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# Mini Project 2: Consolidate Bug Report Explanations

Advanced Software Engineering
WiSe 24-25

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# Training the Model: Prepare Data

- adding text complexity column
- chose TTR (type-token-ratio) as metric for diversity of vocabulary
    - low value = tendency to use same words
    - easy to comprehend & implement
    - text length influences score

```
def calculate_ttr(text):
    # split on non-alpha. chars, lower case
    tokens = tokenize(text)
    # unique tokens
    types = set(tokens)
    return len(types) / len(tokens) if len(tokens) > 0 else 0
```

# Training the Model: Precision & Recall

| **Bug Report** | **Precision** | **Recall** |
|---|---|---|
| Overall | 0.2286 | 0.0381 |
| HIT03_6 | 0.44 | 0.09 |
| HIT04_7 | 0.08 | 0.02 |
| HIT05_35 | 0.25 | 0.03 |
| HIT06_51 | 0.11 | 0.02 |
| HIT07_33 | 0.60 | 0.05 |
| HIT08_54 | 0.14 | 0.02 |

Cross-Validation Metrics

- used Random Forest Classifier
- not so great results
- small amount of data
- ground truth heavily skewed (training set - 0: 1840, 1: 420)

| **Dataset** | **Precision** | **Recall** |
|---|---|---|
| Holdout | 0.3333 | 0.025 |
| HIT01_8 | 0.25 | 0.03 |
| HIT02_24 | 0.50 | 0.03 |

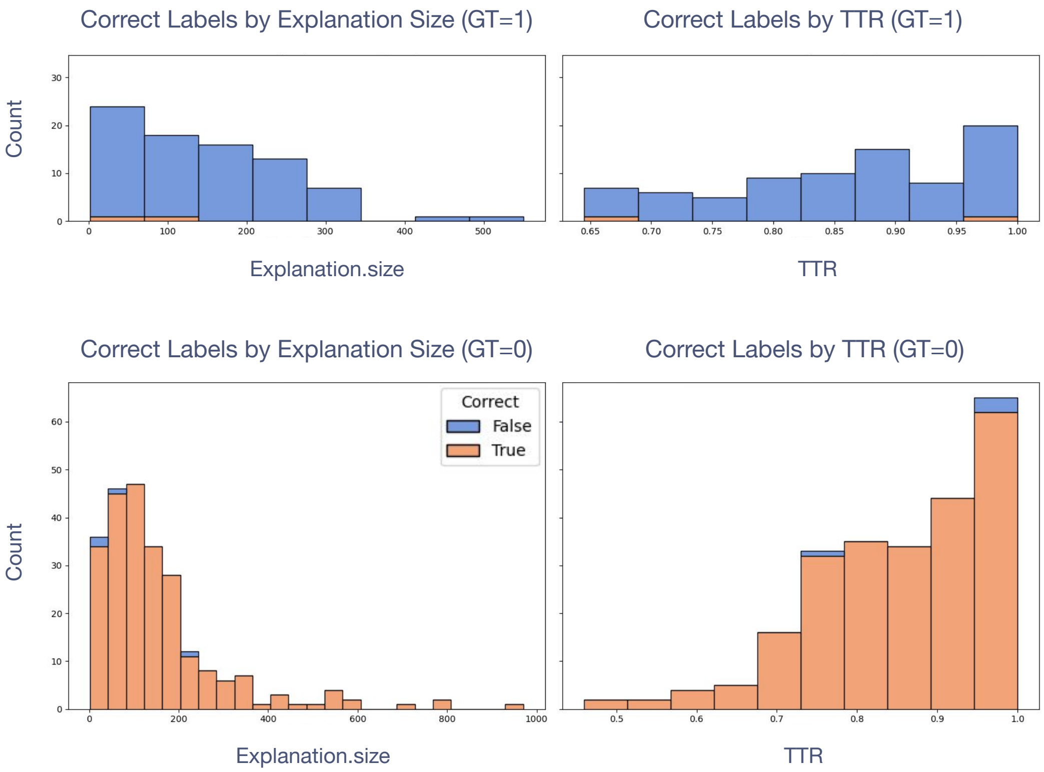
Holdout Metrics

# Training the Model: Categorizing Answers

- detection performance on holdout set
- classifier biased towards predicting 0
- label 1 predicted in only 6 of 320 cases

