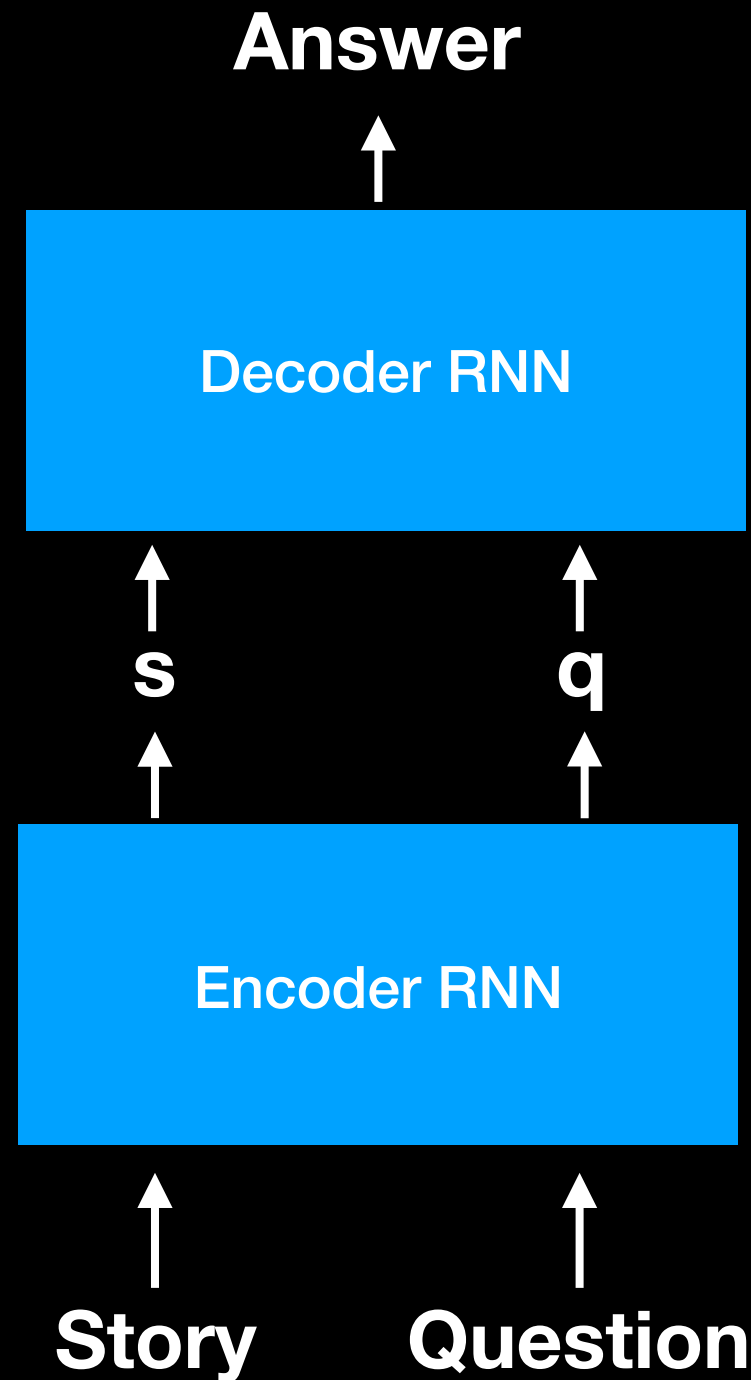


# Ask me (almost) anything

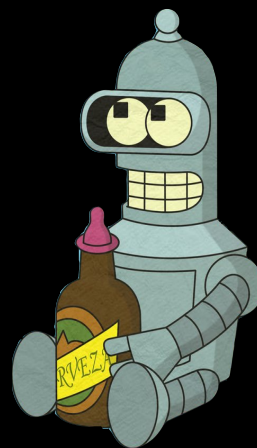
Question answering with recurrent neural networks



# Neural network model



# The bAbI tasks



# Time reasoning (14)

This morning Mary moved to the kitchen.

This afternoon Mary moved to the cinema.

Yesterday Bill went to the bedroom.

Yesterday Mary journeyed to the school.

Yesterday Fred went back to the cinema.

Bill journeyed to the office this morning.

Mary went to the school this evening.

This afternoon Bill journeyed to the kitchen.

Julie went to the office yesterday.

This morning Fred journeyed to the office.

This evening Fred journeyed to the school.

