



# DICE ROLL ACTION GENERATIVE OPERATIONAL NETWORK (DRAGON)

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**DRAGON generates action effect descriptions in response to player input. Model output is evaluated using a quantum cost function.**

## INTRODUCTION

### DRAGON Architecture System

- Traditional approach: bag-of-words models, and grammar rules, pattern matching.
- Our approach: leverage quantum computing to handle large scale datasets. Optimize massive parameter spaces, using exponential parallelism.

### This Work

- Aims to target the computational efficiency of LLM IF inference on GPU's.
- An improved exponentially faster factorization and decomposition.
- An enhanced semantic representation.

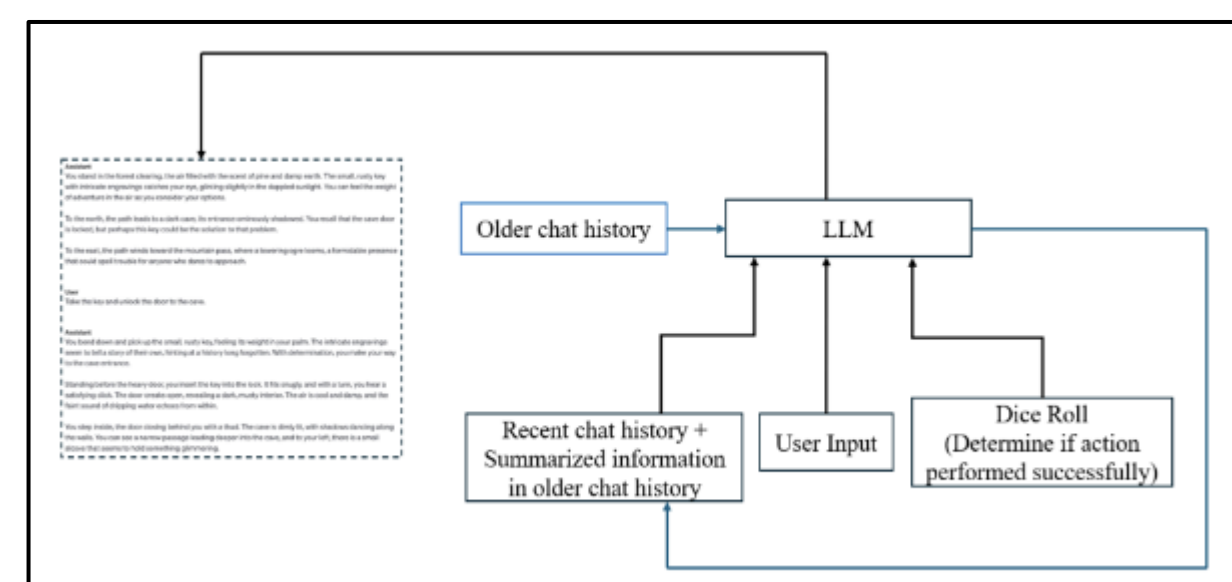


Figure 1: Dragon Architecture D

## METHODOLOGY

The design adopts the LLM model.

- Selected a LLAMA-2 model fine-tuned on D&D text data
- Prompted the model with an action description and a die result
- Evaluated the model output using the following metrics:

