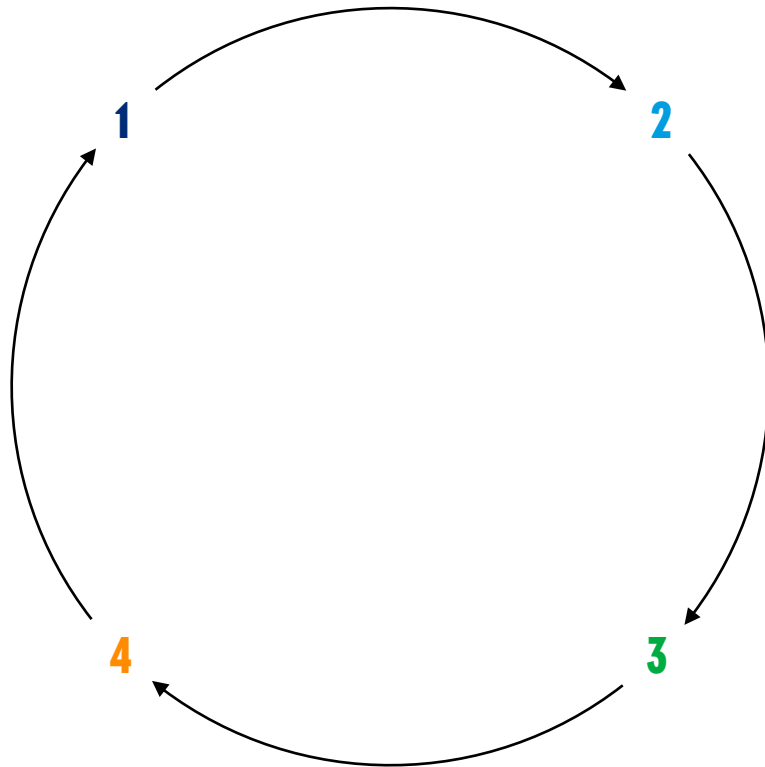
Same as few-shot but only one demonstration is allowed

ZERO-SHOT LEARNERS

Prompt
"Can you tell me a joke about a cat and a dog?"

No demonstrations are allowed – the model is only given a natural language description of the task

ADDING REINFORCEMENT LEARNING LAYERS AND A MODERATION API ENABLES THE TRANSITION FROM GPT TO CHATGPT



Sources:
<https://openai.com/blog/chatgpt/>
<https://openai.com/blog/new-and-improved-content-moderation-tooling/>

1



Fine-tune GPT-3.5

ChatGPT focused language model that has been fine-tuned on conversational data such as short, informal sentences and specific conversational conventions.

2



Train a reward model

A labeler ranks possible responses to prompts, and this data is used to train a reward model to determine the final response.

3



Use reinforcement learning to optimize reward

An agent learns to choose the best response to a prompt by receiving feedback in the form of the rewards from step 2.