This afternoon Fred journeyed to the bedroom.

**Where was Mary before the school?**

**Cinema!**

# Basic induction (16)

Julius is a swan.  
Bernhard is a swan.  
Greg is a frog.  
Brian is a swan.  
Brian is gray.  
Lily is a frog.  
Julius is gray.  
Lily is green.  
Bernhard is gray.

**What color is Greg?**

**Green!**

# Baseline results

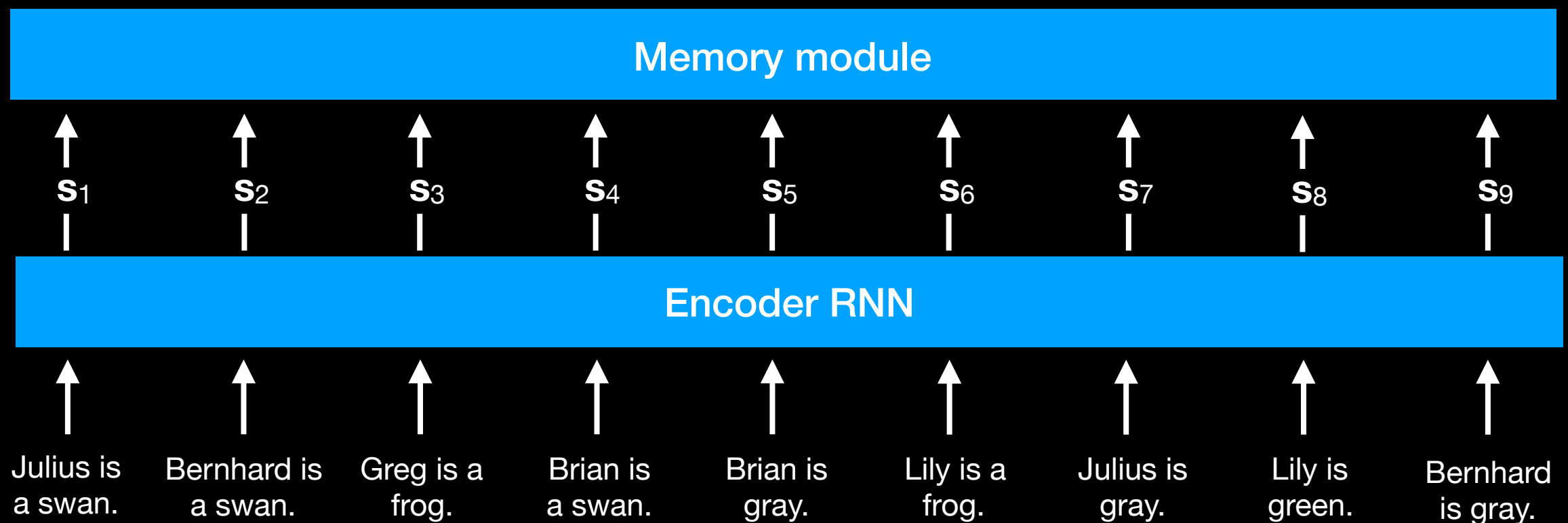
Task	Test set accuracy
1. Single supporting fact	48.4%
2. Two supporting facts	19.2%
3. Three supporting facts	17%
4. Two argument relations	74.6%
5. Three argument relations	81.6%
6. Yes/no questions	46.8%
7. Counting	79%
8. Lists/sets	74%
9. Simple negation	59.8%
10. Indefinite knowledge	46.4%
11. Basic conference	74%
12. Conjunction	78%
13. Compound coreference	94%
<b>14. Time reasoning</b>	<b>35.8%</b>
15. Basic deduction	56.6%
<b>16. Basic induction</b>	<b>48.8%</b>
17. Positional reasoning	61.2%
18. Size reasoning	93.4%
19. Path finding	8%
20. Agent's motivations	97.6%

