

EXPERIMENTS

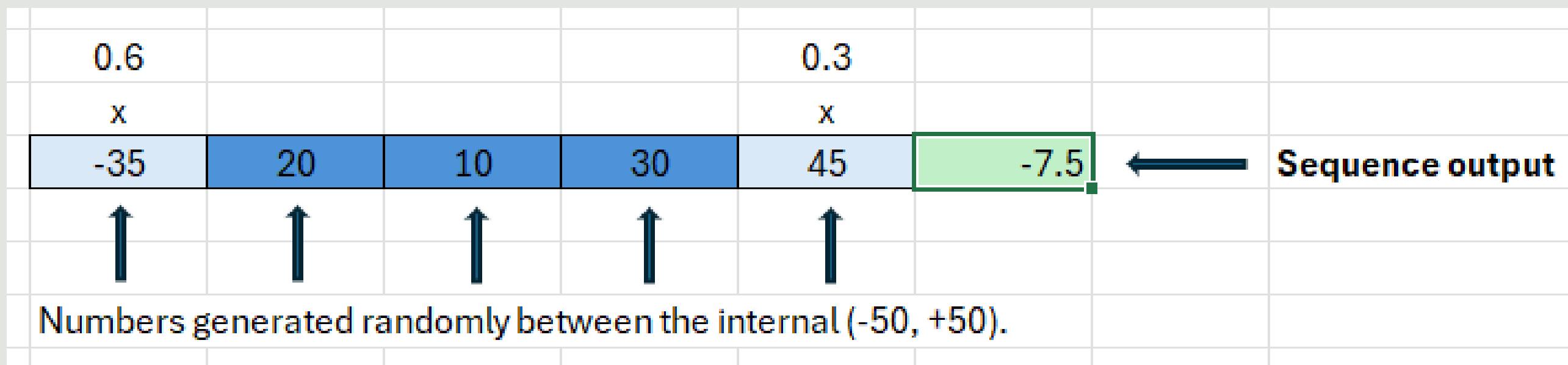
RNN & LSTM

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OVERVIEW

- Input Sequences
- Model Configurations
- Observations

INPUT SEQUENCES - 1



INPUT SEQUENCES - 2

- Simple Input Sequences
- Realistic Input Sequences

INPUT SEQUENCES - 3

- Simple Input Sequences
 - Noise-free Input Sequences

Simple Input Sequence - Noise Free						
	0.6	x	0.3	x		
Numbers generated randomly between the internal (-50, +50).	→	-35	20	10	30	45
Numbers generated randomly between the internal (-50, +50).	→	15	30	15	25	35
Numbers generated randomly between the internal (-50, +50).	→	20	15	-4	16	22
Numbers generated randomly between the internal (-50, +50).	→	20	15	-4	16	22
Numbers generated randomly between the internal (-50, +50).	→	32	-10	33	23	-14
					-7.5	19.5
					18.6	18.6
					15	

- Noisy Input Sequences

INPUT SEQUENCES - 4

- Simple Input Sequences
 - Noise-free Input Sequences
 - Noisy Input Sequences

Simple Input Sequence - Noisy with standard deviation of 2							
		0.6			0.3		
x	x				x		
Numbers generated randomly between the internal (-50, +50).	→	-35	20	10	30	45	1.1
Numbers generated randomly between the internal (-50, +50).	→	15	30	15	25	35	-0.5
Numbers generated randomly between the internal (-50, +50).	→	20	15	-4	16	22	-1.5
Numbers generated randomly between the internal (-50, +50).	→	20	15	-4	16	22	2
Numbers generated randomly between the internal (-50, +50).	→	32	-10	33	23	-14	2.1
							-6.4
							19
							17.1
							20.6
							17.1

INPUT SEQUENCES - 5

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the interval (-50, +50).						→	0.6	x	0.3	x	Sequence output
-35	20	10	30	45	-7.5						
20	10	30	45	-7.5	9.75						
10	30	45	-7.5	9.75	8.925						
30	45	-7.5	9.75	8.925	20.6775						
45	-7.5	9.75	8.925	20.6775	33.20325						

- Noisy Input Sequences

INPUT SEQUENCES - 6

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the internal (-50, +50).					
					0.6 0.3
x	-35	20	10	30	45 -7.5
20	10	30	45	-7.5	9.75
10	30	45	-7.5	9.75	8.925
30	45	-7.5	9.75	8.925	20.6775
45	-7.5	9.75	8.925	20.6775	33.20325

- Noisy Input Sequences

INPUT SEQUENCES - 7

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the interval (-50, +50).						→	0.6	x	0.3	x	←	Sequence output
-35	20	10	30	45	-7.5							
20	10	30	45	-7.5	9.75							
10	30	45	-7.5	9.75	8.925							
30	45	-7.5	9.75	8.925	20.6775							
45	-7.5	9.75	8.925	20.6775	33.20325							

