# Let’s Ask Again: Refine Network for Automatic Question Generation


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## 1. Motivation

- Existing Approaches focus on generating questions in *one single pass*. However, we observe that the generated questions look like an incomplete draft of the desired question with a clear scope for refinement.
- We propose a method which tries to mimic the human process of generating questions by first creating an initial draft and then refining it

**Passage 1**

Liberated by **Napoleon's** army in 1806, Warsaw was made the capital of the newly created Duchy of Warsaw.

**Generated Questions**

| | |
|---|---|
| ***Baseline*** | What was **the capital** of the newly duchy of Warsaw? |
| ***RefNet*** | **Who liberated** Warsaw in 1806? |
| ***Reward-RefNet*** | **Whose army** liberated Warsaw in 1806? |

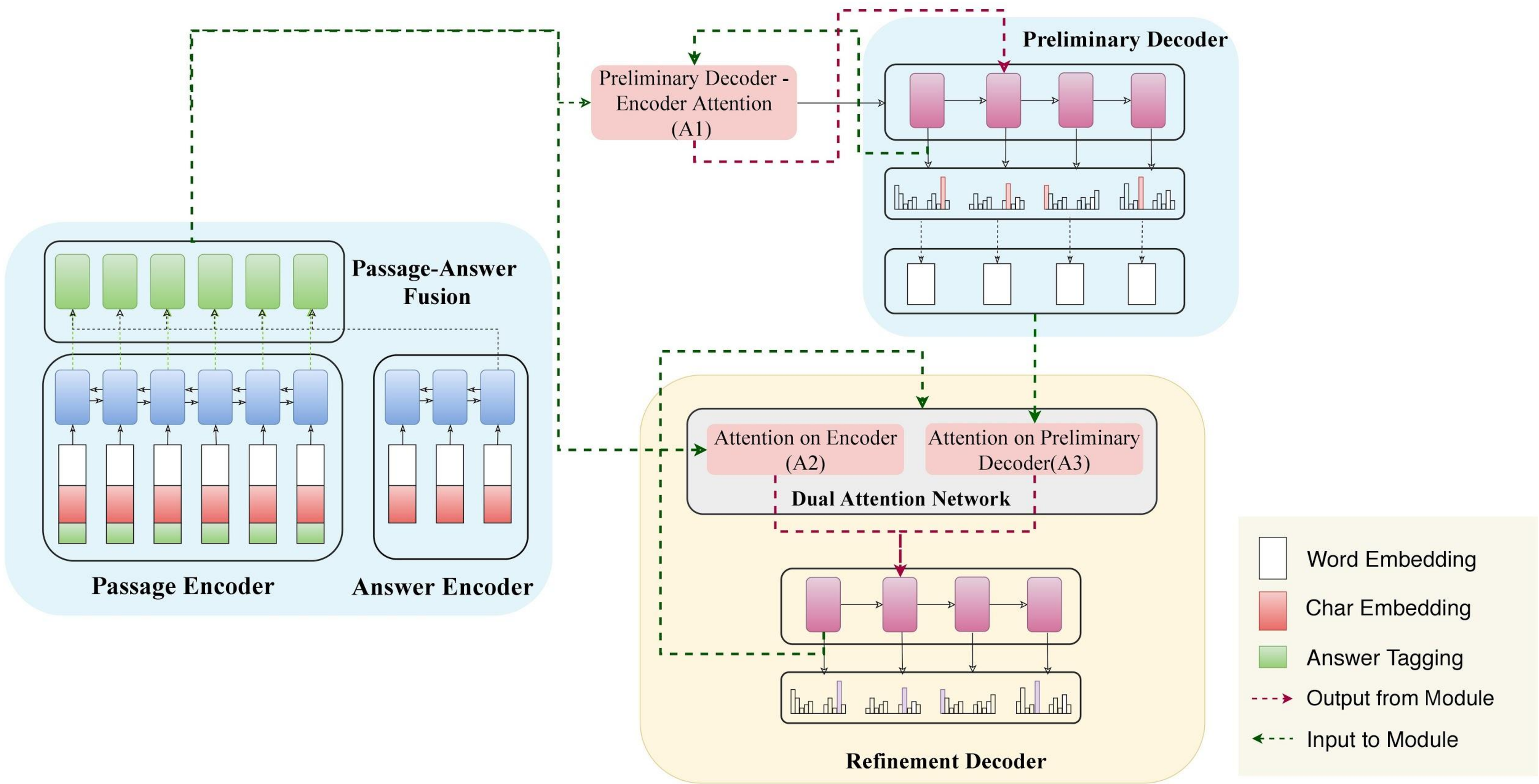
**Passage 2**

To fix carbon dioxide into sugar molecules in the process of photosynthesis, chloroplasts use **an enzyme called rubisco**