# Baseline results

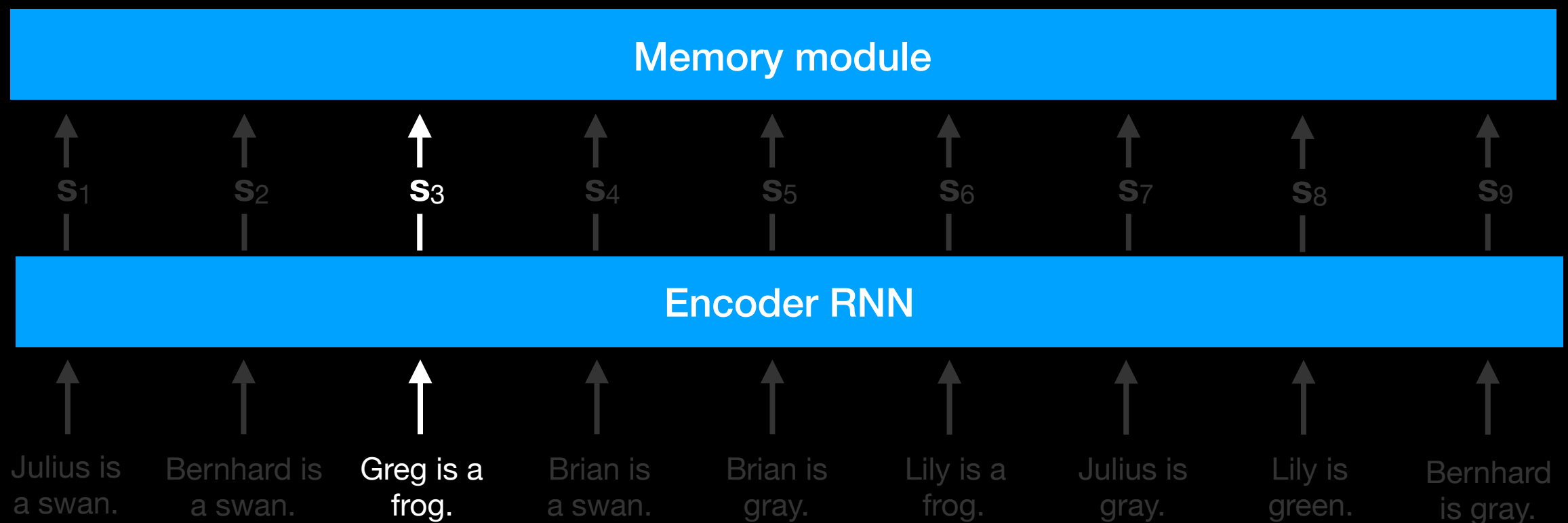
Task	Test set accuracy
1. Single supporting fact	48.4%
2. Two supporting facts	19.2%
3. Three supporting facts	17%
4. Two argument relations	74.6%
5. Three argument relations	81.6%
6. Yes/no questions	46.8%
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14. Time reasoning	35.8%
15. Basic deduction	56.6%
16. Basic induction	48.8%
17. Positional reasoning	61.2%
18. Size reasoning	93.4%
19. Path finding	8%
20. Agent's motivations	97.6%



