Sentence Salience Classification Using Linguistic and Semantic Features in QA Systems

Project Presentation — Computer Linguistics 2

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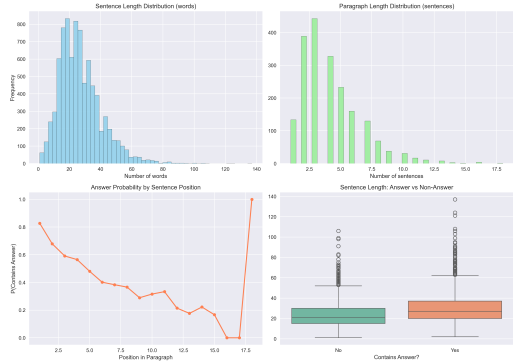
"How can linguistic and semantic features such as word length, number of POS tags, sentence position, and surprisal estimations be extracted and utilized to enhance sentence salience classification in question-answering systems?"

Dataset — SQuAD v1.1 Training Set

- Source: SQuAD v1.1 **training set**
- Total passages: **19,035**
- Sampled: **2,000 passages**
- Total sentences: **8,328**
- Answer sentences: **5,178** (62.17%)



Class Imbalance in the Data

Observation

With 2,000 passages: **62.17% Answer sentences** → moderate positive skew Smaller samples

All 26 Features

Original Proposal Category	Actual Features Implemented (26 total)
Surface features	sentence_length_words sentence_position sentence_position_norm
Lexical features	type_token_ratio lexical_density
POS-based features	noun_ratio, verb_ratio adj_ratio, pronoun_ratio
Discourse features	causal_marker_ratio contrast_marker_ratio named_entity_density
Surprisal (GPU/CUDA) — GPT-2	gpt2_surprisal_mean, sum, std gpt2_surprisal_var, min, max
Surprisal (GPU/CUDA) — BERT	bert_surprisal_mean, sum, std bert_surprisal_var, min, max

Methodology & Final Results

- Model: Logistic Regression (`class_weight='balanced'`)
- Split: 80/20 stratified
- Main run: 2,000 passages

Final Performance

Metric	Score
Accuracy	**69.27%**
F1 (Answer class)	**0.7377**

Ablation

Top-10 features only $\rightarrow$ 68.29% accuracy, 0.7360 F1 (negligible drop)

Top 10 Most Predictive Features

Rank	Feature	Coefficient
1	sentence_position	**-0.796**
2	gpt2_surprisal_sum	+0.663
3	gpt2_surprisal_var	-0.444
4	bert_surprisal_std	+0.364
5	noun_ratio	+0.331
6	bert_surprisal_var	-0.315
7	named_entity_density	+0.298
8	gpt2_surprisal_std	+0.283
9	sentence_position_norm	+0.257
10	lexical_density	-0.256

Performance Scaling

Passages	Sentences	Answer %	Accuracy	F1
100	577	73.5%	70.7%	0.793
500	2,277	68.3%	66.0%	0.740
1,000	4,485	63.8%	69.1%	0.748
2,000	**8,328**	**62.2%**	**69.3%**	**0.738**

Future Work — Including Class Imbalance Handling

Planned Extensions

- **Semantic Role Labeling (SRL)** — AllenNLP
- **Rhetorical Structure Theory (RST)** annotations
- Question–sentence dependency paths
- Coreference resolution features

Specific Focus on Class Imbalance

- Future:
  - Undersampling / oversampling (SMOTE, NearMiss)
  - Focal Loss or class-aware sampling
  - Cost-sensitive learning with dynamic weights

These improvements + discourse features expected to push $F1 > 0.80$

Conclusion

Yes — hand-crafted features are highly effective!

- Achieved **69.3% accuracy** and **0.738 F1** using only linguistic + surprisal features
- No BERT embeddings or neural encoders used
- Class imbalance successfully mitigated with balanced weights
- Strong foundation for SRL, RST, and advanced imbalance handling

Thank You

Questions?