

# AI Converts Recipes to Gluten-Free

## Introduction

Traditional recipe conversion is error-prone. This AI-Guided Model transforms any recipe to be gluten free. It must:

- Parse messy ingredient text,
- Never miss gluten (recall  $\approx 1.0$ ),
- Suggest only gluten-free, culinary-appropriate replacements,
- Adjust any quantity changes, and
- Keep all instructions consistent.

## System Design

Key components of this multi-model integration (implemented in Python/PyTorch):

- Preprocessing & Parsing (Attention-based Ingredient Parser)
- Gluten Classifier (Fine-tuned BERT-based classifier)
- Substitution Engine (BERT semantic embedder guided by GISMo graph)
- Recipe Rewriter (SHARE-inspired model)
- Rule-Based Fallback (Simple heuristics)

## Results

- The full pipeline (ingredient parsing  $\rightarrow$  classification  $\rightarrow$  gluten detection  $\rightarrow$  semantic substitution  $\rightarrow$  recipe rewriting) functions reliably end-to-end, smoothly handling different recipe text formats.
- A simple Streamlit-based web UI demonstrates the system. Users input recipe URL or text and then the substituted ingredients with the gluten-free recipe is displayed. (Figure 1)
- The Top-20 ingredient frequency plots show gluten-dense items drop while gluten-free replacements rise in the post-transformation distribution. (Figures 2 & 3)
- The confusion matrix reveals strong classification accuracy for common ingredient categories. (Figure 4)
- Training curves across dataset versions show a decrease in training loss as more labeled ingredient data is added, indicating improved representation learning and model generalization. (Figure 5)

This prototype transforms any recipe into a **fully gluten-free** version using **advanced NLP models**, ingredient classification, semantic substitution, and intelligent rewriting.

	Original	Converted	Status
0	1 1/2 cups granulated sugar*	1 1/2 cups granulated sugar*	gluten_free
1	3/4 cup all-purpose flour	3/4 cup gluten-free flour	substituted
2	2/3 cup cocoa powder , sifted if lumpy	2/3 cup cocoa powder , sifted if lumpy	gluten_free
3	1/2 cup powdered sugar , sifted if lumpy	1/2 cup powdered sugar , sifted if lumpy	gluten_free
4	1/2 cup dark chocolate chips	1/2 cup dark chocolate chips	gluten_free
5	3/4 teaspoons sea salt	3/4 teaspoons sea salt	gluten_free
6	2 large eggs	2 large eggs	gluten_free
7	1/2 cup canola oil or extra-virgin olive oil**	1/2 cup canola oil or extra-virgin olive oil**	gluten_free
8	2 tablespoons water	2 tablespoons water	gluten_free
9	1/2 teaspoon vanilla	1/2 teaspoon vanilla	gluten_free

### Rewritten Gluten-Free Instructions

Preheat the oven to 325°F. Lightly spray an 8x8 baking dish (not a 9x9 dish or your brownies will overcook) with cooking spray and line it with parchment paper. Spray the parchment paper. In a medium bowl, combine the sugar, flour, cocoa powder, powdered sugar, chocolate chips, and salt. In a large bowl, whisk together the eggs, olive oil, water, and vanilla. Sprinkle the dry mix over the wet mix and stir until just combined. Pour the batter into the prepared pan (it'll be thick - that's ok) and use a spatula to smooth the top. Bake for 40 to 48 minutes, or until a toothpick comes out with only a few crumbs attached (note: it's better to pull the brownies out early than to leave them in too long). Cool completely before slicing.\*\*\* Store in an airtight container at room temperature for up to 3 days. These also freeze well!