# Dynamic memory network

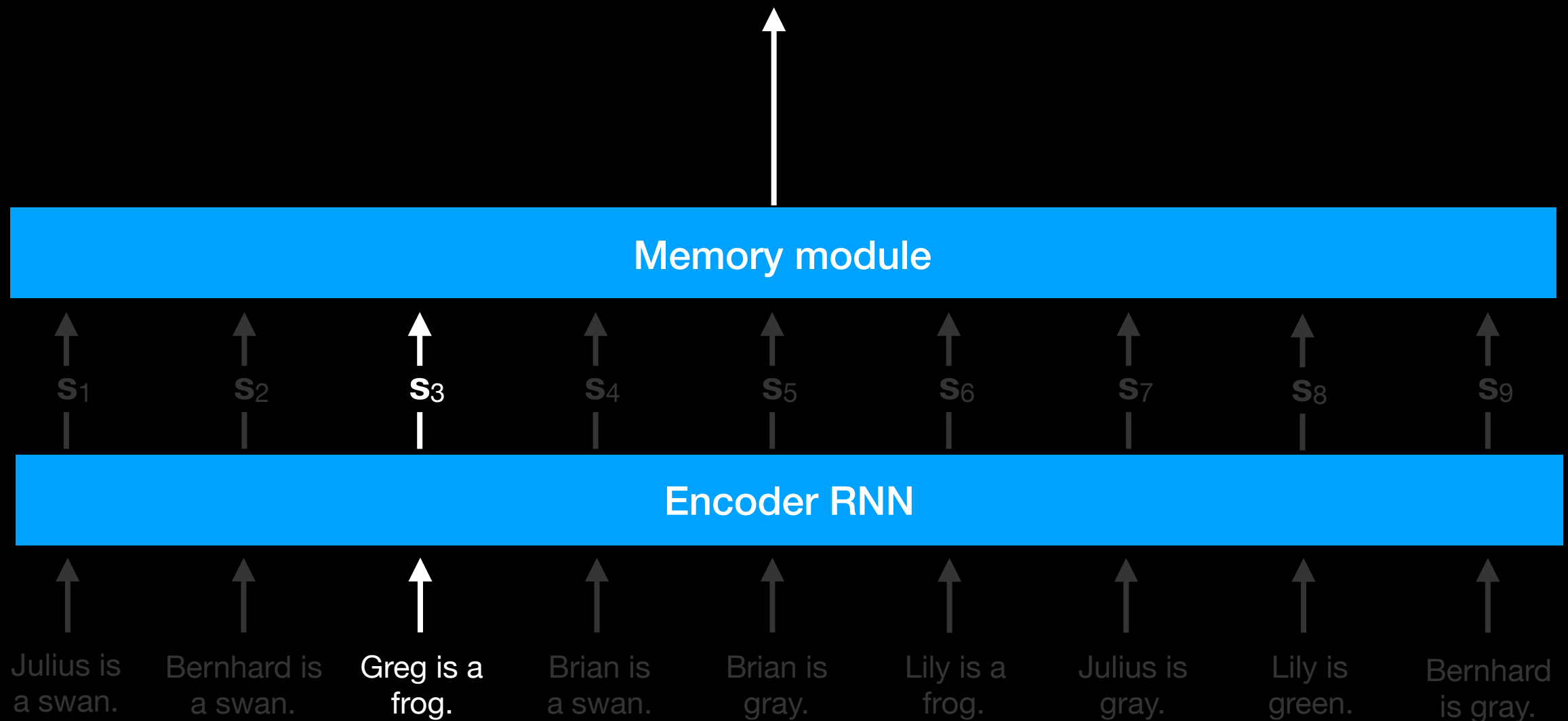


# Dynamic memory network



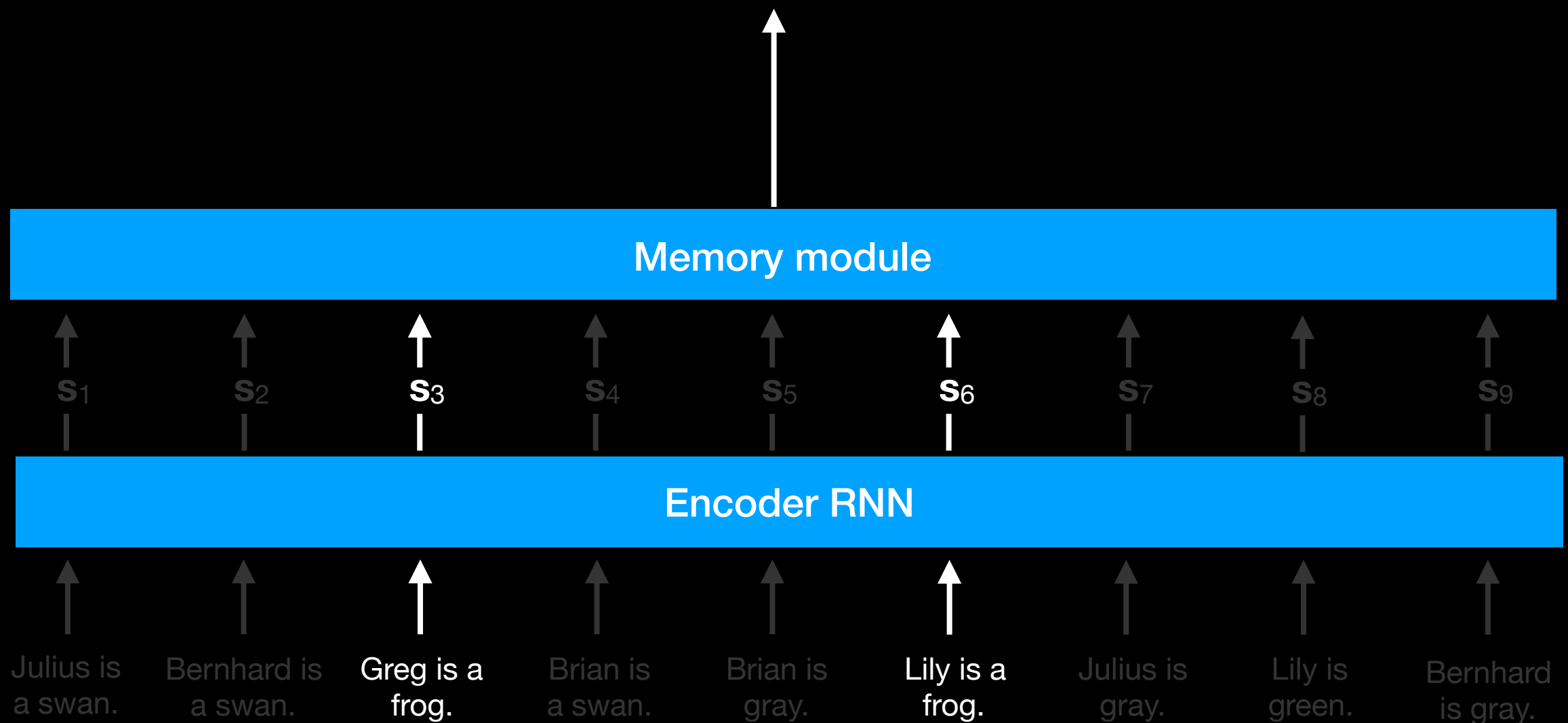
# Dynamic memory network

$$\mathbf{m}_1 = \left[ \text{Greg is a frog.} \right]$$



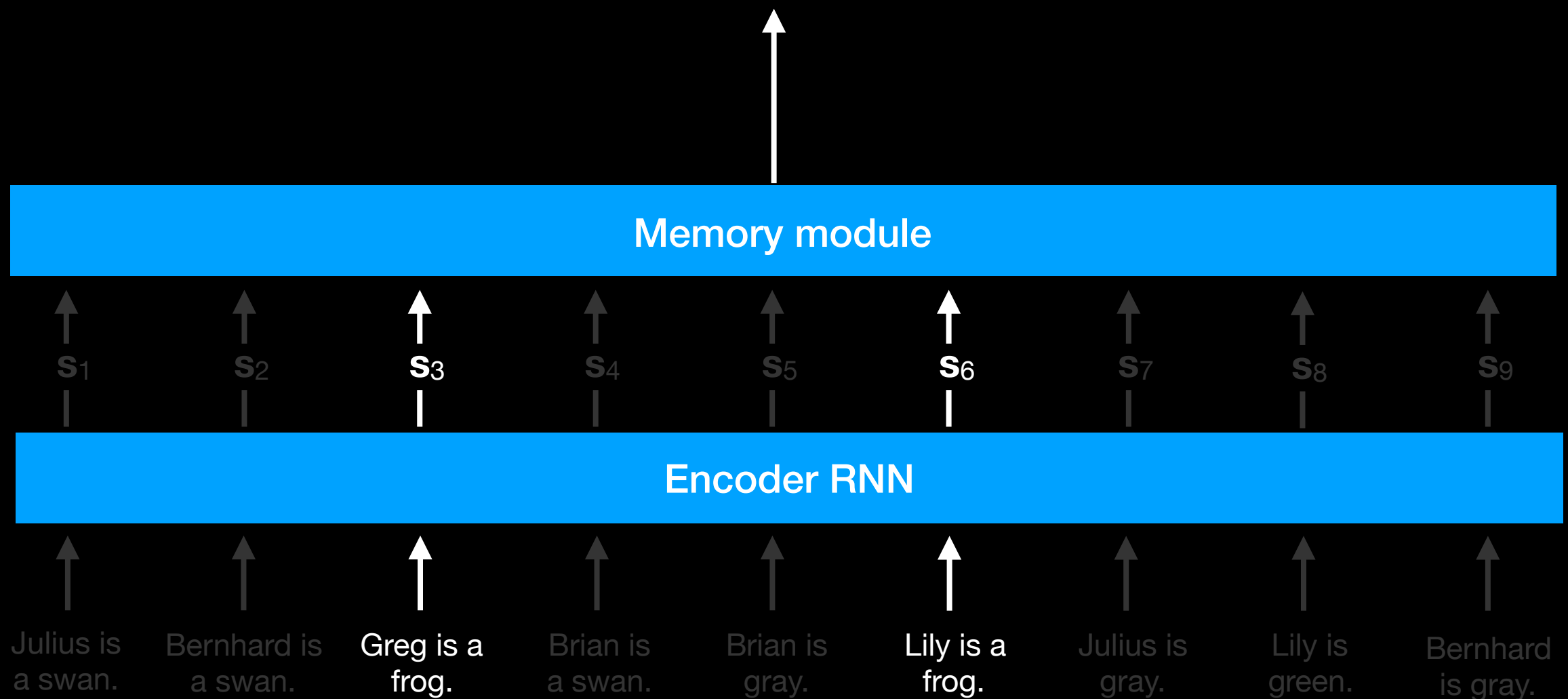
# Dynamic memory network

$$\mathbf{m}_1 = \left[ \text{Greg is a frog.} \right]$$



