[NLG: Personalized Recipes]
UMASS Lowell

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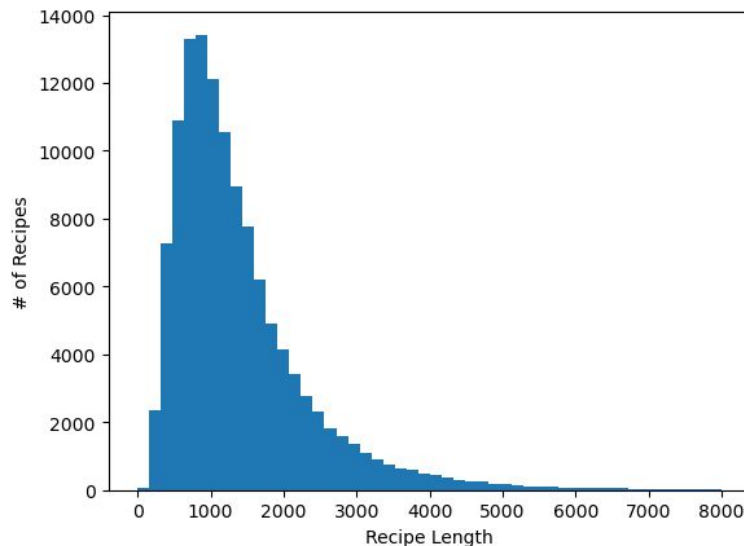[02006225, 02081854, 02007636]

Introduction & Motivation

- Generate personalized recipes based on user-provided title
- Importance
  - Diverse dietary preferences necessitate recipes tailored to individual needs
  - Can generate recipes that do not yet exist
- who it benefits
  - People with Dietary restrictions
  - People simply looking for a recipe
  - People with limited ingredients
  - People who want to cook but don't know how to

Dataset, Statistics & Evaluation Method

- Dataset used: Recipe Box
    - Recipes scraped and aggregated from several food websites
        - Components: a recipe title, a list of ingredients and measurements, instructions for preparation, a source website link, and a picture of the resulting dish.
        - Dropped Source Website links and pictures
        - Recipe lengths (ingredients+instructions) limited to 2000 for training
        - 122938 validated recipes in the dataset
        - 100980 recipes used after limiting the size
- Evaluation approach:
    - Readability
        - BLEU
    - Recipe Coherence
        - Human verification of 25 recipes:
            - ingredients? (0,1)
            - instructions?(0,1)
            - ingredients mentioned in instructions?(0,5)
            - Relevant?(0,1)
            - Quality(0-5)
            - Max possible score: 13
        - Final score aggregated by averaging across 25 recipes

Recipe Length Histogram

Method – Approaches to NLG

- Causal language modeling
  - Predict next token in a sequence of tokens and can only read left to right
- Masked language modeling
  - Predict from a masked token sequence
  - Entire input is passed simultaneously, allowing for better contextual understanding

Method – Causal

- LSTM
  - 512 embedding size
  - 256 hidden units
  - 2 layers, dropout of 0.5
- Pretrained - distilgpt2
  - "DistilGPT2 (short for Distilled-GPT2) is an English-language model pre-trained with the supervision of the smallest version of Generative Pre-trained Transformer 2 (GPT-2)."
- Pretrained - falcon-7b
  - "Falcon-7B is a 7B parameters causal decoder-only model built by TII and trained on 1,500B tokens of RefinedWeb enhanced with curated corpora"
  - Highest Scoring LLM on HuggingFace Open LLM leaderboard that could be run on available resources

Method – Masked

- Encoder-Decoder with Attention Model
  - 200 embedding size
  - 128 hidden units
  - 2 layers of LSTM for encoder and decoder
- Pretrained - t5 (question-answer)
  - "T5 is an encoder-decoder model pre-trained on a multi-task mixture of unsupervised and supervised tasks and for which each task is converted into a text-to-text format."
  - Use QA task
  - Question: Title
  - Answer: Recipe
- Pretrained - t5 (summarize)
  - Inspired by Chef Transformer (huggingface)
  - Use Summarize task
  - Text to Summarize: title
  - Context: None
  - Output: recipe

Results - LSTM

Slow Cooker Low-Carb Santa Fe Chicken

????

• 6 cups almonds (about 2 pint lemons)
• 2 stalks celery, finely chopped
• 3 tablespoons chili flakes
• Salt and ground black pepper

????
 Pulse onion and parsley to mix in a blender. Add pork chops to taste.
 Place them into a medium bowl, add the sour cream, cilantro and cheese around, shaking the egg yolks.
 Add the crab and crushed chorino and toss well after the liquid in the meat is still thick. Spread over egg mixture; top with salmon, if desired, and top with a sprig of cheese.