4

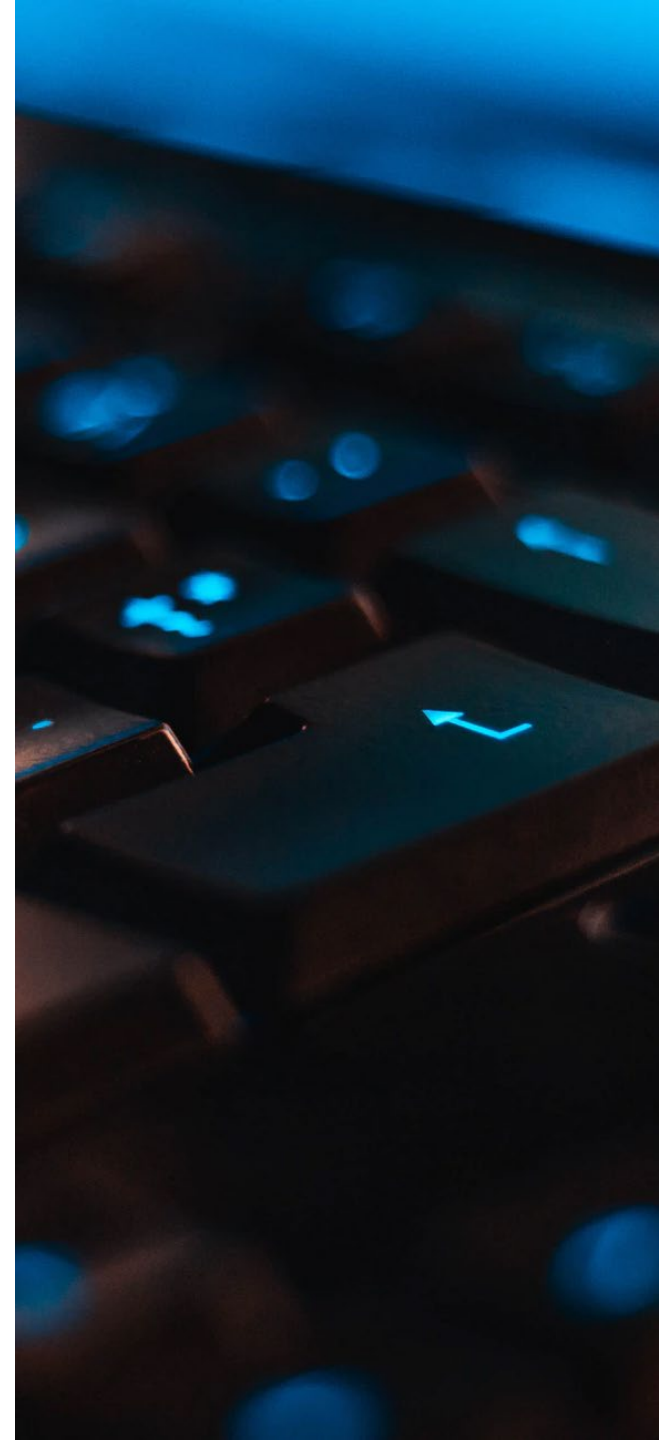


Moderation endpoint

A separate language model is used to classify text as whether they violate content policy by being “sexual, hateful, violent, or promoting self-harm”.

3

ACTUARIAL APPLICATIONS



GPT-ENABLED TOOLS CAN HELP ACTUARIES EXECUTE THEIR WORK (1/3)

Fitting a model using GitHub Copilot

```
In _ 1 # The target variable is target_total_claim_amount
2 # Split the data into train and test
3 X = df.drop('target_total_claim_amount', axis=1)
4 y = df['target_total_claim_amount']
5 X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
6
```

```
In _ 1 # Fit an XGBoost model
2 xgb_model = xgb.XGBRegressor(objective="reg:squarederror", random_state=42)
3
```

```
Out 14 ▾ XGBRegressor
XGBRegressor(base_score=None, booster=None, callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytrees=None, early_stopping_rounds=None,
             enable_categorical=False, eval_metric=None, feature_types=None,
             gamma=None, gpu_id=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=None, max_bin=None,
             max_cat_threshold=None, max_cat_to_onehot=None,
             max_delta_step=None, max_depth=None, max_leaves=None,
             min_child_weight=None, missing=nan, monotone_constraints=None,
             n_estimators=100, n_jobs=None, num_parallel_tree=None,
             predictor=None, random_state=42, ...)
```

```
GitHub Copilot x
Accept solution
xgb_model = xgb.XGBRegressor(objective="reg:squarederror",
                             n_estimators=10, seed=123)
xgb_model.fit(X_train, y_train)
###
# Predict on test set
y_pred = xgb_model.predict(X_test)
###
Accept solution
xgb_model = xgb.XGBRegressor(objective='reg:squarederror',
                             n_estimators=1000)
xgb_model.fit(X_train, y_train)
###
# Evaluate the model
y_pred = xgb_model.predict(X_test)
rmse = np.sqrt(mean_squared_error(y_test, y_pred))
Accept solution
model = xgb.XGBRegressor(objective='reg:squarederror',
                         colsample_bytrees = 0.3, learning_rate = 0.1,
                         max_depth = 5, alpha = 10, n_estimators = 10)
model.fit(X_train, y_train)
###
# Make predictions
preds = model.predict(X_test)
Accept solution
```

