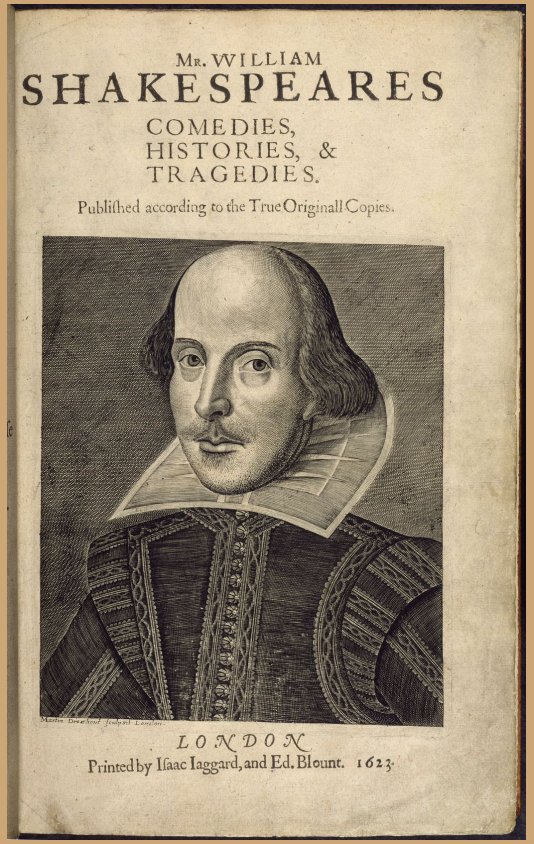
Generating Shakespearean Text using RNN

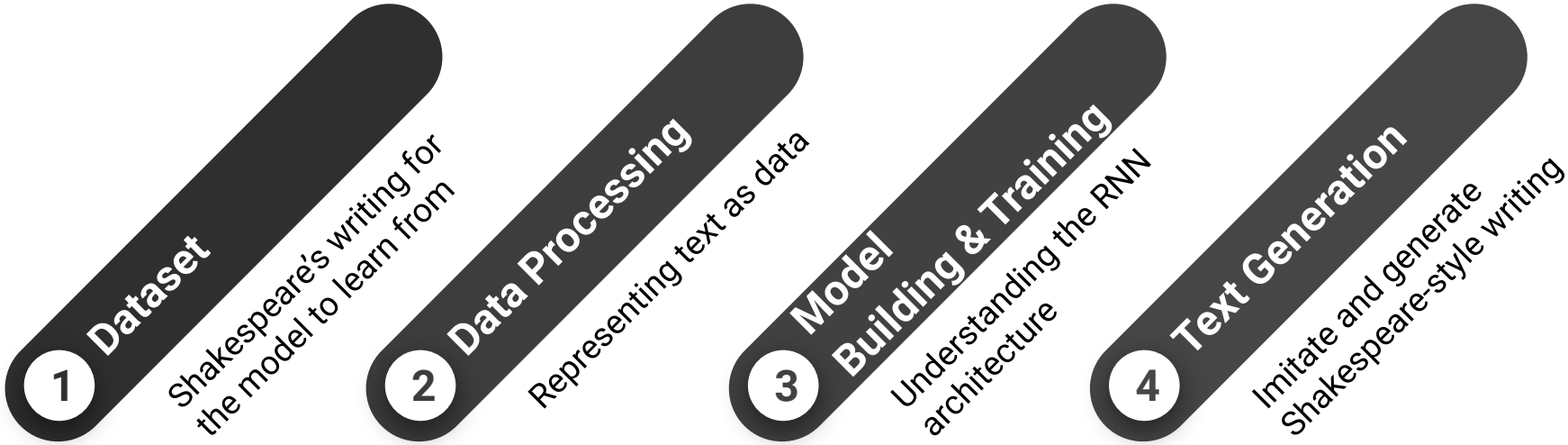
UTMIST Study Group

Problem: Generate Shakespearean writing using the RNN model

"To be, or not to be, that is the question."
– Hamlet



Overview of Steps



1. Dataset

Dataset of Shakespeare's writing:

https://storage.googleapis.com/download.tensorflow.org/data/shakespeare.txt

tf.keras.utils.get_file(): download file from URL

Text length: 1115394 characters

Unique characters: 65

```
JULIET:
'Tis but thy name that is my enemy;
Thou art thyself, though not a Montague.
What's Montague? it is nor hand, nor foot,
Nor arm, nor face, nor any other part
Belonging to a man. O, be some other name!
What's in a name? that which we call a rose
By any other name would smell as sweet;
So Romeo would, were he not Romeo call'd,
Retain that dear perfection which he owes
Without that title. Romeo, doff thy name,
And for that name which is no part of thee
Take all myself.

ROMEO:
I take thee at thy word:
Call me but love, and I'll be new baptized;
Henceforth I never will be Romeo.
```