**Generated Questions**

| | |
|---|---|
| ***Baseline*** | What does chloroplasts use? |
| ***RefNet*** | What does chloroplasts use **to fix carbon dioxide into sugar molecules?** |
| ***Reward-RefNet*** | What **do** chloroplasts use to fix carbon dioxide into sugar molecules? |

## 2. Proposed Model

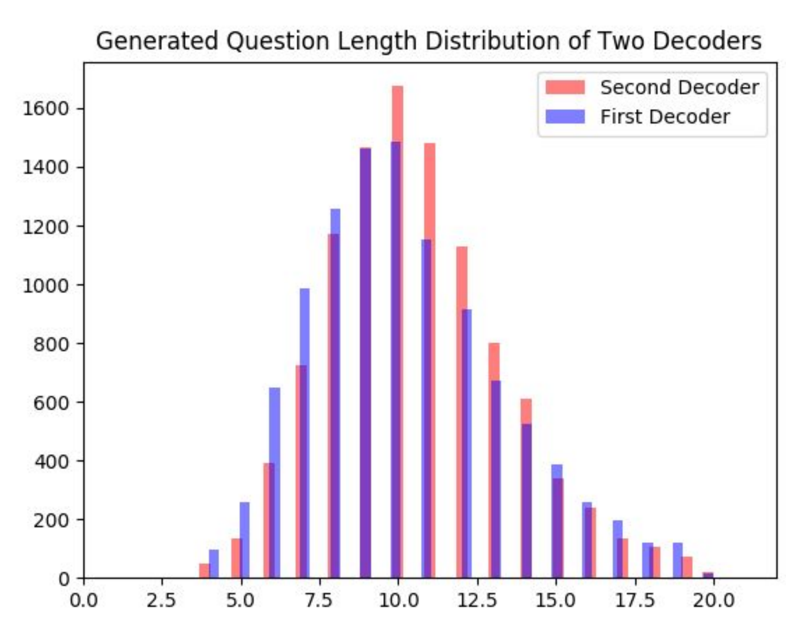



## 3. Results

| Dataset | Model | n-gram BLEU-1 | BLEU-2 | BLEU-3 | BLEU-4 | ROUGE-L | METEOR | QBLEU4 |
|---|---|---|---|---|---|---|---|---|
| SQuAD (Sentence Level) | (Sun et al., 2018) | 43.02 | 28.14 | 20.51 | 15.64 | - | - | - |
| | (Zhao et al., 2018) | 44.51 | 29.07 | 21.06 | 15.82 | 44.24 | 19.67 | - |
| | (Kim et al., 2019) | - | - | - | 16.17 | - | - | - |
| | EAD | 44.74 | 29.79 | 22.00 | 16.84 | 44.78 | 20.60 | 24.70 |
| | RefNet | **47.27** | **31.88** | **23.65** | **18.16** | **47.14** | **23.40** | **27.40** |
| SQuAD (Passage Level) | (Zhao et al., 2018)* | 45.07 | 29.58 | 21.60 | 16.38 | 44.48 | 20.25 | - |
| | EAD | 44.61 | 29.37 | 21.50 | 16.36 | 43.95 | 20.11 | 24.20 |
| | RefNet | **46.41** | **30.66** | **22.42** | **16.99** | **45.03** | **21.10** | **26.60** |
| Hotpot QA | (Zhao et al., 2018)* | 45.29 | 32.06 | 24.43 | 19.29 | 40.40 | 19.29 | 25.70 |
| | EAD | **46.00** | 32.47 | 24.82 | 19.68 | 41.52 | 23.27 | 26.20 |
| | RefNet | 45.45 | **33.13** | **26.05** | **21.17** | **43.12** | **25.81** | **28.70** |
| Drop Dataset | (Zhao et al., 2018)* | 39.56 | 29.19 | 22.53 | 18.07 | 45.01 | 19.68 | 31.40 |
| | EAD | 39.21 | 29.10 | 22.65 | 18.42 | 45.07 | 19.56 | 31.80 |
| | RefNet | **42.81** | **32.63** | **25.78** | **21.23** | **47.49** | **22.25** | **33.60** |

