Shakespeare - English Sequence to Sequence Modeling

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Problem

Data

Data

- **8 aligned** plays
  - GIZA++ and Moses SMT systems
- **10,365** sentence pairs
- 9,004 source words
- 7,497 target words
- 233,282 total words
- Taken from **eNotes**

Play	Line Count
Hamlet	2,010
Julius Caesar	1,201
Macbeth	1,085
Merchant of Venice	831
Midsummer Night's Dream	833
Othello	1,893
Romeo and Juliet	1,743
Tempest	769
TOTAL	**10,365**

Preprocessing

- **Replace proper nouns** with a special token
- Use NLTK **tokenization** to split sentences, contractions, etc
- Use Start of Sentence (SOS) Tokens to begin phrases
- Use End of Sentence (EOS) Tokens to signal end of sentence
- **Pad target sentences** with EOS for **batching** by source sentence length

Sample Data Pairs

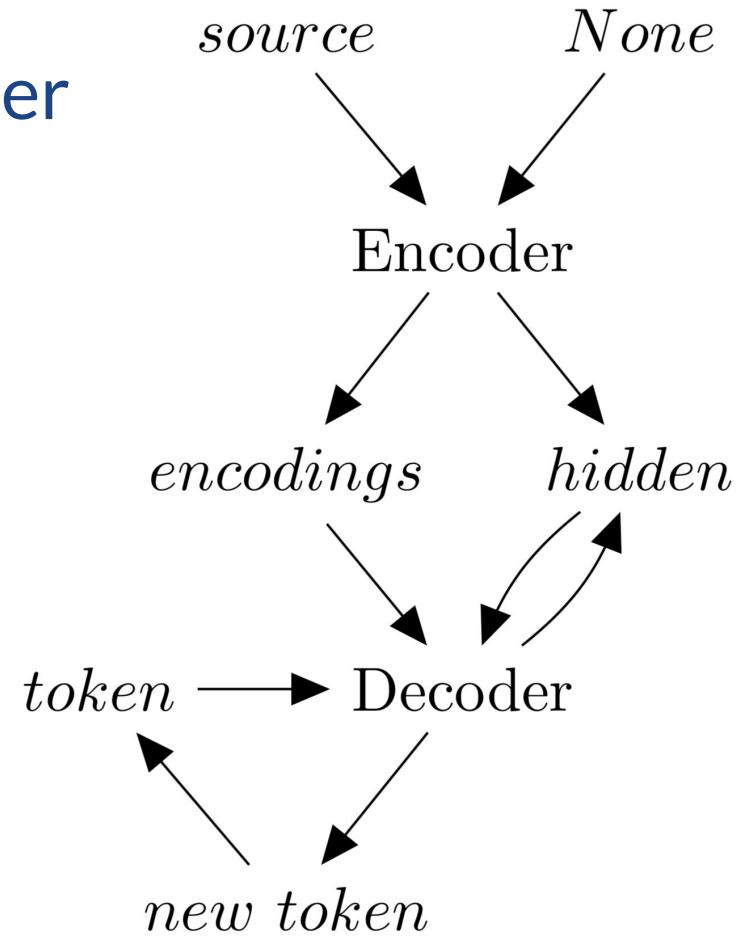
Shakespeare Sentence	Modern Sentence
take me with you , take me with you , wife .	catch me , catch me , wife .
that ’s fouler .	that ’s even more evil .
then weep no more .	so stop crying .
of propn , a n’t please your mastership .	of propn , if it pleases you , sir .
how ill this taper burns !	how badly this candle burns !
the charm ’s wound up .	the charm s going to bring things to a head .
before the time be out ?	before the debt is paid ?