GPT-ENABLED TOOLS CAN HELP ACTUARIES EXECUTE THEIR WORK (2/3)

An entire modeling process using ChatGPT and Copilot



To build a model for predicting the target_total_claim_amount based on the given features, you can follow these general steps:

1. Load the data: Load the data into your preferred data analysis tool. This can be done using various libraries such as pandas in Python.
2. Explore the data: Analyze the dataset to identify the types of variables, number of missing values, and possible outliers. You can visualize the data to get a better understanding of the relationships between variables.
3. Clean the data: Clean and preprocess the data by handling missing values, outliers, and encoding categorical variables. You can use techniques like one-hot encoding for categorical variables, and scaling for continuous variables.

1. Load the data

```
In 2 1 # Load data from data folder
      2 df = pd.read_csv('.\\data\\rpm_2023_sample_data.csv')
```

```
In 3 1 df.head()
```

```
Out 3  |< 5 rows v > | 5 rows x 6 columns
      |-----|-----|-----|-----|
      | feature_monthly_premium_auto | feature_income | feature_coverage | feature_location_code | |
|---|---|---|---|---|
      | 0 | 94 | 0.0 | Extended | Suburban |
      | 1 | 108 | 48767.0 | Premium | Suburban |
      | 2 | 71 | 14072.0 | Basic | Suburban |
      | 3 | 93 | 28812.0 | Extended | Urban |
      | 4 | 67 | 0.0 | Basic | Suburban |
```

2. Explore the data

```
In 4 1 # Check data types
      2 df.dtypes
```

SA

in python, how do I plot histograms of numerical variables with overlaying line that shows average target variable in each bin?



You can use the `matplotlib` library to create a histogram of numerical variables in Python. Here's an example code that shows how to create a histogram with an overlaying line that shows the average target variable in each bin:

```
python Copy code
import pandas as pd
import matplotlib.pyplot as plt

# Create some sample data
df = pd.DataFrame({'x': [2, 3, 4, 5, 6, 7, 8, 9, 10],
                  'y': [4, 6, 5, 8, 7, 6, 5, 9, 10]})

# Calculate the average target variable in each bin
bins = 5
bin_means, bin_edges, _ = plt.hist(df['x'], bins=bins, alpha=0.5, label='Histogram')
bin_centers = 0.5 * (bin_edges[1:] + bin_edges[:-1])
y = []
for i in range(bins):
    y.append(df.loc[(df['x'] > bin_edges[i]) & (df['x'] <= bin_edges[i + 1]), 'y'].mean())

# Plot the histogram and overlaying line
plt.plot(bin_centers, y, '-o', color='r', label='Mean')
plt.legend()
plt.show()
```

GPT-ENABLED TOOLS CAN HELP ACTUARIES EXECUTE THEIR WORK (3/3)

Using ChatGPT to debug code

```
1 # Fit an XGBoost model
2 xgb_model = xgb.XGBRegressor(objective=reg:squarederror, random_state=42)
```

Cell In[18], line 2

```
xgb_model = xgb.XGBRegressor(objective=reg:squarederror, random_state=42)
```

SyntaxError: invalid syntax

SA

Why am I getting a syntax error in the following code:

```
xgb_model = xgb.XGBRegressor(objective=reg:squarederror, random_state=42)
```



The issue with this code is that `reg:squarederror` should be a string, but it's currently being interpreted as an object. To fix this, you can surround `reg:squarederror` with quotes like this:

```
python
```

Copy code

```
xgb_model = xgb.XGBRegressor(objective='reg:squarederror', random_state=42)
```

By doing so, you're telling Python that `'reg:squarederror'` is a string, which is the expected format for the `objective` parameter.