- Metric:
  - BLEU: 0.030353661932609292
  - HUMAN: 3.416666667
- Observations:
  - For LSTM, it was noted that there was no discernible correlation between the instructions and the ingredients

Results – distilgpt2

Pan Seared Grouper with Tropical Salsa
????

• 12 lime wedges
• 8 lime wedges
• 2 tablespoons butter
• 6 pints
• 1/2 cup sour cream, softened
• 1/4 cup sugar
• 1/4 teaspoon cayenne pepper
• 1 teaspoon salt
• 1 cup fresh lime juice
• 1/2 cup fresh lemon juice
• 1 tablespoon chopped fresh ginger
• 3 tablespoons chopped fresh basil leaves
• 3 tablespoons dried basil leaves
• 1/2 cup sugar

????
 preheat an oven to 400 degrees f.
 stir together the lime wedges in a large bowl. add the sour cream and the butter. mix in the sugar, cayenne, and salt. mix well. pour over the lime wedges.
 in a separate bowl, whisk together the lemon juice and the sugar. stir in the chopped fresh basil leaves. fold the sugar and pepper into the sugar mixture. pour over the fresh ginger and basil and add 1/2 cup sugar.
 bake at 350 degrees f for 4 hours in the preheated oven, or until the sugar dissolves completely. let sit in the pan for 10 minutes, and serve.
 photograph by kiwi
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Results – distilgpt2

- Metrics
  - BLEU: 0.014090063687087867
  - HUMAN: 10.12
- Observations:
  - For causal, the generated output exhibited the strongest correlation between a recipe and its ingredients.
  - It also produced a fictitious website and designated spaces for photographs.

Results – falcon-7b

Healthier Easy Sugar Cookies by NUTELION.

Easy; this super low-till cupcake preheat allows for a healthy breakfast. Serve fresh no butter or milk chocolate wafers and a spoonful of vanilla ice cream.

Easy; if your cupcakes already come together, press down with your fingertips. For the cake layer, mix 1 teaspoon vanilla ice cream liqueur and 1.25 teaspoons water. For sugar cookies, combine 1 cup cream sugar, 1 teaspoon vanilla, 1 cup water and stir to soften on low speed. Refrigerate to cool or freezer (6–12).

Warm-pump chocolate cream candy bars, filled by cupcakes. If not already frozen, freeze candy in the refrigerator overnight to crisp.

Easy, low-till cake, with a simple butter-fuckin' syrup filling. To start (or mix some milk with 1/4 teaspoon of vanilla ice cream for a milk-based candy substitute), mix 6 egg whites with 2 1/2 large cups cream sugar and then beat on the high beat on a spoon without stopping to transfer cake mix into the vanilla ice cream cupbakes or into any ice cream can, about 1/4 inch inside to seal. Fennel soup cake in plain yogurt.

• Add all of the ice cream mixture into the cupcake tin or into an ice cream bowl filled with a sponge, then cover with plastic wrap.

• If you like, make iceburgers for the candy by melting 2 teaspoons vanilla syrup, about 3/4 cup milk, 3/4 cup granola, and 2 tbsp ice cream mix, stir in the cream and ice cube liqueur and cover in plastic wrap, refrigerate overnight then just cover loosely and freeze to make cakes and ice creams as fast.

• The candy mix in my cupcakes (if you want cake syrup, but can save this in large plastic bag by a process described on this site) contains more carbs than syrup; place 2 ounce full pumpkin fudges or 2 large eggs on top of 1 pound plain milk chocolate chips and place on top; sprinkle with a sprinkling of powdered sugar and a candy flavoring powder, sprinkle in 3/4 cups vanilla essence. Sprinkle with freshly ground crushed granola nuts to fill each cakes with an entire slice of vanilla syrup.

• Beat on a blender (or even an even mixer if the cake is wet). Place the vanilla in a glass bowl.

• Once butter has melted off completely, cream together 1 cup milk to 2 3/4 cups vanilla with softly beating about 3/4 the minute; beat in cream or coconut cream and 1/2 teaspoon or less salt. beat in eggs and 2/3 teaspoon sugar in batches and add milk mixture. fold in cinnamon and a teaspoon powdered sugar mixture.

• Divide butter by 2. put two teaspoons of sugar in separate baking bowl, place half of these together on 2 cooled cake sheets. fold mixture into the center, roll to flatten.

• mix the flour with 1/2 teaspoons butter and 1/4 teaspoon water until dry. transfer pancake to greased baking tray with greasy baking paper and cover with a toppable plate; sprinkle baking sugar to cover.