Data Split

Split	Line Count	Percentage
Train	9,069	87.5 %
Dev	1,036	10.0 %
Test	260	2.5 %
TOTAL	**10,365**	**100 %**

Models

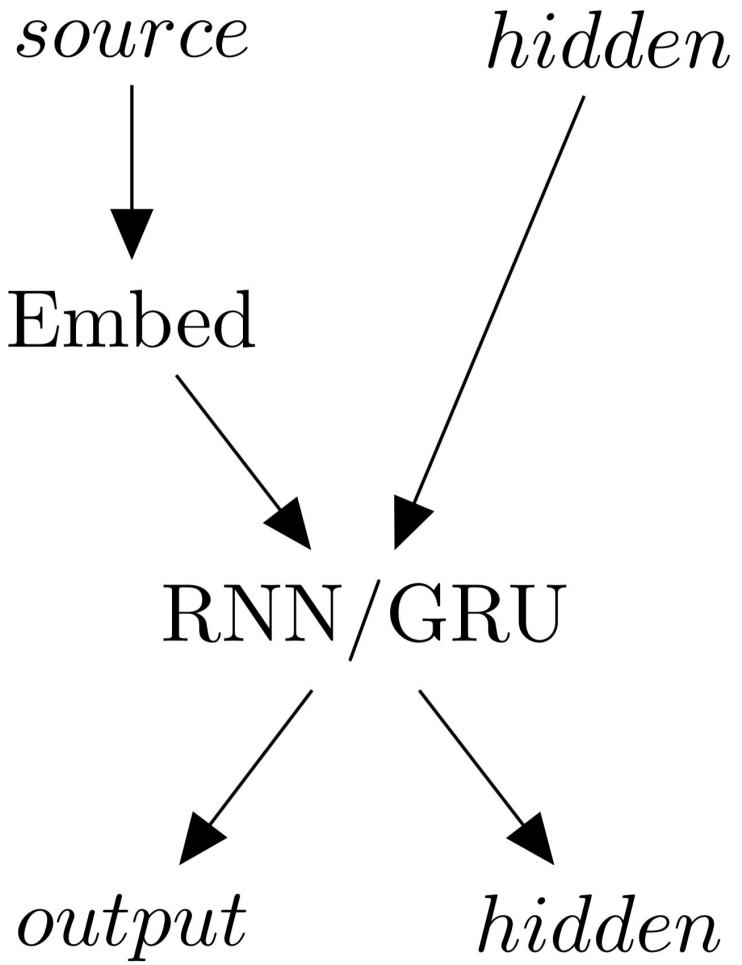
Encoder-Decoder



Encoder

- **Inference Network**

$$\vec{h} = \begin{cases} \mathrm{RNN}(W_e[\vec{x}]) \\ \mathrm{GRU}(W_e[\vec{x}]) \\ \mathrm{BiGRU}(W_e[\vec{x}]) \end{cases}$$

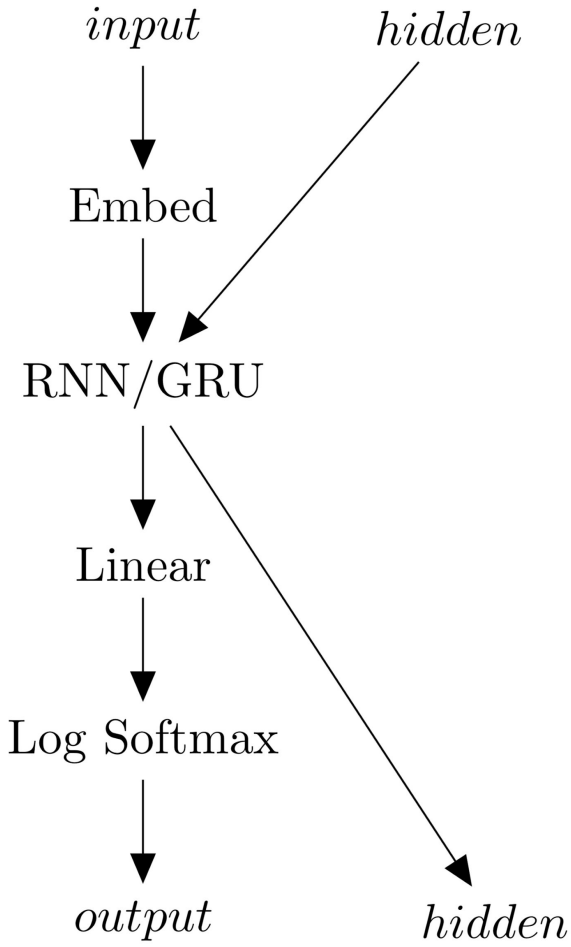


Decoder - Without Attention

- **Generative Network**

$$\mathbf{y} = W_d \cdot \begin{cases} \mathrm{RNN}(\tau_i,\ s_{i-1}) \\ \mathrm{GRU}(\tau_i,\ s_{i-1}) \end{cases}$$

