Generate

Hurry up, I'm hungry!

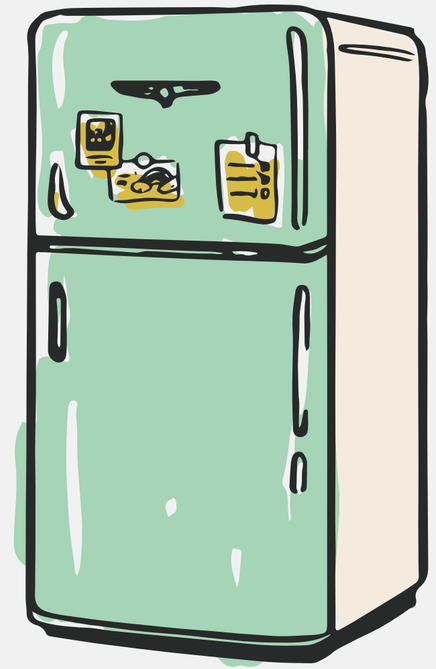
Generating Culinary Recipes

The Kitchen Challenge: What to Cook?

- Problem: You have ingredients, but no recipe idea.
  How to create something new and tasty?

- Traditional Approach: Search existing recipes
  (requires knowing the name of the dish often).
  Do you have all the ingredients for the recipe?

- Our Goal: Generate a novel, coherent, and culinarily plausible recipe from a **given list of ingredients**.



How It Works: System Overview

A hybrid approach combining **Word2Vec** and **GPT-2** for recipe generation

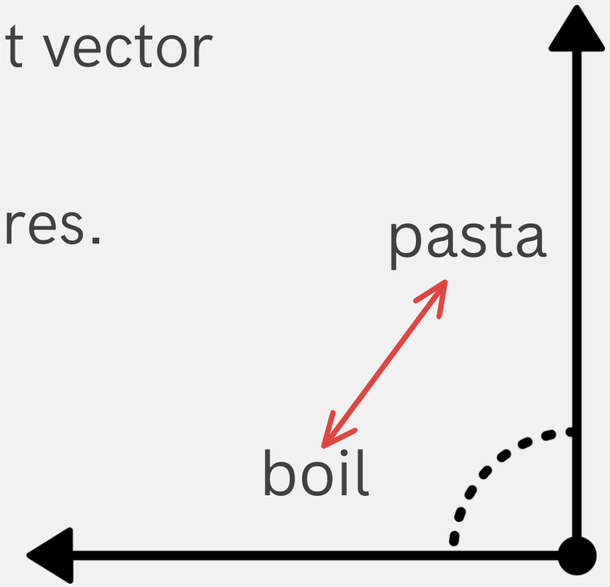
- Stage 1: **Technique Prediction** (Word2Vec)
  - Input: User ingredients
  - Output: Suitable cooking techniques.

- Stage 2: **Recipe Generation** (Fine-tuned GPT-2)
  - Input: User ingredients + Predicted techniques
  - Output: Generate full recipe steps.

Predicting Techniques with Word2Vec

- **Training**: Word2Vec learns semantic relationships between words (ingredients & techniques) based on co-occurrence in the dataset.

- **Prediction** Process:
  - Calculate the average **vector representation** of the input ingredients.
  - Compute **Cosine Similarity** between the average ingredient vector and all known technique vectors.
  - Select the Top-N techniques with the highest similarity scores.



Generating Recipes with GPT-2

- Base Model: GPT-2 (a powerful **pre-trained** Transformer language model).
- **Fine-Tuning**: Adapting GPT-2 to the recipe domain using our recipes dataset.
- Structured Input: Used special **tokens** to guide the model:
  - [INGREDIENTS] ... ingredients ...
  - [TECHNIQUES] ... techniques ...
  - [STEPS] ... (Model generates this part)
- Generation: Model takes ingredients + predicted techniques and generates the **[STEPS]** content.