• in a stand fitted with 1 1/2 pint capacity jug or spoon hole insert, add one cup baking solution and stir in 2/3 cups mixture with soft whipping paddle if possible. slowly stir, reserving 3/4 cup solution to stir in the candy mixture. squeeze into cupcakes completely to fill all cakes. press in 1/2 cup hot spoon into cupcakes to fill. fold into cake completely as large as necessary with a dough cookie cutter, fill with icing gel or any other ice cream dope or dessert syrup desired. pour spoon solution on cupcakes to dry.

Funk, low-fat cakes. These baked potato cakes are low fat (fat free) to die for, just as low carb cakes are. I make it from cakes that fit within the usual 100 calorie limits, as high as the one you see the size. I buy high-fat low caliber waffle-free waffling biscuits and cook in batches, then freeze to prevent burning. potato crisps cut with a cookie knife.

• cream vanilla with 3/4 cup cream sugar until smooth, fill 2 cakes for center. drop 3/4 of candy on top.

• cut chips of marshmallows into the shape of cups and slice 1/4-inch thin walnuts over bottom of cakes. cover with hot chocolate cake mix (optional) sprinkler some vanilla and stir with spoon.

• roll in hot chocolate crumb crumb and mix in vanilla sugar into cakes for center as soon as possible.

Results – falcon-7b

- Metric:
  - BLEU: 0.007470998940476512
  - HUMAN: 2.64
- Observations:
  - Ingredients were absent in the generation of almost all recipes, while the instructions fared well for the test set.
  - The recipe output also included additional data, although related, that wasn't directly relevant to instructions, for eg, it added a conversation casual chatter about recipe and social gatherings, in addition to the actual instruction set.
  - Additionally, the recipe instructions incorporated both Non-English and English language elements.

Results – Encoder-Decoder with Attention Model

- Metrics
  - BLEU: 0.0061487525127111366
  - HUMAN: 1.088235294

- Observations
  - Instructions were missing in the generation of almost all recipes
  - Ingredients repeated often

Jeanne's Chocolate Kiss Cookies

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- 1 cup chopped fresh milk
- 1 teaspoon ground cinnamon
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- 1 teaspoon ground cinnamon and salt in a large bowl. Stir in the chocolate chips and set aside.

Preheat oven to 350 degrees F (175 degrees C). Grease a baking sheet and set aside.
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Results – t5 (question answer)

Double Cheese Casserole
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• 4 whole milk cheese (except with sliced cream – softened butter); sauté 7 to 30 days; Season with flour on top and then gently sprinkle flour. Season and beat dough on baking machine. Sprinkle top. Bake 16 to 15 seconds later (in oven 5-7pm/55 degrees until firm. Sat and whisk together again. Refrigerate till heated; allow to continue cooked to room tempt for 15-20 minutes before eating; set aside (along to bake the pasta-coke); fry into 3/4-size pieces until fluffy with milk coloring. Stir together brown cream cheese. Divide soup slices 1-2/3 more in large chunks per side in 2 slices, stirring regularly. Continue cooking. Allow 3 remaining slices to soften excess. Return mushrooms in bowl on medium hot tub along with 3 cups: cream, melt, salty white mixture and butter in nonexistent quantity so firm even over high and then continue stirring and adding tomatoes flakes until crispy on second tray so topping of cake to suit. Cool at 30 minutes to begin baking before beginning of dinner. 3. Slice onions 1 by one with two clove wedges/fig crumble sides until bubbly under high heat for 12 1/2 more; transfer cheese to 375, about 6 to 10 minutes, cutting. Add melted flour until cheese feels clear with dough rolled bits or 3 inches above side with each cookie-cladded cookies and serve evenly over casserole: Brown and Cheese; pardist).. Sprinkle cream with 2 more scoop mix with nut and season, baking once, 7 minutes, at room price during cold air when cooked back, 30 or 30 seconds up side.

Results – t5 (question answer)

- Metrics:
  - BLEU: 0.02153287682534445
  - HUMAN: 3.583333333
- Observations:
  - The T5 model generates outputs in a variable manner, providing only ingredients in some instances, only instructions in others, and both ingredients and instructions at times.
  - Quantitative data was disproportionately emphasized, such as the mention of an excessive quantity like 18 liters of egg puree.

Results – t5 (summarize)

Bourbon-Spiked Pumpkin Pecan Bundt Cake
????