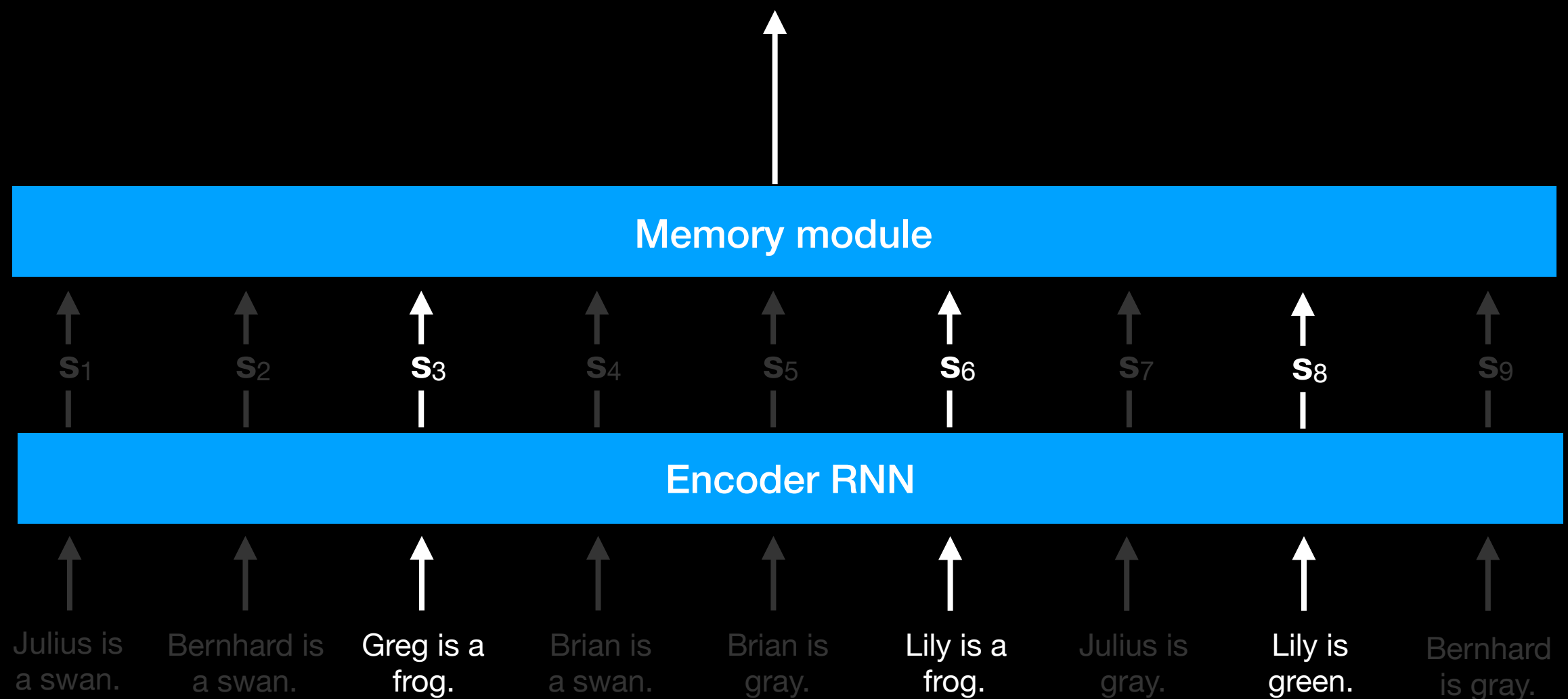
# Dynamic memory network

$$\mathbf{m}_2 = \begin{bmatrix} \text{Greg is a frog.} \\ \text{Lily is a frog.} \end{bmatrix}$$