- Noisy Input Sequences

INPUT SEQUENCES - 8

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the interval (-50, +50). →

	0.6	x	0.3				
	-35	20	10	30	45	-7.5	←
	20	10	30	45	-7.5	9.75	←
	10	30	45	-7.5	9.75	8.925	←
	30	45	-7.5	9.75	8.925	20.6775	←
	45	-7.5	9.75	8.925	20.6775	33.20325	←

Sequence output

- Noisy Input Sequences

INPUT SEQUENCES - 9

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the interval (-50, +50). →

0.6	x	0.3	x
-35	20	10	30
20	10	30	45
10	30	45	-7.5
30	45	-7.5	9.75
45	-7.5	9.75	8.925
			20.6775
			33.20325

Sequence output ← ← ← ← ← ←

- Noisy Input Sequences

INPUT SEQUENCES - 10

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the internal (-50, +50). →

0.6	x	0.3	x
-35	20	10	30
20	10	30	45
10	30	45	-7.5
30	45	-7.5	9.75
45	-7.5	9.75	8.925
			20.6775
			33.20325

Sequence output ← ← ← ← ← ←

- Noisy Input Sequences

INPUT SEQUENCES - 11

- Realistic Input Sequences
 - Noise-free Input Sequences

Numbers generated randomly between the internal (-50, +50). →

0.6	x	0.3	x
-35	20	10	30
20	10	30	45
10	30	45	-7.5
30	45	-7.5	9.75
45	-7.5	9.75	8.925
			20.6775
			33.20325

Sequence output ←

The diagram illustrates a process flow for generating input sequences. It starts with a list of numbers: -35, 20, 10, 30, 45, -7.5. These numbers are processed by two parallel sequences of operations, labeled 0.6 and 0.3. The sequence 0.6 processes the numbers sequentially: -35, 20, 10, 30, 45, -7.5. The sequence 0.3 processes the numbers sequentially: 20, 10, 30, 45, -7.5, 9.75. Arrows indicate the flow of data from left to right through each sequence. The final output is 33.20325.

- Noisy Input Sequences

INPUT SEQUENCES - 12

- Realistic Input Sequences
 - Noise-free Input Sequences
 - Noisy Input Sequences

Realistic Input Sequence - Noisy with standard deviation of 2							
0.6				0.3			
x	x	x	x	x	x	x	x
-35	20	10	30	45	1.1	-7.5	←
20	10	30	45	-7.5	-0.5	9.75	←
10	30	45	-7.5	9.75	-1.5	8.925	←
30	45	-7.5	9.75	8.925	2	20.6775	←
45	-7.5	9.75	8.925	20.6775	2.1	33.20325	←