- 1.BLEU score
- 2.ROUGE score
- 3.lambeq score\*

## ALGORITHM

The lambeq

1. Encoded NLP circuit into DisCoCat.

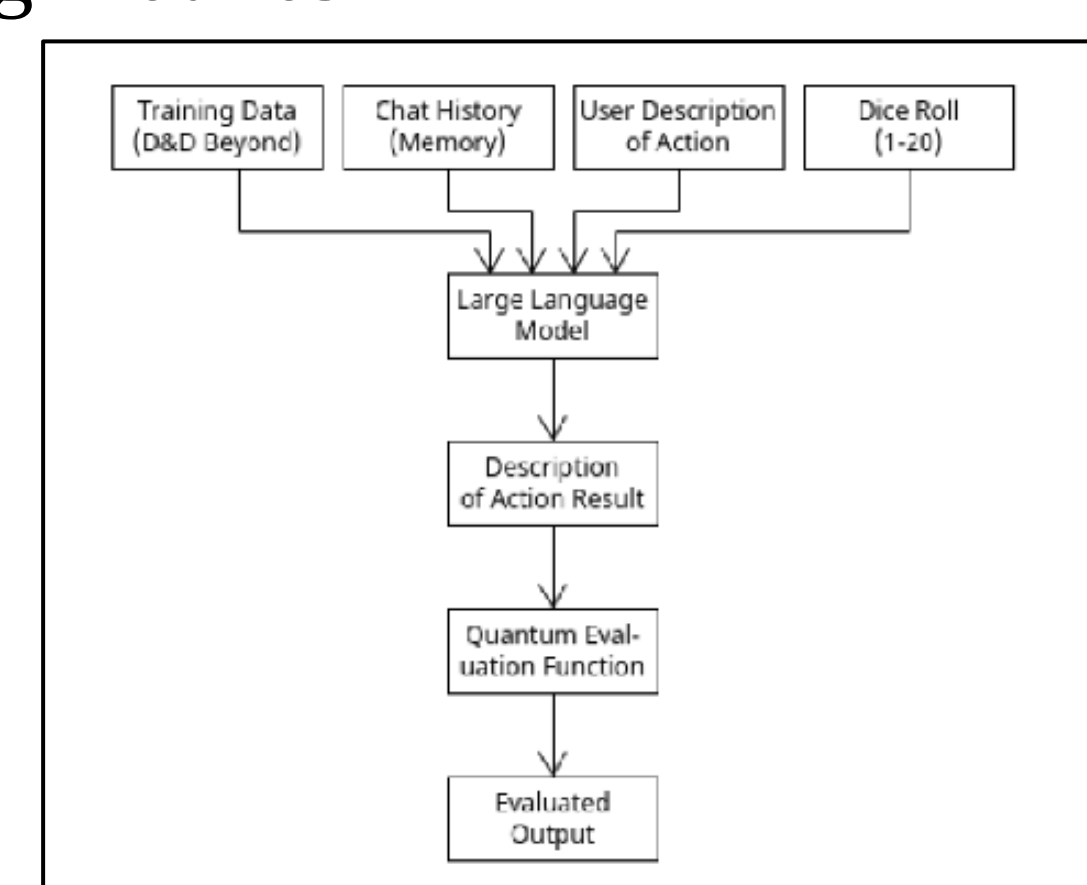


Figure 2: Flow Diagram

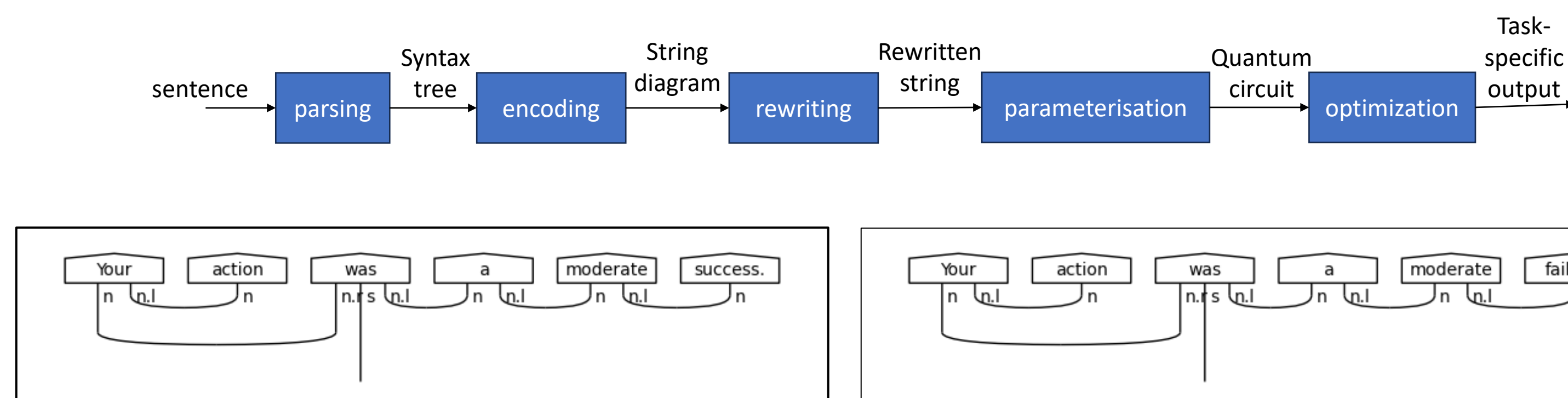


Figure 3: Target