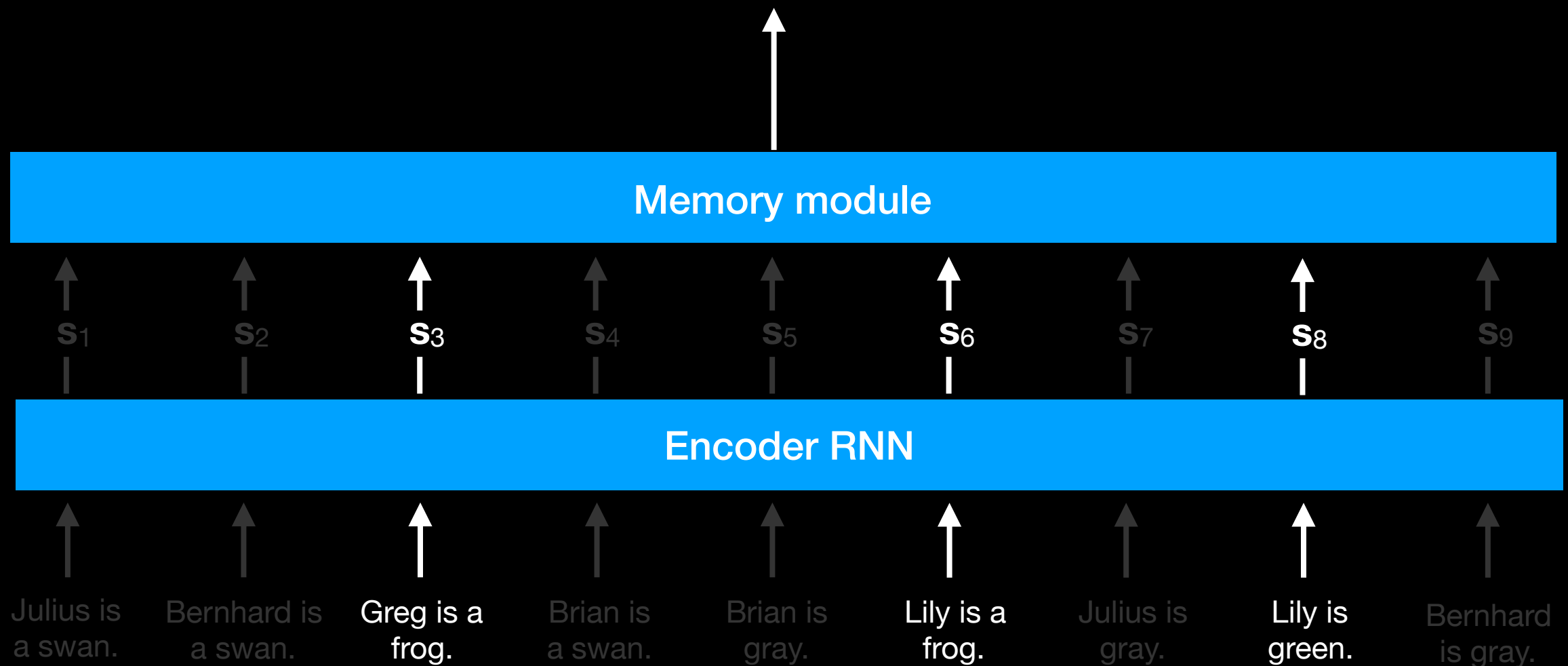
# Dynamic memory network

$$\mathbf{m}_2 = \begin{bmatrix} \text{Greg is a frog.} \\ \text{Lily is a frog.} \end{bmatrix}$$



# Dynamic memory network

$$\mathbf{m}_3 = \begin{bmatrix} \text{Greg is a frog.} \\ \text{Lily is a frog.} \\ \text{Lily is green.} \end{bmatrix}$$



# Attention weights

Sentence	1st pass	2nd pass	3rd pass	Target
Julius is a swan.	0.0000	0.0000	0.0000	0
Bernhard is a swan.	0.0000	0.0000	0.0000	0
Greg is a frog.	0.9988	1.0000	1.0000	1
Brian is a swan.	0.0000	0.0000	0.0000	0
Brian is gray.	0.0004	0.0062	0.0001	0
Lily is a frog.	0.0000	0.9995	1.0000	1
Julius is gray.	0.0010	0.0004	0.0000	0
Lily is green.	0.0002	0.0022	0.9997	1
Bernhard is gray.	0.0005	0.0007	0.0003	0