2. Data Processing: Representing Text

String → Numeric ID

1. Split text into tokens

   tf.strings.unicode_split()

2. Convert tokens to character IDs

   tf.keras.layers.StringLookup(vocab)

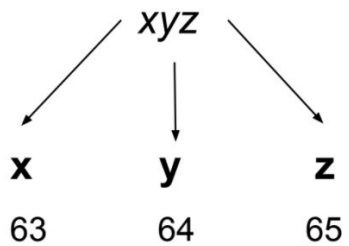
Numeric ID → String

1. Convert character IDs to tokens

   tf.keras.layers.StringLookup(get_vocabulary)

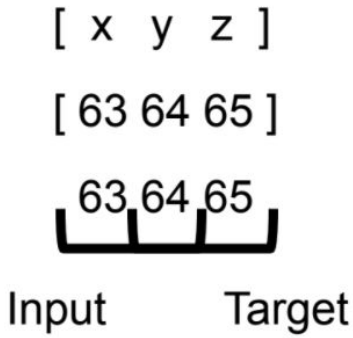
2. Join tokens into string

   tf.strings.reduce_join()



2. Data Processing: Building Training Sets

1. Convert text array into scalar character elements
   a. tf.data.Dataset.from_tensor_slices()
2. Group characters into sequences of set length
   a. batch(sequence_length)
3. Duplicate and shift sequences to produce (input, label) pairs
4. Batch and shuffle dataset



Some background knowledge regarding the RNN model...

Sequential Memory

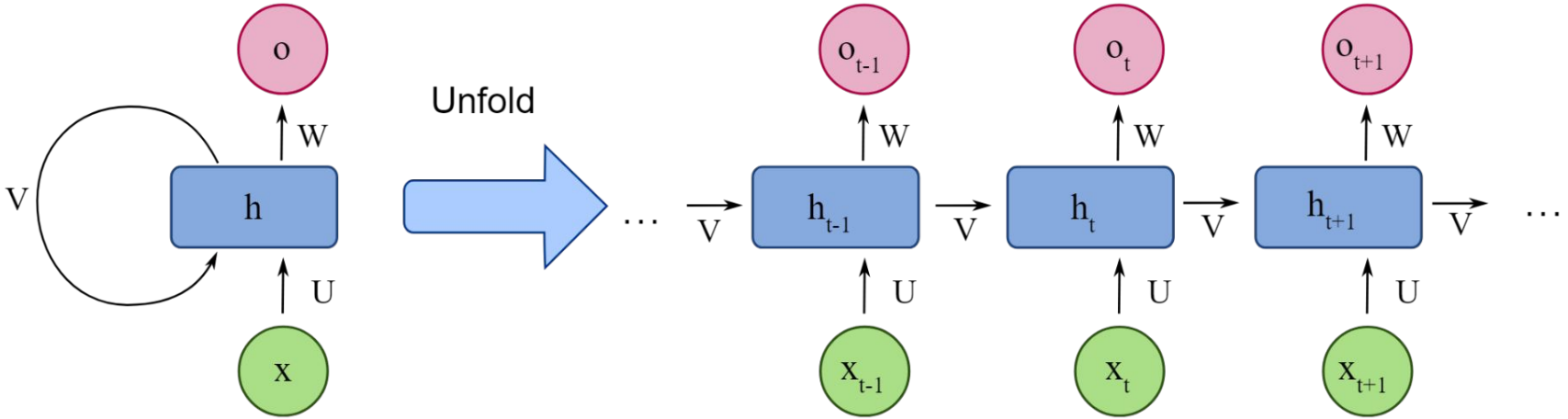
- Try saying the alphabet in forwards or backwards order. Which one is easier?
- Start saying the alphabet at G. Did you struggle with the first few letters but got easier afterwards?

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

https://towardsdatascience.com/illustrated-guide-to-recurrent-neural-networks-79e5eb8049c9