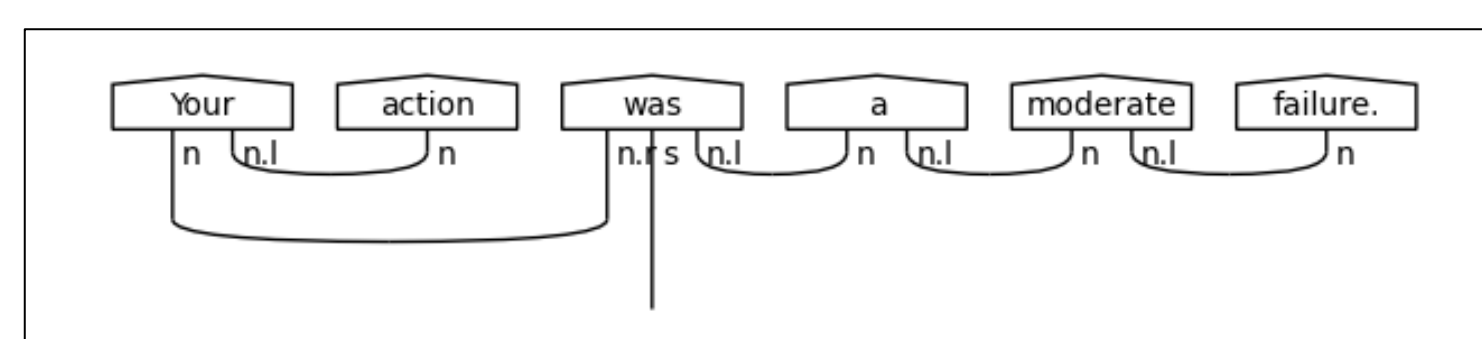


Figure 4: Hypothesis

### Accuracy Analysis

- Circuit representation quantum neural network with parameterized gates.
- Qubit Hadamard gates, rotation gates and controlled operation highly entangled.