Numbers generated randomly between the internal (-50, +50). →

Sequence output

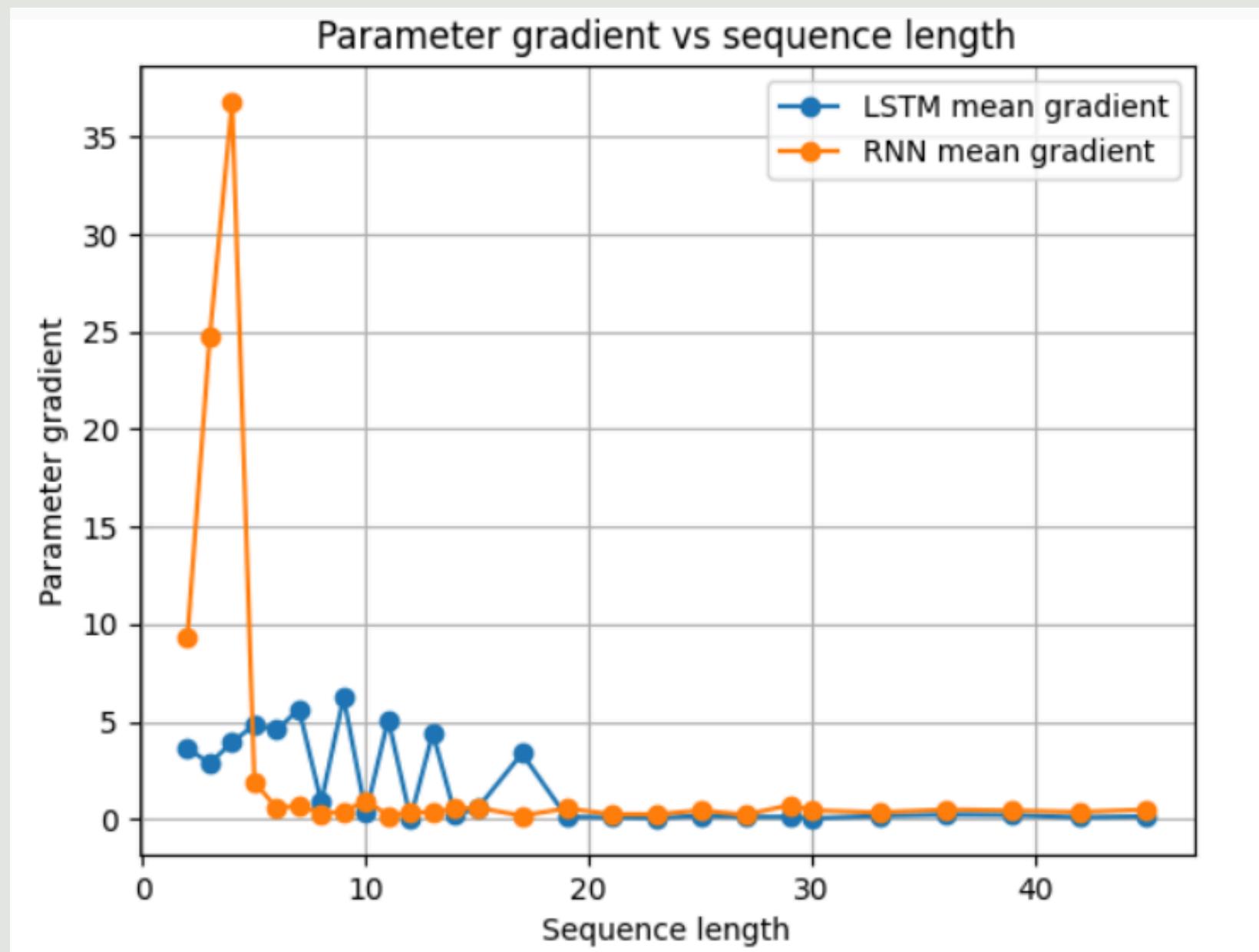
MODEL CONFIGURATIONS

Model parameters/hyper-parameters	
Hidden size	6
Number of layers	1
Input dimension	1
Sequence length	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 21, 23, 25, 27, 29, 30, 33, 36, 39, 42, 45
Standardize inputs	Yes/No

- Training and validate
 - Record model performance (MAD).
 - Record mean of parameter gradient.