RNN Architecture

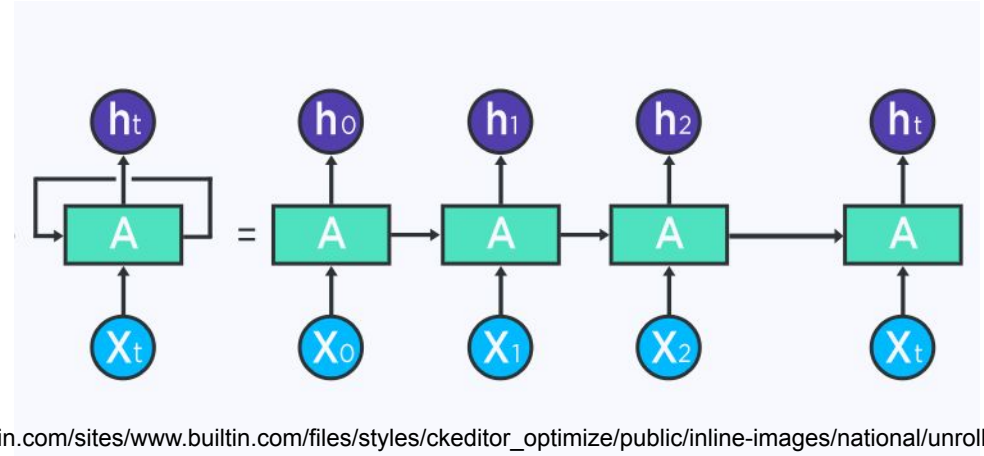
- Previous output used as input
- Process input of arbitrary length
- Weight shared across time



https://upload.wikimedia.org/wikipedia/commons/b/b5/Recurrent_neural_network_unfold.svg

Backpropagation Through Time

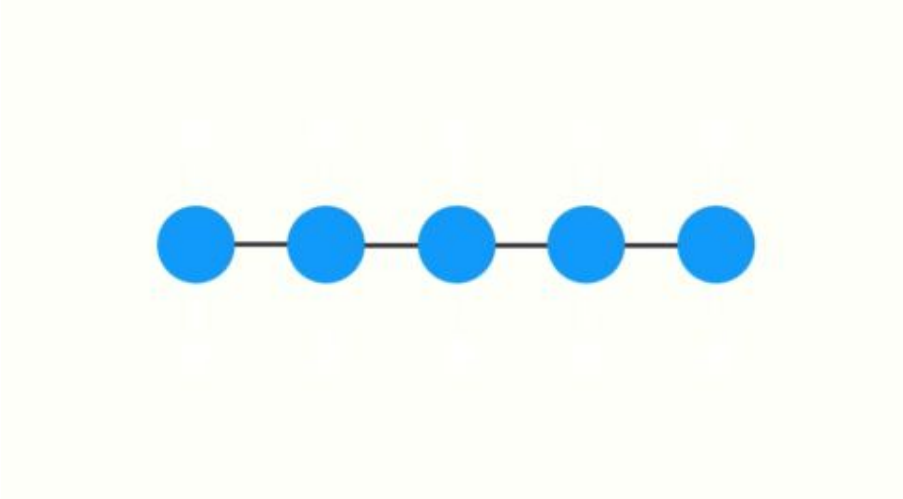
1. Unroll RNN through time
2. Back propagate error from last to first time step
3. Calculate loss at each time step
4. Update weight at each time step



https://cdn.builtin.com/sites/www.builtin.com/files/styles/ckeditor_optimize/public/inline-images/national/unrolled-rnn_0.png

Vanishing Gradient Problem

- Short-term memory
- In back-propagation, gradient calculation is dependent on previous layer
- This causes gradient and weight adjustment to shrink



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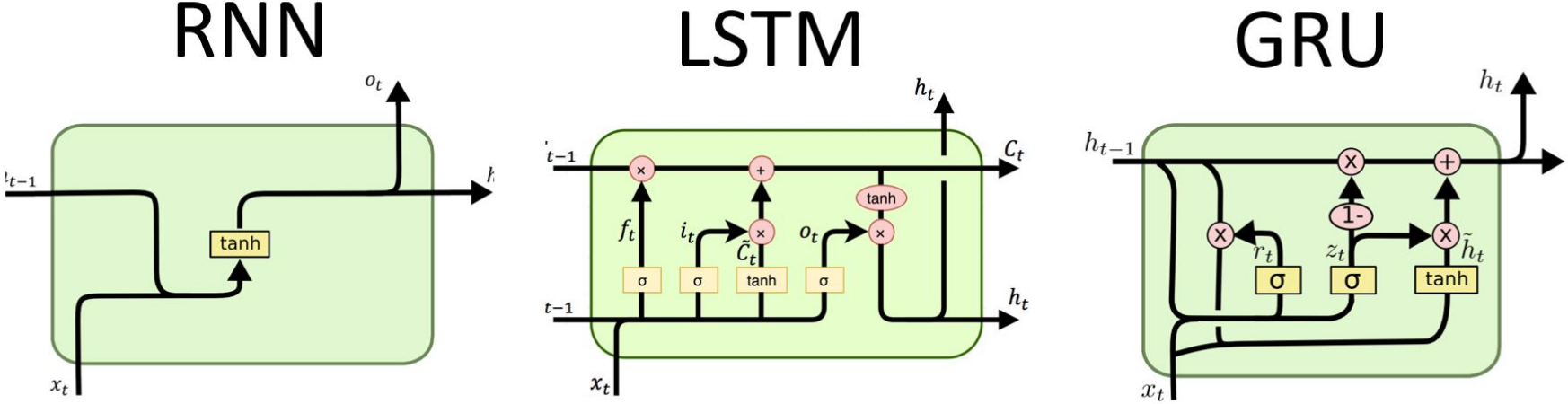
Solution: LSTM & GRU