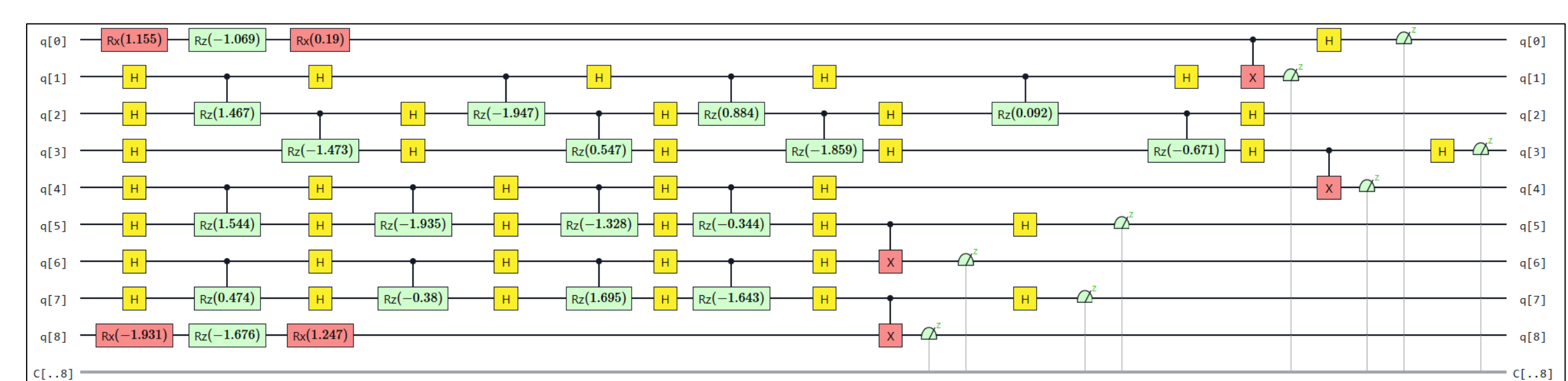


Figure 5: Circuit representation DisCoCat:

## EVALUATION/RESULTS

The player finds themselves in a small, rural town nestled in the heart of a dense forest. The town is surrounded by towering trees, their branches stretching towards the sky like bony fingers. The air is crisp and clean, with a hint of woodsmoke and the distant chirping of birds. As the player looks around, they notice that the town is eerily quiet, with only a few people visible in the distance, going about their daily business.

What would you like to do? (type 'quit' to end)

> I light a torch and throw it into a clearing to draw attention away from me.

[DICE ROLL: 7]

Your action was a moderate success. You manage to throw the torch in a clearing, but it doesn't draw as much attention as you hoped. The people in the distance continue their daily activities, seemingly oblivious to your presence. However, you notice a few of them glancing in your direction, their eyes narrowing with suspicion. The air around you grows colder, and you can sense an unseen presence watching you.

Target: Your action was a moderate success.

Hypothesis: Your action was a moderate failure.

Figure 6: game simulation inference results.

What would you like to do? (type 'quit' to end)

> With a heavy heart that there is no alternative, I fire an arrow from my bow at the armed attacker.

[DICE ROLL: 14]

Your arrow hits the attacker, but it doesn't seem to have much effect. The attacker grunts in pain but doesn't fall down. The people around you look at each other nervously, but they don't seem to be taking action to help you. The air grows even colder, and you can sense the presence growing more menacing.

Target: Your arrow hits the attacker, but

Hypothesis: Your action was a regular success.]

Figure 7: game simulation inference results.

The results illustrate a dynamic, interactive narrative system uses dice rolls to evaluate player actions, generating adaptive feedback based on probabilistic success. The system evaluates actions, providing descriptive feedback that aligns with the player's decision and the computed success level.

Trial	BLEU	ROUGE	LAMBEQ
#1 Target (success) Hypothesis(success)	0.937	1.0	0.986
#2 Target (success) Hypothesis(failure)	0.875	0.830	0.913
#3 Target (failure) Hypothesis(success)	0.453	0.224	0.201

Table 1: Score results during inference.

## SUMMARY

We developed a dynamic generating game framework that incorporates quantum computing for inference optimization. Using the lambeq toolkit, we implemented cost control mechanisms based on quantum-native constructs. Experimental results demonstrate that our proposed framework achieves near-optimal performance acceleration compared to commonly used classical methods, showcasing its potential for efficient and effective NLP and LLM applications.

- [1] Kartsaklis, D., Fan, I., Yeung, R., Pearson, A., Lorenz, R., Toumi, A., de Felice, G., Meichanetzidis, K., Clark, S., & Coecke, B. (2021). lambeq: A High-Level Python Library for Quantum NLP. CQCL/lambeq.
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- [3] Zhang, L., Lyu, Q., & Callison-Burch, C. (2020). Reasoning about Goals, Steps, and Temporal Ordering with WikiHow. EMNLP, pp. 4630–4639. Association for Computational Linguistics..

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