$$\log \sigma(\mathbf{y}) = \log \frac{\exp(y_i)}{\sum_j \exp(y_j)}$$

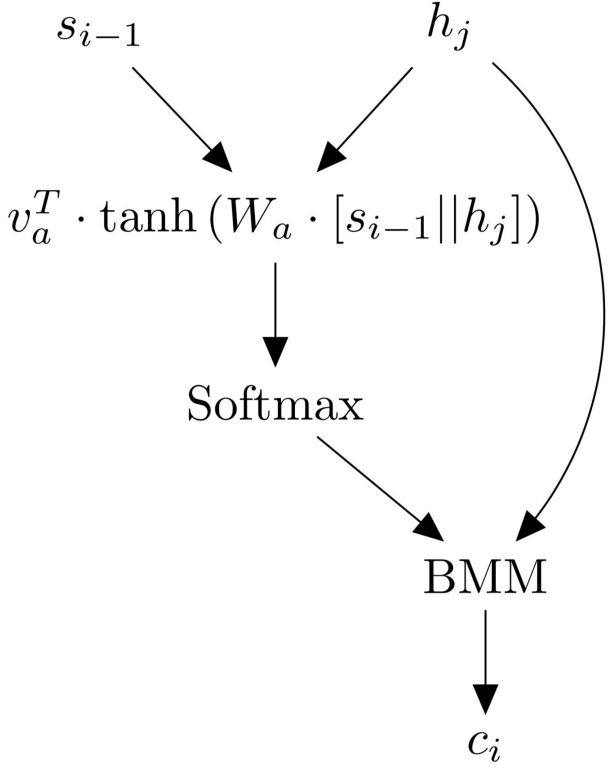


Attention Mechanisms - Concatenation

$$score(s_{i-1}, h_j) = v_a^T \cdot \tanh(W_a \cdot [s_{i-1} \| h_j])$$

$$a(s_{i-1}, h_j) = \frac{\exp(score(s_{i-1}, h_j))}{\sum_{j'} \exp(score(s_{i-1}, h_{j'}))}$$

$$c_i = \sum_{j'} a(s_{i-1}, h_{j'}) \cdot h_{j'}$$

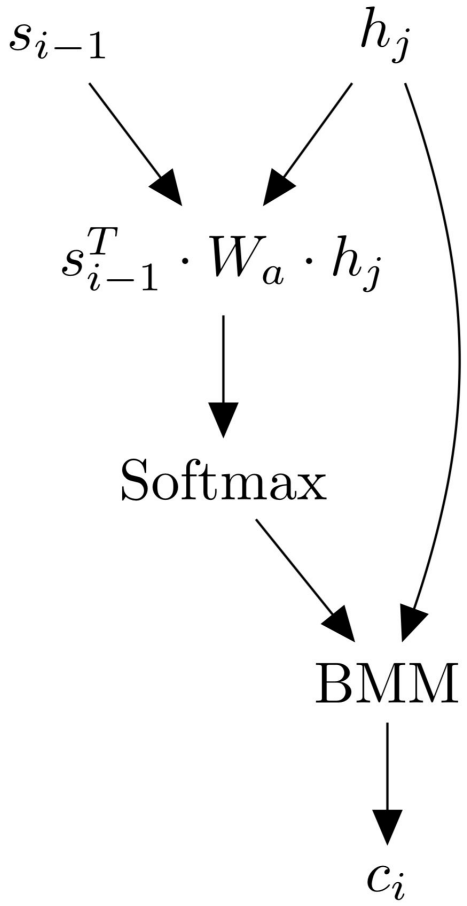


Attention Mechanisms - General

$$score(s_{i-1}, h_j) = s_{i-1}^T \cdot W_a \cdot h_j$$

$$a(s_{i-1}, h_j) = \frac{\exp(score(s_{i-1}, h_j))}{\sum_{j'} \exp(score(s_{i-1}, h_{j'}))}$$