OBSERVATIONS - 1

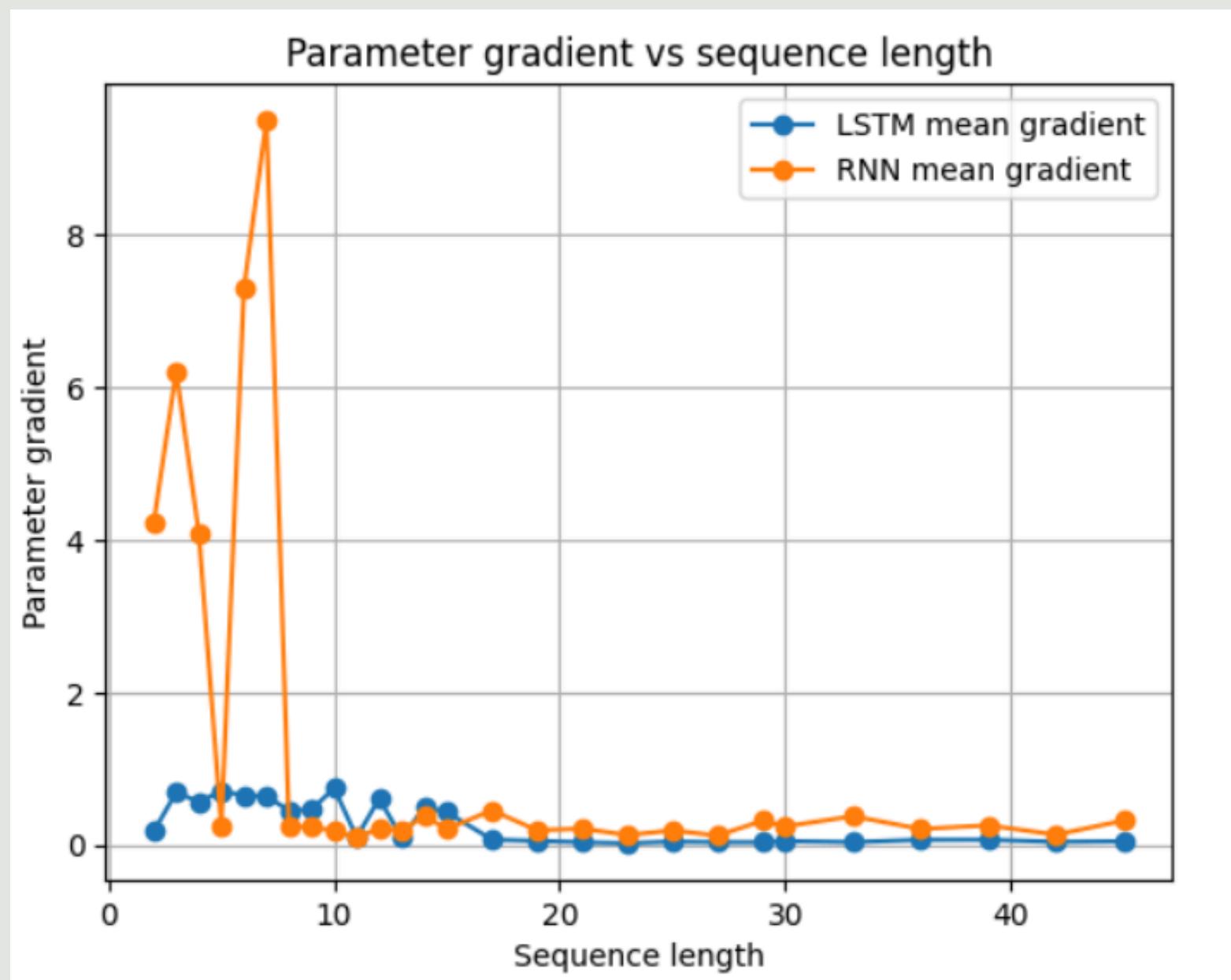
PARAMETER GRADIENTS



- Sequence type = Simple noise-free input sequence
- Standardize Inputs = No

OBSERVATIONS - 2

PARAMETER GRADIENTS

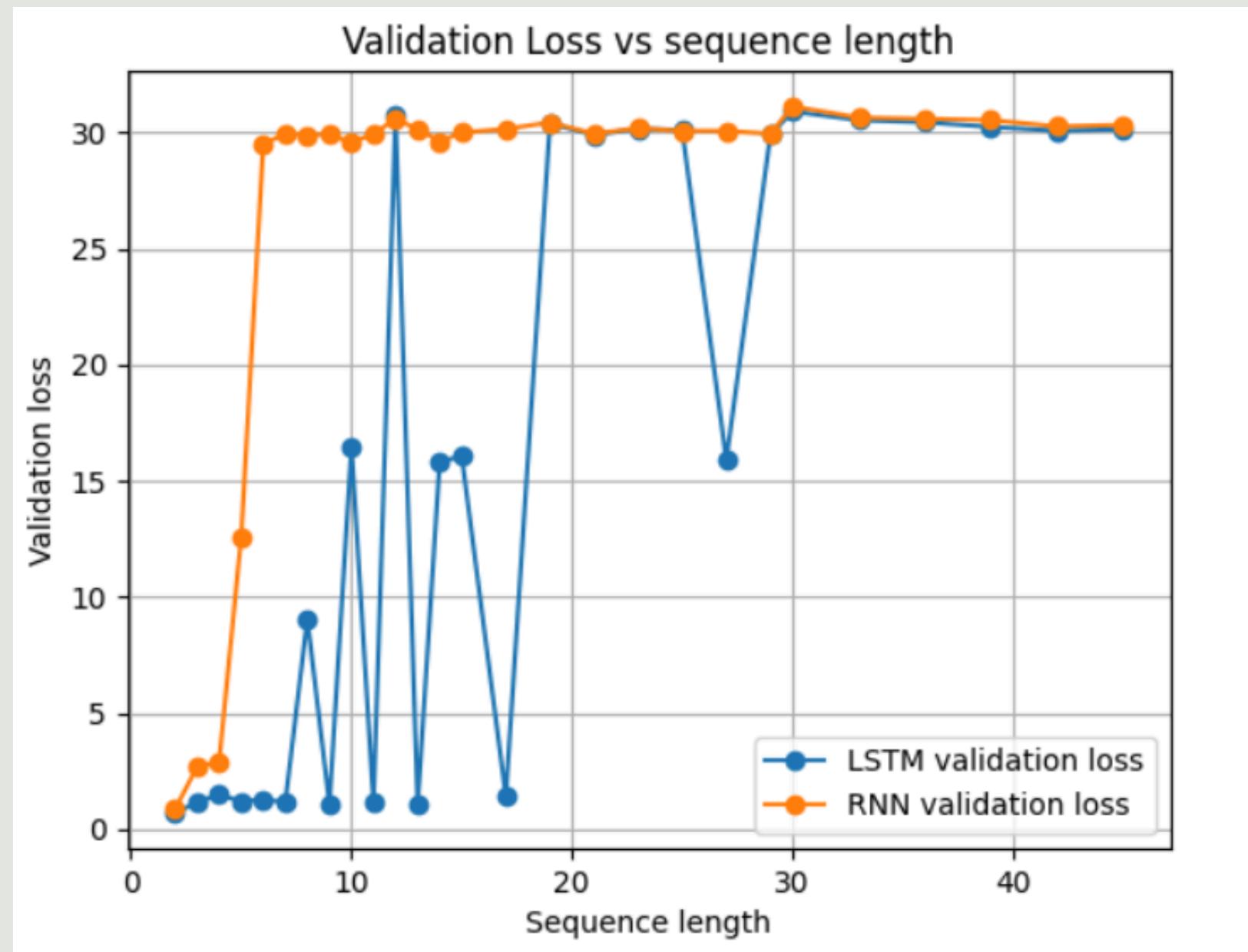


- Sequence type = Simple noisy input (std dev = 6) sequence