NLP OPENS THE DOOR TO INNOVATIVE SOLUTIONS FOR SEVERAL INSURANCE PROCESSES



Customer service

Chatbots powered by GPT models can understand natural language and provide personalized responses



Analysis of unstructured claims data
Classify/label unstructured data in claims to gather insights from documents such as medical reports and automate claims processes



Summarizing and searching policy contracts
Identify key provisions and search to identify specific clauses or provisions



Fraud detection

Analyze data from alternative sources to identify potential risks through detection of anomalies



Web scraping for commercial lines underwriting

Streamline quoting process by automating capture of potential policyholder information



Employee Productivity Enhancement

Enable non-technical users to perform data exploration; aid in writing reports or sales content; parsing, transcribing, organizing unstructured data sources (powerpoints, e-mails)

ANALYSIS OF UNSTRUCTURED CLAIMS DATA USE CASES



Root Cause Analysis

Understand patterns in root causes of claims to better understand how to mitigate risk and narrowly tailor loss control and safety initiatives.



Safety Initiatives Tracking

Monitor effectiveness of risk management initiatives precisely and in real-time. Proactively measure claim actions as the actions occur.



Manual Task Automation

Automate some sections of the claim review. Preemptively scan for critical events daily, making previously hidden information available for claim managers instantly.



Automated, Timely Claim Audits

Artificial intelligence can automatically identify and classify key claim events that are included in claim audits.



Detailed Claim Lifecycle Prediction

Predict the likeliness of specific claim events for each claims. Predictions are updated each time new claim notes are added.



Claim Severity Model Accuracy Improvement

Predict problematic claims more accurately and earlier in the claim adjusting process.

ANALYSIS OF UNSTRUCTURED DATA EXAMPLE 1 – GENERAL LIABILITY

- Fortune 1000 non-insurance company, with large general liability retentions, asked us to create a model that would predict the likelihood of a claim becoming severe
 - 1800 claims with cost, per year
 - Less than 100 claims were litigated per year
 - The model used the following features:
 - Characteristics of claims captured in structured data fields (e.g., state, report lag, nature of injury, etc.)
 - Characteristics of the location of the incident using external data (e.g., judicial profile, density of legal professionals, employment mix in the population, etc.)
 - Unstructured data, including intake form information, inspection documents, and adjuster notes

NLP on adjuster notes was the most predictive element of the model (akin to the combination of part of body, report lag and the nature of injury)

VALUE OF ADJUSTER NOTE EXAMPLE IN CLIENT DATA

Note Subject	Note Text
003 (Investigation)	FACTS OF ACCIDENT AND INJURY: Said it broke his mouth out and is stomach hurt. He said he face swelled up and he was having cramps. Said it was 30 minutes after he stated to feel his symptoms. Said he has trouble breathing. He had a multitude of symptoms. Went to the ER and they told him it was some kind of bacteria. They gave him some medicine and he still feels sick.
003 (Investigation)	ER will bill him, no co-pay. No health insurance. No stool sample taken or tested. I explained the policy and the issue with having no stool sample. He said he understood and would send over the information that he has. MEDICAL TREATMENT: went to the ER, no stool sample. PRIOR INJURIES: None WITNESS INFORMATION: None POLICE/FIRE/AMBULANCE REPORTS: No reports
003 (Investigation)	Reports - Police: No policed involved. - Fire: No fire department involved. - Water: No water as this is not a property claim. - Maintenance: No maintenance reports maintained by staff. - Inspection: No inspection reports available. - Contractual documents: No interior lease, slip and fall. Or if product, no contracts as product made in house.
003 (Investigation)	D.F.I. - Guest Ticket - Statement Category : File Name : AMBER STATEMENT.PDF Description : Guest Ticket - Statement System Information: File Name : EX202011095885B89B0FDA4B1B8A09EB26DF52022F.PDF File Location: Attachments
003 (Investigation)	D.F.I. - Guest Ticket - Statement Category : File Name : RECEIPT.PDF Description : Guest Ticket - Statement System Information: File Name : EX20201109E586B9B2AC7C496B8FCF1503A613BF95.PDF File Location: Attachments
007 (Supervision)	NReassigning represented file to XXXX. Updated LOR log.