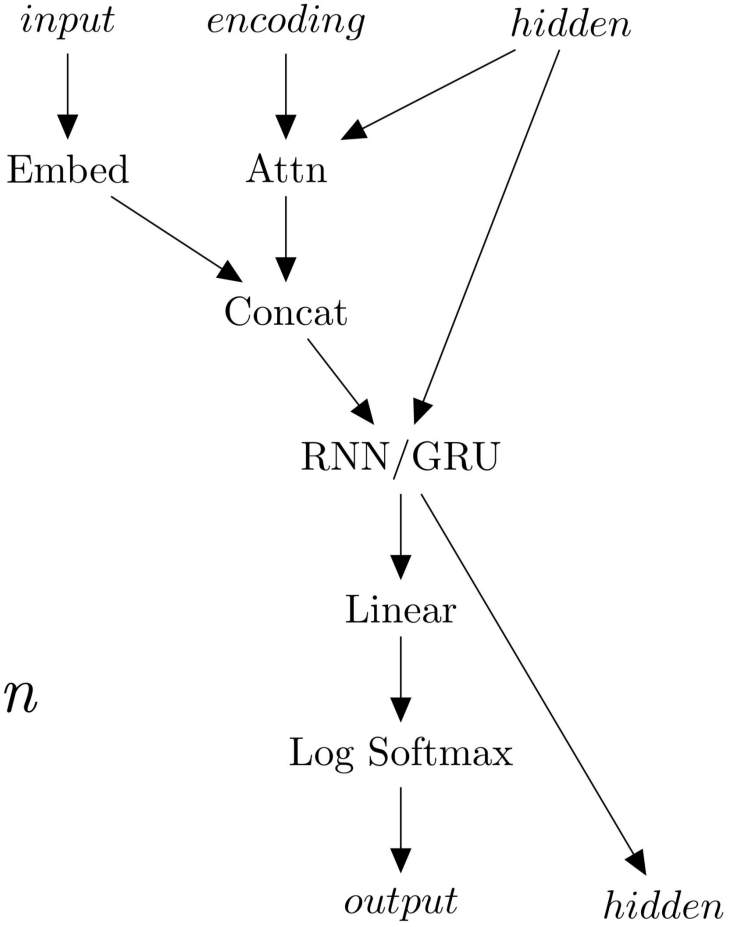
$$c_i = \sum_{j'} a(s_{i-1}, h_{j'}) \cdot h_{j'}$$