- Standardize Inputs = Yes

- Increased possibility of vanishing gradients with increasing sequence length.
- Parameter gradients exhibit relatively less fluctuations for LSTMs as compared to RNNs.

OBSERVATIONS - 3

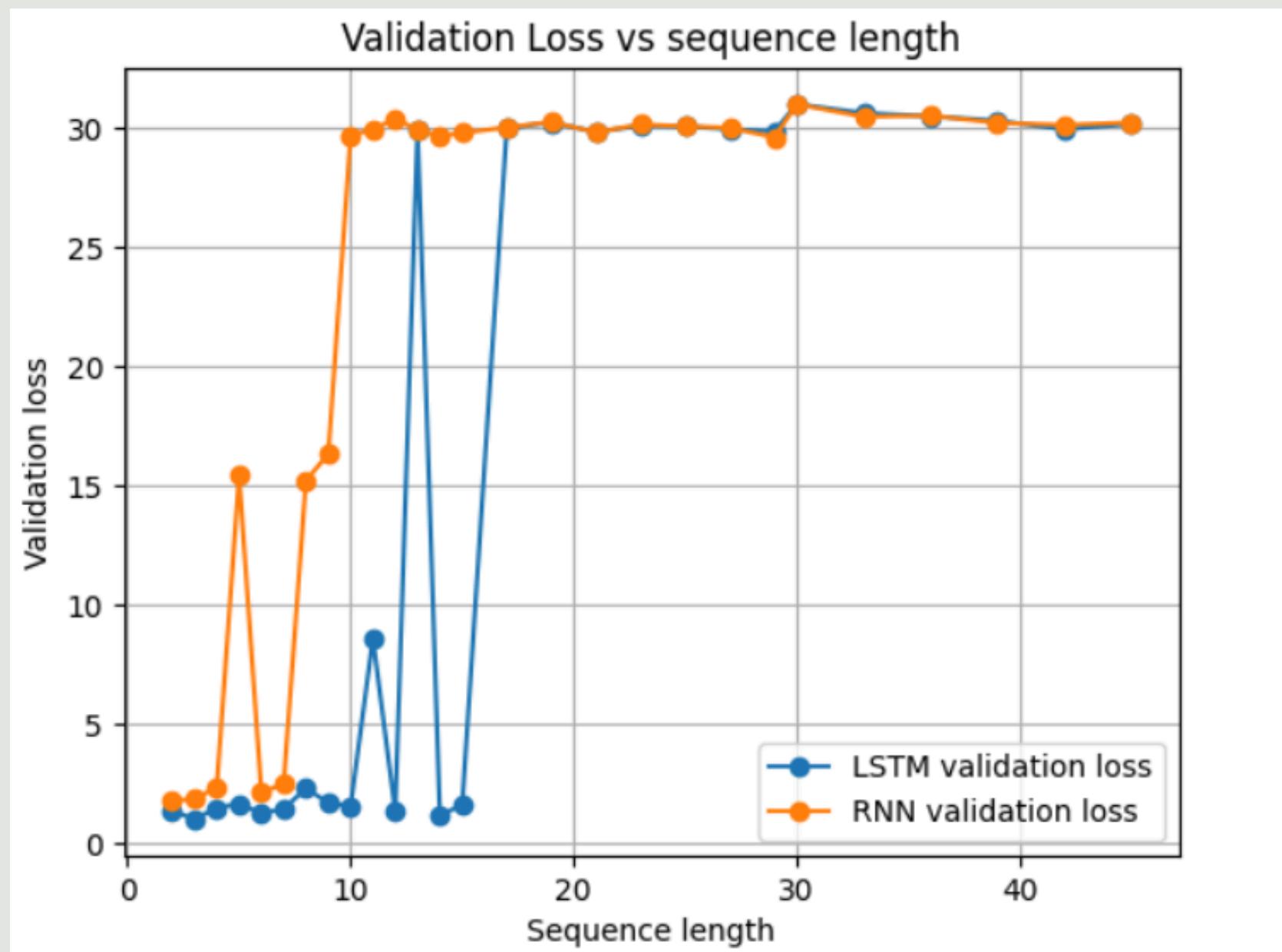
MODEL PERFORMANCE (MAD)