Significantly more extensive event description

Even non-descriptive supervision notes inform the model, if permissible

ANALYSIS OF UNSTRUCTURED DATA EXAMPLE 2

- Oliver Wyman received claim adjuster notes for 100 Worker's Compensation claims in the form of free text, as well as three years of loss runs, and developed a proof of concept of leveraging the free form data for analytics purposes.
- The business goals included:
 - Cost reduction through improved claims handling
 - Being able to predict loss severity earlier in the claim process and in a more accurate manner leads to optimal claim triaging
 - Manual and repetitive day-to-day tasks of claim adjusters can be automated using artificial intelligence.
 - Cost reduction through loss mitigation
 - By understanding drivers and patterns in claims, the client could design improved safety programs.
 - Additionally, artificial intelligence can help track loss control efforts more specifically.

Even with this limited data, our models were able to create meaningful new structured data fields from the unstructured data

ANALYSIS OF UNSTRUCTURED DATA LIST OF FEATURES PULLED FROM ADJUSTER NOTES

We were able to extract the following features from the adjuster notes for a client's top 100 WC claims.

1



Employee Characteristics

- Age
- **Married**
- **Dependents**
- Height
- Weight
- Designation
- Employment tenure
- Average weekly wage

2



Injury Details

- Body part
- Type of injury
- Cause of injury
- Depression/anxiety
- Subrogation
- TTD/PPD rate

3



Claim Events

- Employer cannot accommodate injury
- Meaningful claimant contact
- Claimant missed medical appointment
- Follow up claimant contact
- Legal action

4



Treatment Details

- Hospital
- Surgery
- Physical therapy
- X Ray
- MRI
- DME

GPT LIMITATIONS ... OR AREAS OF OPPORTUNITY FOR ACTUARIES?

GPT-SPECIFIC LIMITATIONS

- GPT is proprietary. It would be expensive to use the API in production if thousands of requests are made per day
- Insurance data often private and data can be sensitive/restricted
 - Example: sharing GL adjuster notes can breach confidentiality requirement for attorney-client privilege and may also lead to unwanted transferring of PII
- Output of a general purpose LLM can rarely be used as-is. Additional layers have to be built. Classification into specific categories, checks for model inaccuracy, conversion of model output (English sentences) into tabular data
 - Concern: clients are already using Chat GPT to mine adjuster notes on their own
 - Value of an industry expert being involved in the modeling

Source: <https://openai.com/blog/chatgpt>

GPT LIMITATIONS ... OR AREAS OF OPPORTUNITY FOR ACTUARIES?

CHATGPT LIMITATIONS

- ChatGPT can be confidently wrong; the system can write “plausible-sounding but incorrect or nonsensical answers”
 - Example: pushing forward a type of loss that is written in Spanish in certain notes, but excluded in English from our model’s consideration
- Can be sensitive to the phrasing of the prompt
- Models do not ask clarifying questions when a prompt is unclear and instead guesses the intent of the user
- It is possible for the model to respond to “harmful instructions or exhibit biased behavior”
 - Example: marital status or dependents; plus, what if notes are in multiple languages – are you certain your model isn’t grabbing
- Supervision and adjustments are often needed by an industry professional

GPT LIMITATIONS ... OR AREAS OF OPPORTUNITY FOR ACTUARIES?

GENERAL LIMITATIONS OF LLMS

- LLMs are computationally expensive to train and run and require vast amounts of resources
- Explainability and interpretability: can be considered a black box since these models are highly complex
 - Can be an area where actuaries/industry professionals help explain and show value of model via ongoing monitoring of results
- Can perpetuate biases present in the data they are trained on, which can lead to unfair or inaccurate predictions
- Requires high level of technical expertise to implement, maintain and use
 - That said, many of these models are now readily available, meaning novice practitioners could use inaccurately

4

RECAP



RECAP & TRAILING QUESTION...

We've seen exponential growth in the complexity of machine learning models, which is largely attributable to the use of deep learning techniques.

Transformer models, including GPTs, have resulted in breakthrough performance on NLP tasks; the process of "self-attention" has been pivotal to this breakthrough.

These breakthroughs impact all fields of work, including insurance and actuarial work.

Converting our industry to one that properly leverages AI will require a lot of work.



QUESTIONS

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