→ balance / augment dataset

- most explanations short
- TTR high



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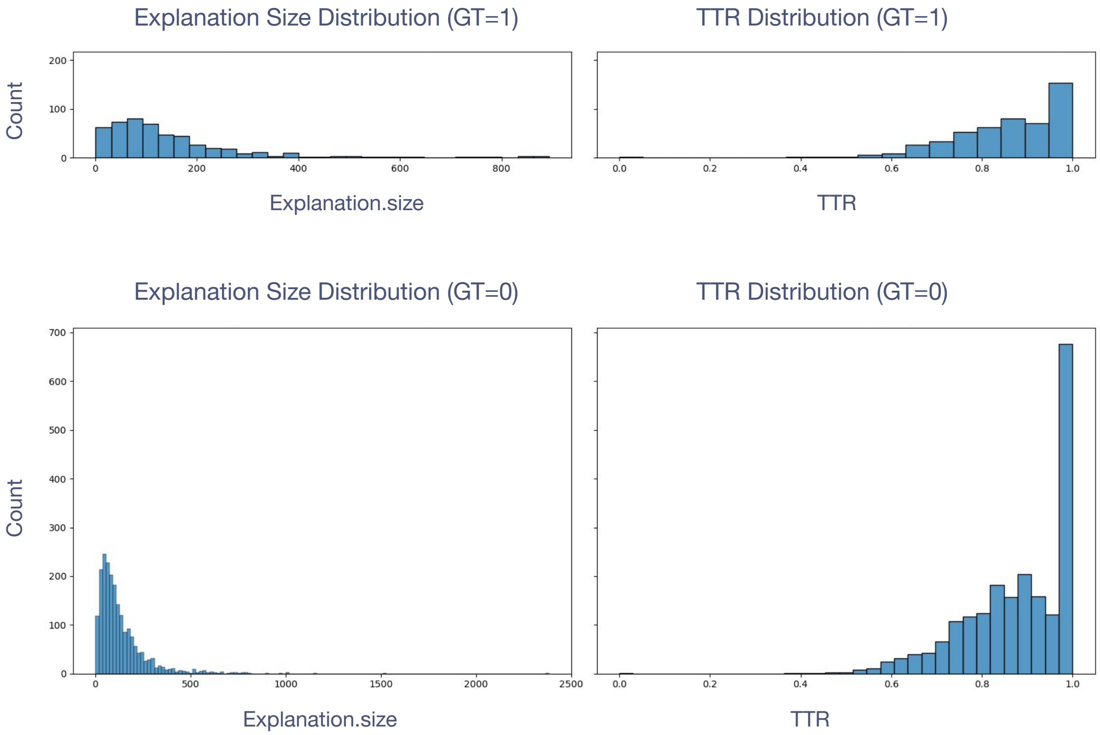

Explanation Size Distribution (GT=1)

TTR Distribution (GT=1)

Explanation Size Distribution (GT=0)

TTR Distribution (GT=0)

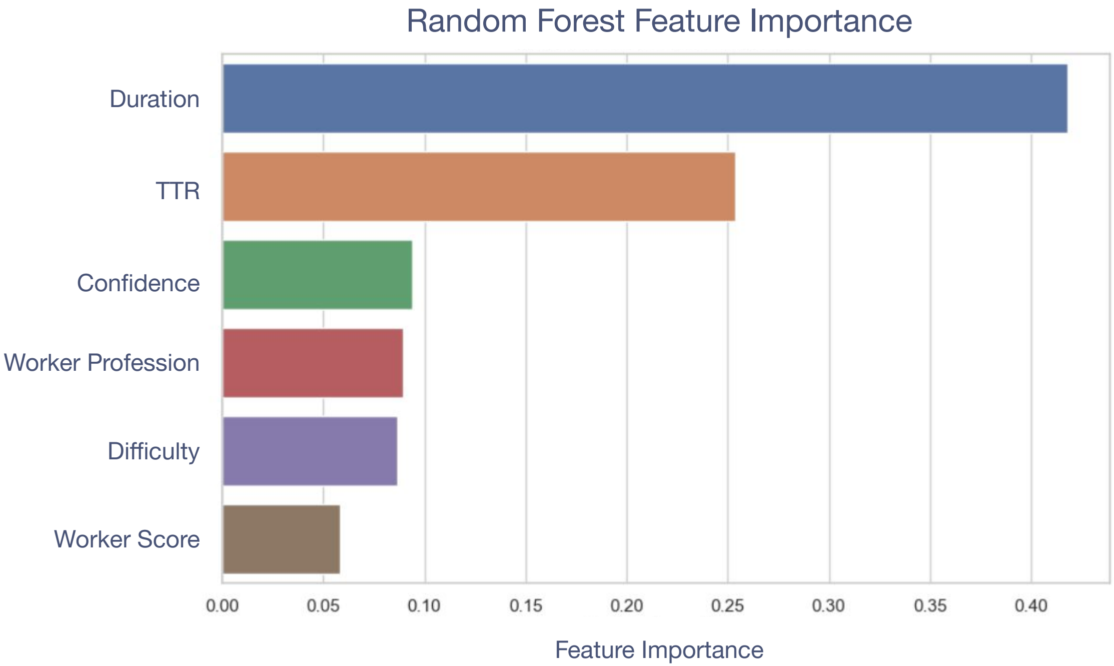
# Training the Model: Categorizing Answers