Figure 1

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Figure 2

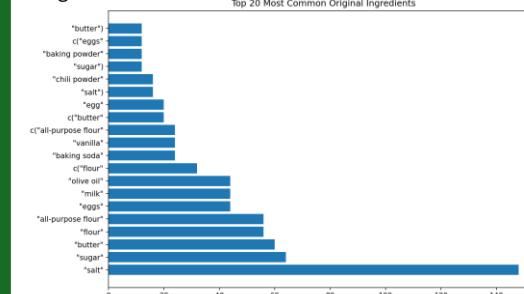


Figure 3

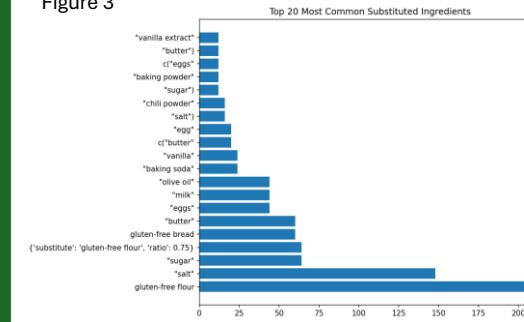


Figure 4

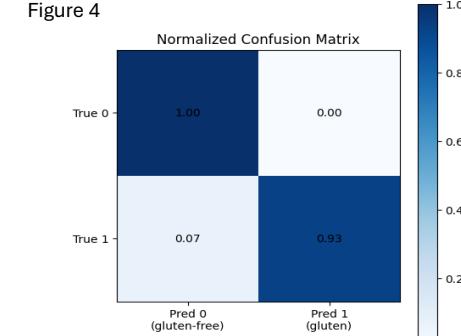
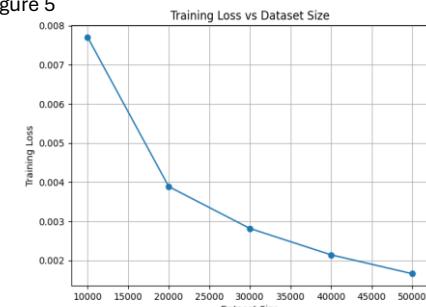


Figure 5



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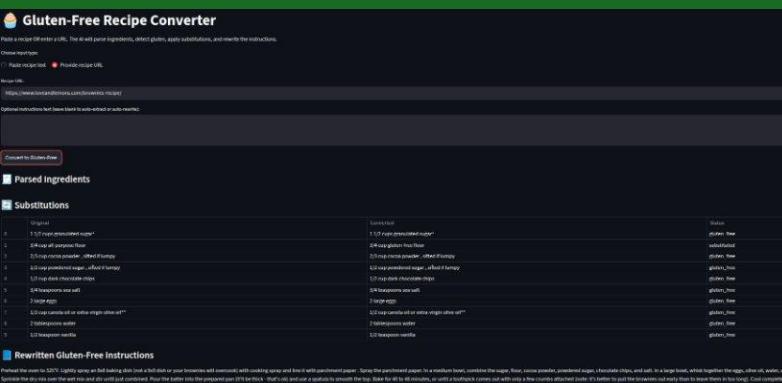


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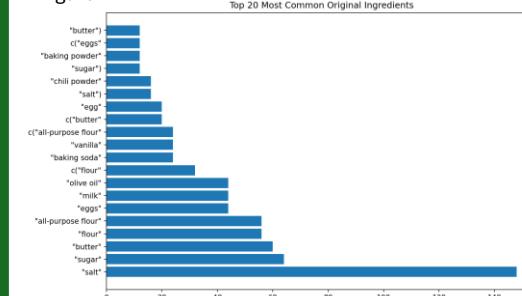


Figure 3

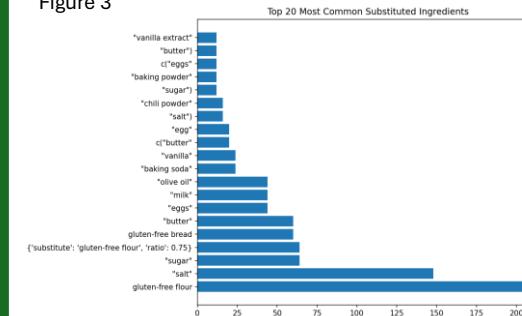


Figure 4

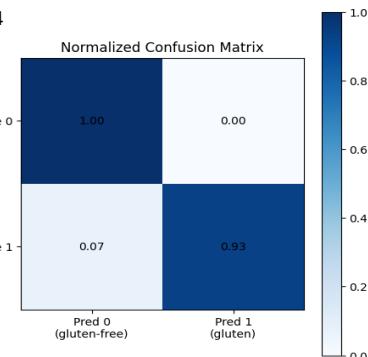


Figure 5