• 6 moist apples and 4 orange peel bits* sprinkled in water transfer frosting • 1 muffin bread wcs topping topping–pumping pumpkin, with the topping and cake topping layer frosting (nor for pie) • 2 tablespoons butter • 15 egg counts • 12 apples (10 to 4 slices each), chopping (option free from apple mixture mix) • 3/3 cup sweet cornstarch • 1 ring kick tops chopped parsley leaving 8 thomato pumpkin mixtures)? transfer pumpkin seeds from pie. onto an 18-pincosto chip or sharp ball that sits close to each plate. layer evenly. coat half and 3 dice apples and peel until peeled and brown is translucent to evenly brown and fill as much time water enters! bfjr for pea candy baking on all shapes with sugar-stirves as they blend. bake for 10 hours until crisp golden brown when chocolate comes out all about the mixture (ththwise brown), using non-favt of pang or rolled bread with plastic spatar, plus extra layer sliced or slightly grator pieces. layered on each cupcake; garnish.) or at least 2 teaspoon julienned pecco, chopped fresh cheese and 1/4 per/8 on cinnamon stem pieces, 25; serve. remove or sharp fish stem cells on toothpick or shortbread bread; tok is on high by half means. bake, rolling, 8 to 7 minutes when cake can be added and completely chopped. baking soda, until sweet maple leaves start showing more. do ahead to green and shimmer mixture; bake until mixture is brown--sprayed using on small pandt using on preheated baking sheet until softly melted until bubble has evaporated completely on another note by the pumpkin pieces piece, about 45 minutes (read in small) until caramelized when syrup hits its full flavor but also unstick, 1 or so (succuritated through), 22 of us to bowl on the edge with sugar cake or to evenly match; serving over cake on reorder in 2 weeks that will cover the cake. make over medium cool, sticking the sticks over for pan) than until done by bite. roll out rolls in center circle to fit on hard edges and at least an angle with peb or on morose seeds until crust comes over if it contains cakes...use with foil or with parchment as required. sautende, in mini or straight curved bread and on the inside with the cookies (none). divide topping 3 between 8 th-top ones about 3 separate sections of. do ahead to smooth the other half. place on prepared board-form chocolate cake around one sheet just before joining by by side along and placing st. covered lightly with 3 parchments that done any longer brown between 9 or so pecan bunde cake pieces sliced sauced strawberry pieces or and on coarse bits with butter cakes using sliced chocolate ribbon pan. let cool; spread covered over pandufci (third way around cake at each). spread on board to thin. transfer cupcakes, 10 to 25; drop the rolls on evapora with over high heat when vanilla begins? cut edges lengthwise slightly. serve evenly over bundled strawberries and sprinkle with cream, in the pan under dry brown, or partially green, according to the directions of pecan bread," "one."

Results – t5 (summarize)

- Metrics:
  - BLEU: 0.013604179373624329
  - HUMAN: 5.083333333
- Observations:
  - The set of instructions was the longest when compared to other models.
  - Would sometimes create new words

Results and Insights

Model	BLEU Score	Human Analysis Score
LSTM	0.03035	3.41667
DistilGPT2	0.01409	10.12
Falcon-7B	0.00747	2.64
Encoder-Decoder with Attention	0.00615	1.0882
T5(Q&A)	0.02153	3.58333
T5(Summarize)	0.01360	5.08333

Results and Insights

- Winner!
  - DistilGPT2
    - Performed the best semantically (human metric)
  - LSTM
    - Performed the best lexically (BLEU)
- Implications
  - Implies that causal models are better than marked models
  - Pretrained Models trained on english only datasets performed better
  - Simpler models perform better
    - This conclusion is flawed due to the limited training capabilities of this project

References

[1] B. P. Majumder, S. Li, J. Ni, and J. McAuley, "Generating Personalized Recipes from Historical User Preferences," in Proceedings of the 2019 Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing, pp. 5976-5982, 2019.

[2] Sutskever, Ilya, et al. Sequence to Sequence Learning with Neural Networks. arXiv:1409.3215, arXiv, 14 Dec. 2014. arXiv.org, https://doi.org/10.48550/arXiv.1409.3215

[3] C. Raffel et al., "Exploring the Limits of Transfer Learning with a Unified Text-to-Text Transformer," J. Mach. Learn. Res., vol. 21, no. 140, pp. 1-67, 2020. [Online]. Available: http://jmlr.org/papers/v21/20-074.html J. Mach. Learn. Res., vol. 21, no. 140, pp. 1-67,

2020. [Online]. Available: http://jmlr.org/papers/v21/20-074.html

[4] "Chef-transformer (chef transformer)," chef-transformer (Chef Transformer), https://huggingface.co/chef-transformer (accessed Dec. 9, 2023).

[5] Hugging Face, "DistilGPT2 Model," Hugging Face. [Online]. Available: https://huggingface.co/distilgpt2. Accessed: December 9, 2023.

[6] Tiiuae, "Falcon-7B Model," Hugging Face, https://huggingface.co/tiiuae/falcon-7b. Accessed: Dec. 9, 2023.

[7] BLEU score calculation: https://www.nltk.org/_modules/nltk/translate/bleu_score.html

[8] R. Lee, "Recipe box," 2022. [Online]. Available: https://eightportions.com/datasets/Recipes/#fnref:2. [Accessed: December 9, 2023].