- detection performance on holdout set
- classifier biased towards predicting 0
- label 1 predicted in only 6 of 320 cases

→ balance / augment dataset

- most explanations short
- TTR high
- model relied on TTR as 2nd most important feature

→ more data for positive examples



# Consolidating Explanations

Compared 5 Prompts for consolidating explanations for HIT02_24 using ChatGPT4o

| | Chain of Density [Adams23] | Our prompt | Summarize | Professional Summarizer [Reddit] | Task copied |
|---|---|---|---|---|---|
| Word Count | 63 | 348 | 299 | 121 | 511 |
| TTR | 0.838 | 0.277 | 0.377 | 0.717 | 0.227 |
| Readability (Flesch-Reading Ease) | - (29.62) | o (44.64) | o (40.24) | ++ (33.81) | + (44.14) |
| Speed* | - | o | o | ++ | o |
| Suggestion | No | Yes | Yes | No | Yes |

Adams, Griffin & Fabbri, Alexander & Ladhak, Faisal & Lehman, Eric & Elhadad, Noémie. (2023). From Sparse to Dense: GPT-4 Summarization with Chain of Density Prompting. 10.48550/arXiv.2309.04269.

# Comparing Explanations: BLEU

- used Chain of Density (CoD) method for summary
- BLEU scores low

→ designed for precise matching & lexical overlap

→ explanation length, structure, word choice varies

→ penalizes shorter summaries (fewer n-gram matches)

→ too much density using CoD?

→ doesn’t account for semantic similarity

| **Issue** | **BLEU Score** |
|---|---|
| HIT01_8 | 0.15 |
| HIT02_24 | 0.00 |
| HIT03_6 | 0.00 |
| HIT04_7 | 0.11 |
| HIT05_35 | 0.00 |
| HIT06_51 | 0.00 |
| HIT07_33 | 0.00 |
| HIT08_54 | 0.00 |

BLEU Scores per Issue

# Comparing Explanations: ROUGE

- used Chain of Density (CoD) method for summary
- ROUGE scores similarly low
  (for full report see Jupyter Notebook)

→ likely similar reasons

- low scores do not necessarily mean poor summary

| **Issue** | **ROUGE Score** |
|---|---|
| HIT01_8 | 0.13 |
| HIT02_24 | 0.11 |
| HIT03_6 | 0.09 |
| HIT04_7 | 0.07 |
| HIT05_35 | 0.08 |
| HIT06_51 | 0.06 |
| HIT07_33 | 0.11 |
| HIT08_54 | 0.09 |

ROUGE Scores per Issue

# Reflection

- **Data quality:** crowd-sourced, diverse, uncleaned
- **Classifier update:** results may worsen over time (concept drift), updating / re-training strategy necessary; concept shift detection difficult
- **Output testing of classifier & LLM:** error propagation risk, manual review, monitor metrics, curate golden data set
- **Estimate consolidation quality:** BLEU / ROUGE seem limited, manual review, field study of devs uing summaries in the wild
- **Classifier-LLM integration:** manual copy paste, (tested) data exchange pipeline necessary