- Sequence type = Simple noise-free input sequence
- Standardize Inputs = No

OBSERVATIONS - 4

MODEL PERFORMANCE (MAD)

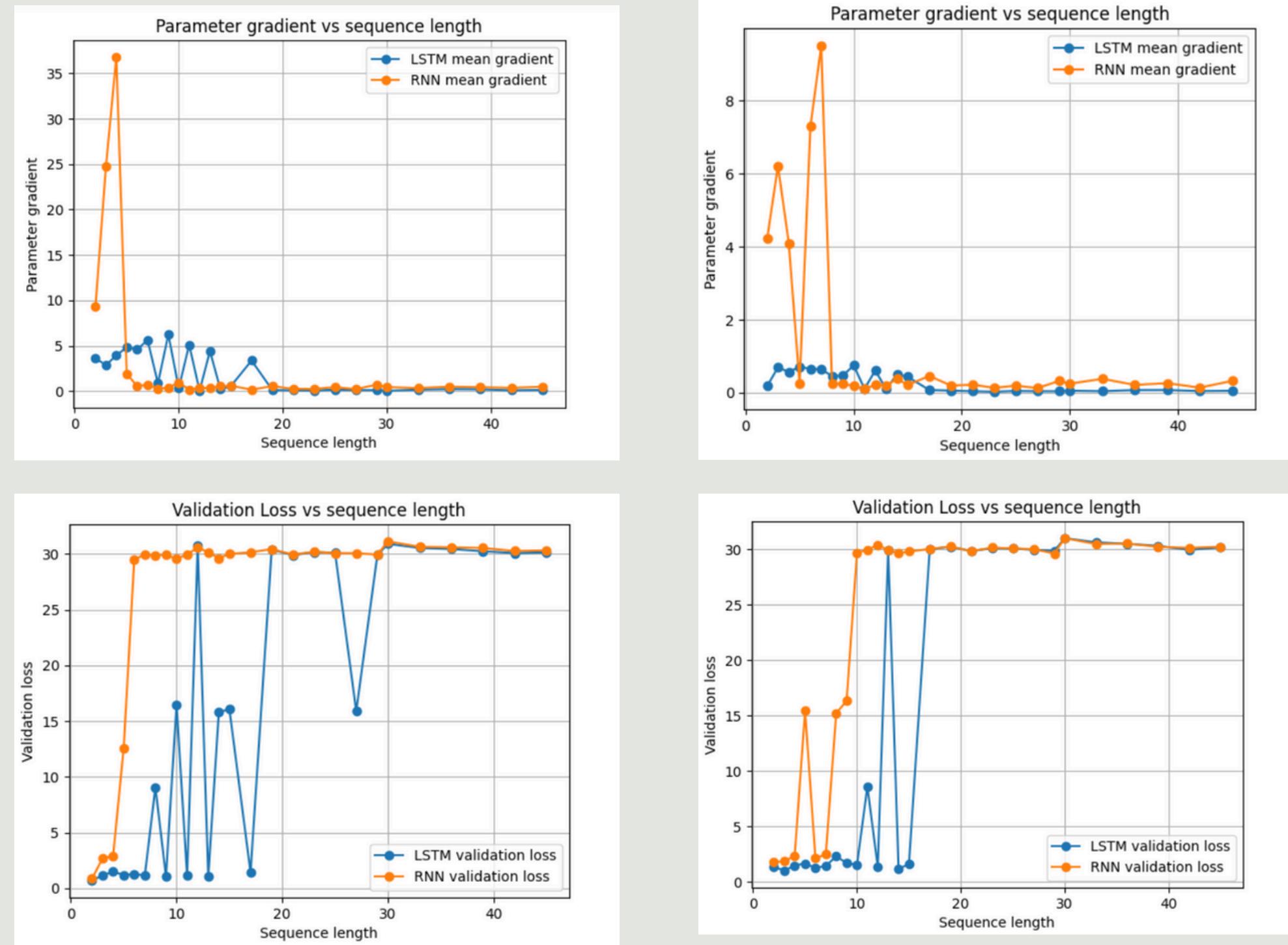


- Sequence type = Simple noisy input (std dev = 6) sequence
- Standardize Inputs = Yes
- Increase in MAD with increase in sequence length.
- LSTMs are able to exhibit lower MADs for longer sequence lengths as compared to RNNs.