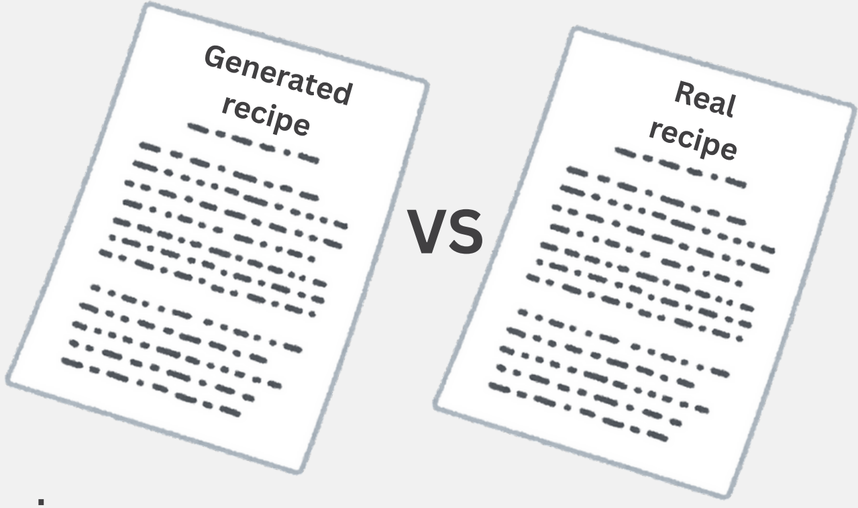
An example

```
Generated Recipe:
[BOS] [INGREDIENTS] tomato, pasta, onion, olive oil, salt [TECHNIQUES] parboil, dice, drain [STEPS] orn
 tomato, pepper, feta cheese, basil [TECHNIQUES] boil, combine, drain, skillet [STEPS] cook pasta
according to package directions. meanwhile, heat olive oil in a large skillet over medium-high heat.
add diced tomatoes and onion and cook, stirring occasionally, until tomatoes begin to soften, about 5
minutes. add drained pasta to tomato mixture and stir to combine. season with salt and pepper to taste.
 serve immediately [EOS]
```

Considerations about the generated recipe:

- The model hallucinates and repeats ingredients and techniques after [STEPS].
- The generated recipe remains consistent with the provided inputs.
- The recipe is edible and in line with the best culinary practices.

Evaluation: Is the Recipe Any Good?



Automatic Evaluation Pipeline:

- Find most similar recipes:
  - Compare generated ingredients to all real recipes using **TF-IDF** and Cosine Similarity.
  - Select Top-K most similar real recipes as benchmarks.

- Generated vs. benchmark recipes comparison:
  - **ROUGE-L**: Measures longest common subsequence (finding the longest overlapping sequence of words in the same order).

  - **BERT Similarity**: Measures semantic meaning using contextual embeddings.

Evaluation: Is the Recipe Any Good?

```
Generated Recipe:
[BOS] [INGREDIENTS] tomato puree, lemon juice, salt, oregano, basil, thyme, garlic powder [TECHNIQUES]
saute, parboil, simmer [STEPS]  [TECHNIQUES] boil, combine, simmer [STEPS] combine all ingredients in a
 large saucepan and bring to a boil. reduce heat and simmer for 20 minutes. remove from heat and let
stand for 5 minutes before serving [EOS]
```

```
--- Real Benchmark #1 ---
Ingredient Similarity: 0.7474
Real Rating: 4.58 stars
ROUGE-L F1: 0.6977
BERT Similarity: 0.9369

Real Recipe Text (Benchmark):
[BOS][INGREDIENTS]tomato puree, water, sugar, olive oil, lemon juice, salt, oregano, basil, thyme,
garlic powder[TECHNIQUES]boil, combine, simmer[STEPS]combine ingredients in a small saucepan over
medium heat bring to a boil reduce heat and simmer for 15 to 20 minutes[EOS]
```

Results and Discussion

- Generates structurally coherent recipes using special tokens.
  Occasional repetition or hallucinated ingredients/steps

- BERT Similarity shows semantic understanding even when wording differs (low ROUGE-L).
  Demonstrating that the semantic context remains consistently similar.

- Model ignores nonsensical inputs (e.g., 'ice cream' + 'chicken') to maintain plausibility.

- Word2Vec technique prediction can lead to more novel and creative outputs compared to just prompting GPT-2 with ingredients alone.