# DMN results

Task	Baseline	DMN
1. Single supporting fact	48.4%	100%
2. Two supporting facts	19.2%	30%
3. Three supporting facts	17%	30.4%
4. Two argument relations	74.6%	100%
5. Three argument relations	81.6%	98.2%
6. Yes/no questions	46.8%	99.8%
7. Counting	79%	98.8%
8. Lists/sets	74%	99.6%
9. Simple negation	59.8%	99.8%
10. Indefinite knowledge	46.4%	98.4%
11. Basic conference	74%	100%
12. Conjunction	78%	100%
13. Compound coreference	94%	99.8%
<b>14. Time reasoning</b>	<b>35.8%</b>	<b>99.2%</b>
15. Basic deduction	56.6%	100%
<b>16. Basic induction</b>	<b>48.8%</b>	<b>98.6%</b>
17. Positional reasoning	61.2%	60%
18. Size reasoning	93.4%	99%
19. Path finding	8%	22.4%
20. Agent's motivations	97.6%	100%

# DMN results

Task	Baseline	DMN
1. Single supporting fact	48.4%	100%
2. Two supporting facts	19.2%	30%
3. Three supporting facts	17%	30.4%
4. Two argument relations	74.6%	100%
5. Three argument relations	81.6%	98.2%
6. Yes/no questions	46.8%	99.8%
7. Counting	79%	98.8%
8. Lists/sets	74%	99.6%
9. Simple negation	59.8%	99.8%
10. Indefinite knowledge	46.4%	98.4%
11. Basic conference	74%	100%
12. Conjunction	78%	100%
13. Compound coreference	94%	99.8%
14. Time reasoning	35.8%	99.2%
15. Basic deduction	56.6%	100%
16. Basic induction	48.8%	98.6%
17. Positional reasoning	61.2%	60%
18. Size reasoning	93.4%	99%
19. Path finding	8%	22.4%
20. Agent's motivations	97.6%	100%

# DMN results

Task	Baseline	DMN
1. Single supporting fact	48.4%	100%
2. Two supporting facts	19.2%	30%
3. Three supporting facts	17%	30.4%
4. Two argument relations	74.6%	100%
5. Three argument relations	81.6%	98.2%
6. Yes/no questions	46.8%	99.8%
7. Counting	79%	98.8%
8. Lists/sets	74%	99.6%
9. Simple negation	59.8%	99.8%
10. Indefinite knowledge	46.4%	98.4%
11. Basic coreference	74%	100%
12. Conjunction	78%	100%
13. Compound coreference	94%	99.8%
14. Time reasoning	35.8%	99.2%
15. Basic deduction	56.6%	100%
16. Basic induction	48.8%	98.6%
17. Positional reasoning	61.2%	60%
18. Size reasoning	93.4%	99%
19. Path finding	8%	22.4%
20. Agent's motivations	97.6%	100%

# Next steps

- Improve and extend DMN implementation.
- Apply to new datasets.
- Web app playground.

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github.com/nbeshouri

**Thanks!**

 python  Keras spaCy

# Appendix

# DMN results

Task	Baseline	DMN	DMN all tasks simultaneously	DMN w/o gate supervision
1. Single supporting fact	48.4%	100%	100%	98.6%
2. Two supporting facts	19.2%	30%	70.2%	34.6%
3. Three supporting facts	17%	30.4%	60.4%	43.8%
4. Two argument relations	74.6%	100%	74%	96.4%
5. Three argument relations	81.6%	98.2%	90.8%	75.2%
6. Yes/no questions	46.8%	99.8%	99%	67%
7. Counting	79%	98.8%	95.4%	80%
8. Lists/sets	74%	99.6%	96.8%	74.8%
9. Simple negation	59.8%	99.8%	98.4%	64%
10. Indefinite knowledge	46.4%	98.4%	89.4%	71%
11. Basic conference	74%	100%	97%	71%
12. Conjunction	78%	100%	99%	82.2%
13. Compound coreference	94%	99.8%	98.2%	93.8%
14. Time reasoning	35.8%	99.2%	79.8%	43.8%
15. Basic deduction	56.6%	100%	92%	54.4%
16. Basic induction	48.8%	98.6%	45.6%	48.8%
17. Positional reasoning	61.2%	60%	57.4%	62.6%
18. Size reasoning	93.4%	99%	95.2%	95.8%
19. Path finding	8%	22.4%	8.8%	8.4%
20. Agent's motivations	97.6%	100%	100%	97.8%