OBSERVATIONS - 5

PARAMETER GRADIENT AND MODEL PERFORMANCE

- Sequence type = Simple noise-free input sequence
- Standardize Inputs = No



- Sequence type = Simple noisy input (std dev = 6) sequence
- Standardize Inputs = Yes

OBSERVATIONS - 6

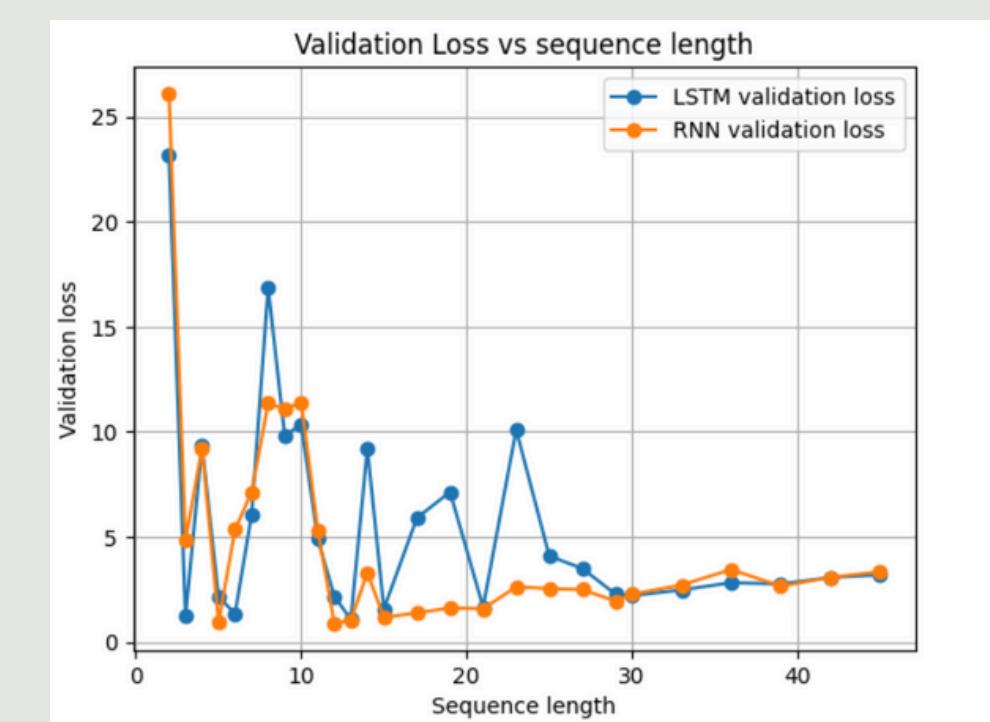
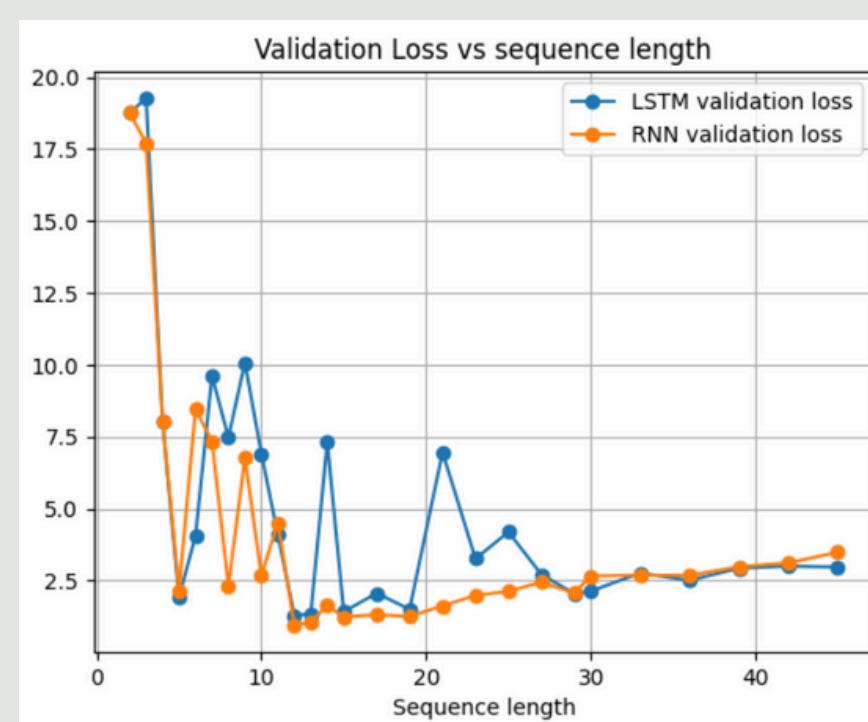
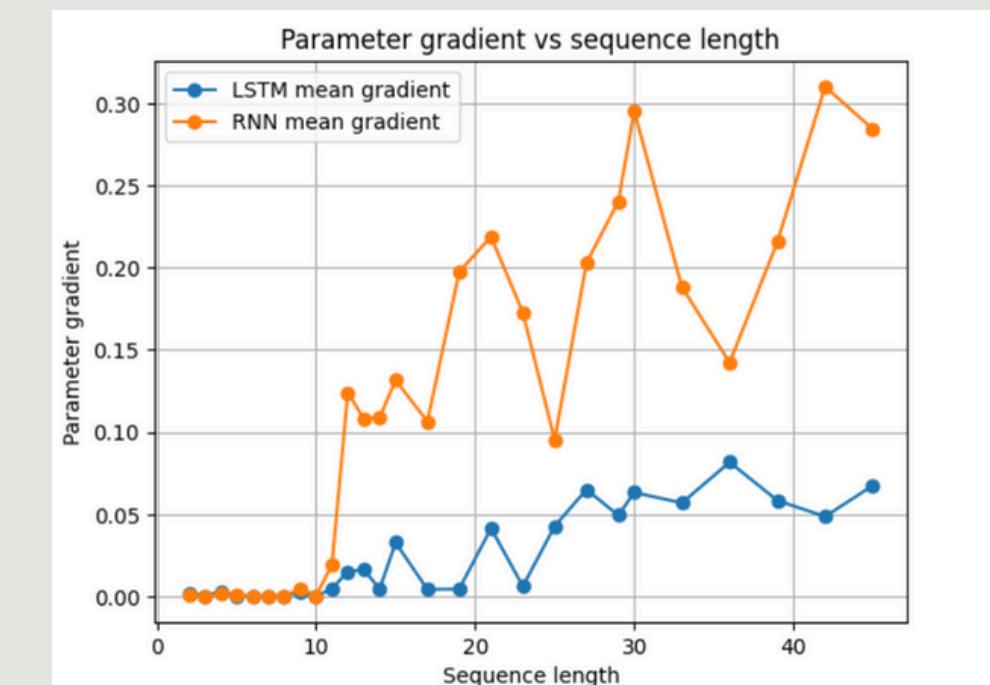
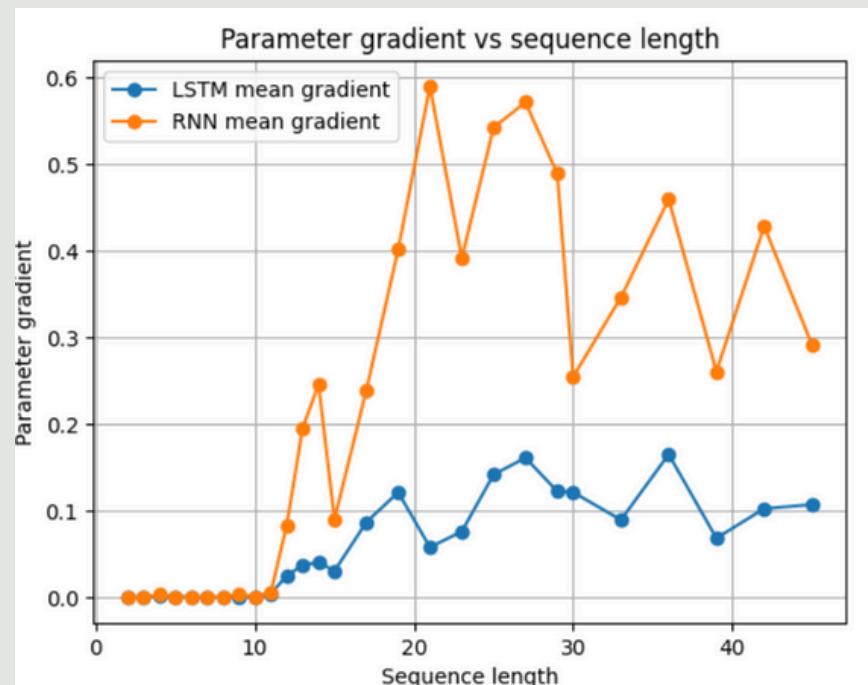
PARAMETER GRADIENT AND MODEL PERFORMANCE

- Vanishing gradients prevent model convergence leading to poor model performance.

OBSERVATIONS - 7

UNEXPECTED RESULTS

- Sequence type = Realistic noise-free input sequence
- Standardize Inputs = No



- Sequence type = Realistic noise-free input sequence
- Standardize Inputs = Yes

THANK YOU

LinkedIn: - <https://www.linkedin.com/in/divyaman-rawat/>

Github Rep: - <https://github.com/DivNewBeg/Experiments-with-LSTM-RNNs>