## 4. Discussions

### Preliminary and Refinement Decoder




| Model | Decoder | BLEU-4 | QBLEU-4 |
|---|---|---|---|
| ***without $A_3$*** | Refinement Decoder | 17.16 | 25.80 |
| | Preliminary Decoder | 17.59 | 26.00 |
| ***with $A_3$*** | Refinement Decoder | 18.37 | 27.40 |
| | Preliminary Decoder | 17.89 | 26.00 |

### Reward-RefNet

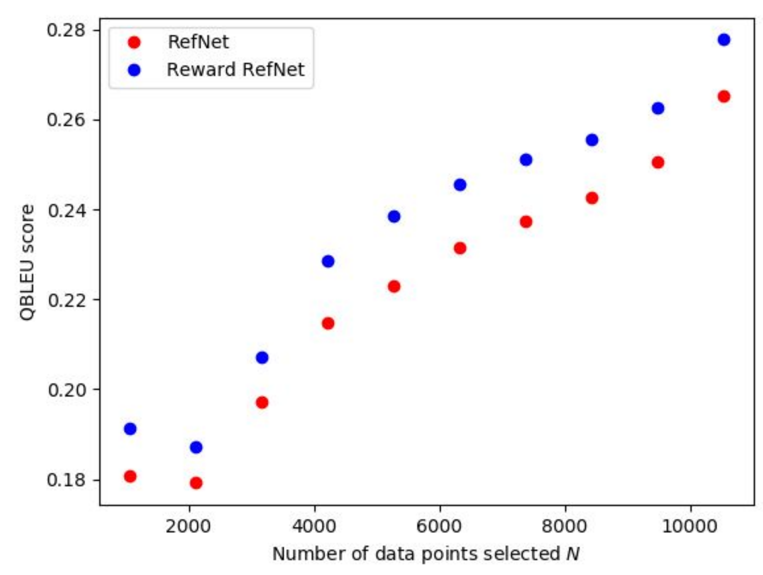
Given Preliminary & Refinement Decoder’s Generated word sequence $\tilde{\mathbf{Q}} = \{\tilde{q}_1, \tilde{q}_2, \ldots, \tilde{q}_T\}$ and $\mathbf{Q} = \{q_1, q_2, \ldots, q_T\}$ respectively, the training loss is defined as follows:

$$L(\mathbf{Q}) = (r(\mathbf{Q}) - r(\tilde{\mathbf{Q}})) \cdot \sum_{t=1}^{T} \log p(q_t | q_{t-1}, \ldots, q_1, \tilde{\mathbf{Q}}, \mathbf{U}, \mathbf{h}^a)$$

where r(**Q**) and r($\tilde{\mathbf{Q}}$) are the rewards obtained by comparing with the reference question **Q*** .

| Model | BLEU Reward Signal | | Answerability Reward Signal | |
|---|---|---|---|---|
| | *BLEU-4* | *%preference* | *QBLEU-4* | *%preference* |
| ***RefNet*** | 18.37 | 32.9% | 36.9 | 30% |
| ***Reward-RefNet*** | 18.52 | 67.1% | 37.5 | 70% |

### Analysis on Originality




**Passage:** McLetchie was elected on the Lothian regional list with Conservatives suffered a net loss of five seats, with leader **Annabel Goldie** **claiming that their support had held firm,** nevertheless, she too announced she would step down as leader of the party

| | |
|---|---|
| ***Baseline*** | Who announced she would step down as leader of the Conservatives ? |
| ***RefNet*** | Who **claiming that their support had held firm ?** |
| ***Reward-RefNet*** | Who was the leader of the conservatives ? |

## 5. Conclusion

- RefNet outperforms existing state-of-the-art models on the SQuAD, HOTPOT-QA and DROP datasets.
- We validate our empirical results using human evaluations.
- We show that Reward-RefNets improves the initial draft on specific aspects like Answerability, Fluency and Originality.

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*Code Available at :*
*https://github.com/PrekshaNema25/RefNet-QG*