# Anhang

# Consolidating Explanations: Chain of Density

```
You will generate increasingly concise, entity-dense summaries of the above answer explanations.

Repeat the following 2 steps 5 times.
Step 1. Identify 1-3 informative entities (";" delimited) from the article that are missing from the previously generated summary.
Step 2. Write a new, denser summary of identical length which covers every entity and detail from the previous summary plus the missing entities.

A missing entity is:
- Relevant to the main answer explanations,
- Specific yet concise (5 words or fewer),
- Novel (not in the previous summary),
- Faithful (present in the answer explanations),
- Anywhere (can be located anywhere in the answer explanations).

Guidelines:
- The first summary should be long (4-5 sentences, ~80 words) yet highly non-specific, containing little information beyond the entities marked as missing. Use overly verbose language and fillers (e.g., "these answer explanations discuss") to reach ~80 words.
- Make every word count: rewrite the previous summary to improve flow and make space for additional entities.
- Make space with fusion, compression, and removal of uninformative phrases like "the article discusses".
- The summaries should become highly dense and concise yet self-contained, i.e., easily understood without the answer explanations.
- Missing entities can appear anywhere in the new summary.
- Never drop entities from the previous summary. If space cannot be made, add fewer new entities.

Remember, use the exact same number of words for each summary.
```

Adapted from: Adams, Griffin & Fabbri, Alexander & Ladhak, Faisal & Lehman, Eric & Elhadad, Noémie. (2023). From Sparse to Dense: GPT-4 Summarization with Chain of Density Prompting. 10.48550/arXiv.2309.04269.

# Consolidating Explanations: Chain of Density Result

The "g" variable, scaled within a 255 range and cast to int, impacts the Color class, triggering IllegalArgumentException if bounds fail. this.lowerBound and this.upperBound inadequacies prevent sanitization, allowing negatives. Misusing "value" over "v" (line 117) worsens errors. Reliance on Math.max() and Math.min(), double types, and input consistency is emphasized. The Color(float, float, float) constructor and RuntimeException encapsulate broader dependency issues in parameter handling.

Adapted from: Adams, Griffin & Fabbri, Alexander & Ladhak, Faisal & Lehman, Eric & Elhadad, Noémie. (2023). From Sparse to Dense: GPT-4 Summarization with Chain of Density Prompting. 10.48550/arXiv.2309.04269.

# Consolidating Explanations: Our Prompt

```
I have a list of explanations of where there is a bug in a given code statement. Please
merge the  explanations in a way that minimizes redundant information, while keeping the
information that would be necessary for someone else to fix the bug.Types of information
that, if present in the explanation, should be preserved - how the program works,how the
failure is happening, what is problem in the code, etc.
Be short, concise, do not use verbose laguage.
```

# Consolidating Explanations: Summarize

```
Summarize
```

# Consolidating Explanations: Professional Summarizer

As a professional summarizer, create a concise and comprehensive summary of the provided text, be it an article, post, conversation, or passage, while adhering to these guidelines:

1. Craft a summary that is detailed, thorough, in-depth, and complex, while maintaining clarity and conciseness.

2. Incorporate main ideas and essential information, eliminating extraneous language and focusing on critical aspects.

3. Rely strictly on the provided text, without including external information.

4. Format the summary in paragraph form for easy understanding.

Adapted from: [Reddit]

# Consolidating Explanations: Professional Summarizer Result

The provided text discusses a technical issue involving the use of the "g" variable in a coding context, where it is scaled within a range of 255 and cast to an integer, potentially causing problems in the Color class. Specifically, an IllegalArgumentException is triggered when values exceed defined bounds. The failure to properly sanitize the this.lowerBound and this.upperBound variables allows negative values, compounding the issue. Additionally, incorrect usage of "value" instead of "v" on line 117 introduces further complications. The text underscores the importance of using methods like Math.max() and Math.min() with consistent double-type inputs to ensure reliability. Broader challenges are identified with parameter handling in the Color(float, float, float) constructor, with dependencies further obscured by encapsulating issues in a RuntimeException.

Adapted from: [Reddit]

# Consolidating Explanations: Copied Task

```
generate a single explanation by merging the participants’ explanations in a way that minimizes
redundant information, while keeping the information that would be necessary for someone else to
fix the
bug.
Types of information that, if present in the explanation, should be preserved - how the program
works, how the failure is happening, what is problem in the code, etc.
```