- Long Short Term Memory (LSTM) & Gated Recurrent Unit (GRU)
- Gates that selectively update long-term memory
- Illustrated example



https://sp-ao.shortpixel.ai/client/q_glossy,ret_img,w_1849/http://dprogrammer.org/wp-content/uploads/2019/04/RNN-vs-LSTM-vs-GRU.png

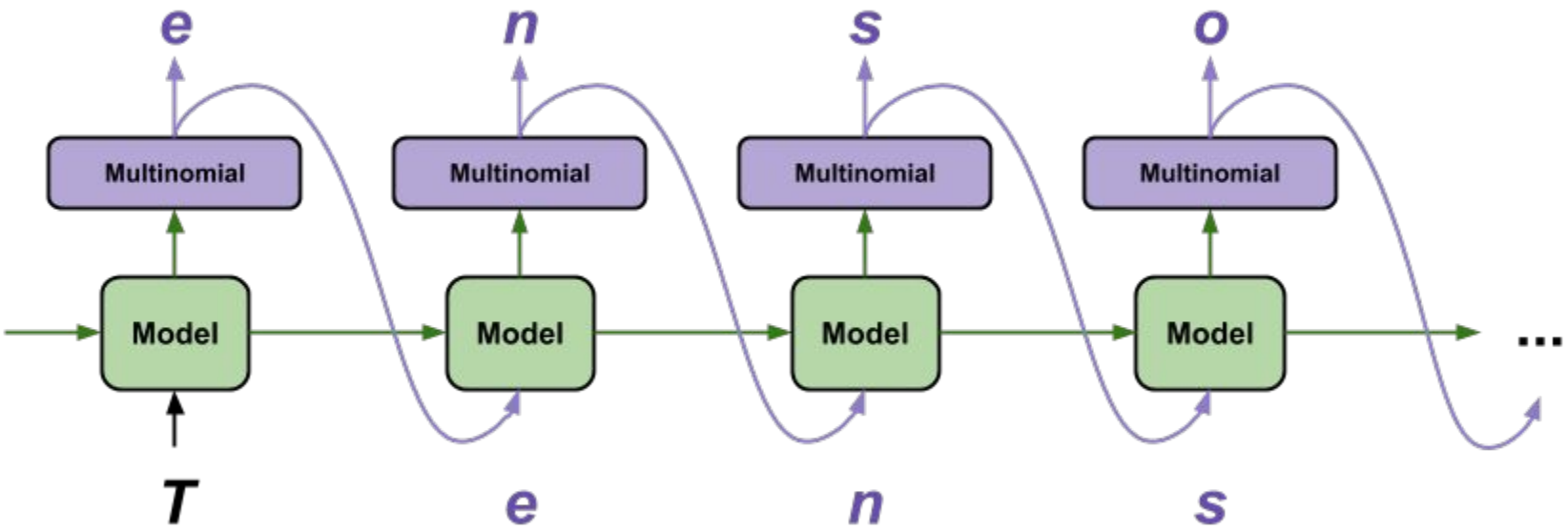
3. Building the Model: Code

tf.keras.Model

1. tf.keras.layers.Embedding
   a. Input layer
   b. Character ID → Embedding
2. tf.keras.layers.GRU
   a. RNN
3. tf.keras.layers.Dense
   a. Output layer
   b. Likelihood of each character in the vocabulary
4. tf.keras.losses.sparse_categorical_crossentropy
   a. Loss function
5. tf.keras.optimizers.Adam
   a. Optimizer

4. Generating Text

1. Run model in loop
2. Pass down prediction and internal state



https://www.tensorflow.org/text/tutorials/images/text_generation_sampling.png

Generated Examples

Prompt: “Q”

Observations:

- Valid English words
- Play writing structure
- Grammatical but does not make sense

```
QUEENE:
I had thought thou hadst a Roman; for the oracle,
Thus by All bids the man against the word,
Which are so weak of care, by old care done;
Your children were in your holy love,
And the precipitation through the bleeding throne.

BISHOP OF ELY:
Marry, and will, my lord, to weep in such a one were prettiest;
Yet now I was adopted heir
Of the world's lamentable day,
To watch the next way with his father with his face?

ESCALUS:
The cause why then we are all resolved more sons.
```

https://www.tensorflow.org/text/tutorials/text_generation

Thank You! :)