Decoder - With Attention

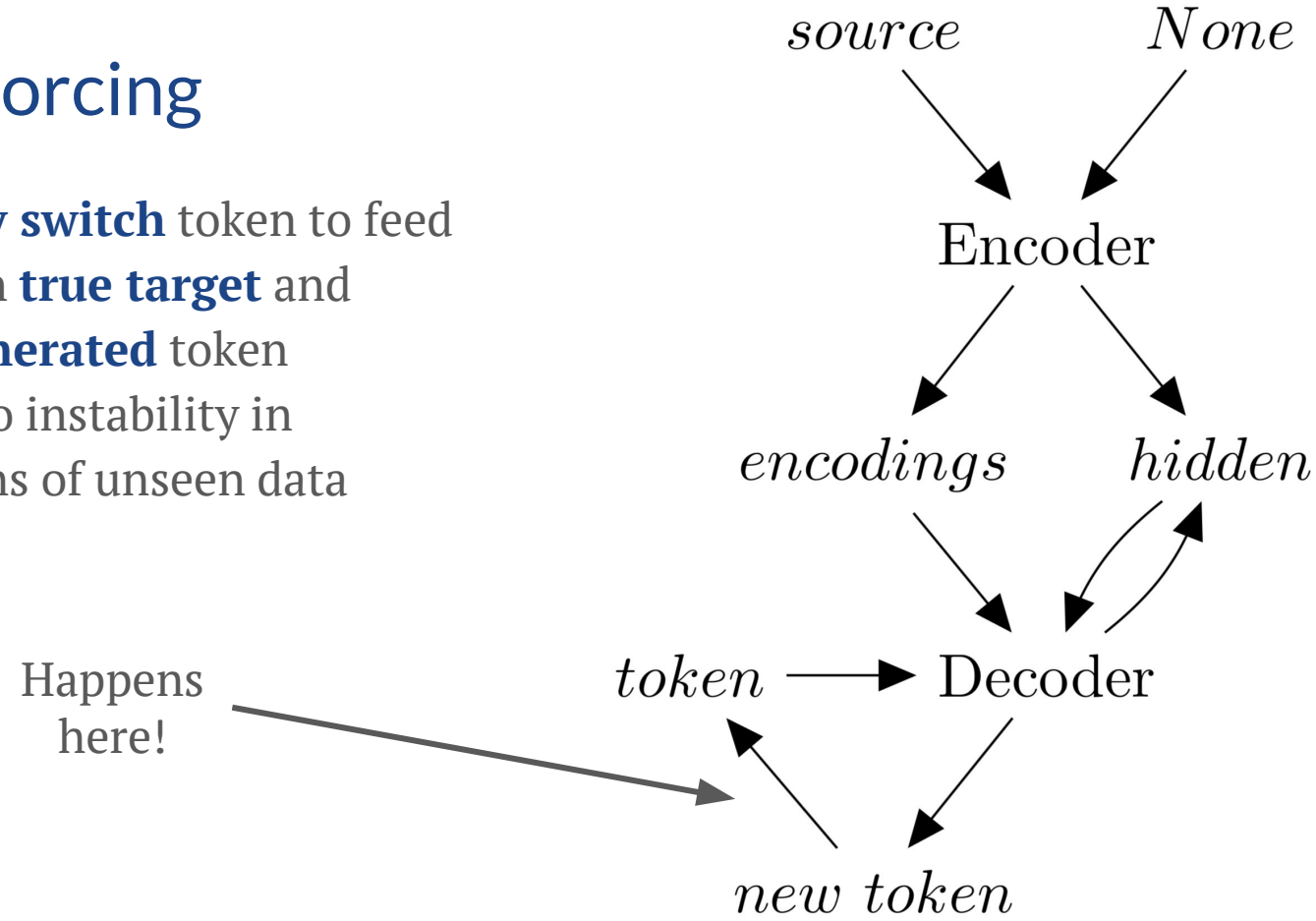
- **Concatenate** the input token embedding with the context vector before the recurrent layer

$$\tau_i = \begin{cases} W_e[t_i] & No\ Attention \\ W_e[t_i] \parallel c_i & With\ Attention \end{cases}$$



Teacher Forcing

- **Randomly switch** token to feed in between **true target** and **model generated** token
- Can lead to instability in translations of unseen data



Results

Experiments

Encoder	Decoder	Attention	Teacher Forcing	Target BLEU
RNN	RNN	-	-	0.0000
GRU	GRU	-	-	0.0238
BiGRU	GRU	-	-	0.0336
BiGRU	GRU	General	-	0.0333
BiGRU	GRU	General	50 %	0.0330
BiGRU	GRU	General	100 %	0.0395
BiGRU	GRU	Concat	-	0.0842
BiGRU	GRU	Concat	50 %	0.1349
BiGRU	GRU	Concat	100 %	0.1042
BiGRU	**GRU**	**Concat**	**100 %**	**0.1450**

Sample Translation 1

Model	Sentence
Source	**Double, double, toil and trouble; fire burn and cauldron bubble.**
RNN	Damned as you are, you have cast the spell, the , (x490)
GRU	Double, double, toil and;; and burn burn burn burn caldron bubble.
BiGRU	Double, double, toil, and;,, burn,, bubble bubble.
BiGRU + General + 100% TF	Double, double, toil and trouble; fire, burn; and caldron, bubble
BiGRU + Concat + 100% TF	Double, double, toil and trouble; fire, burn; and caldron, bubble.
Best Model	**Double, double, toil and trouble; fire, burn; and caldron, bubble.**
Target	**Double, double, toil and trouble; fire, burn; and caldron, bubble.**

Sample Translation 2

Model	Sentence
Source	**Tonight, my lord?**
RNN	What you you,
GRU	How, my lord?
BiGRU	My, my lord?
BiGRU + General + 100% TF	Brother, my lord?
BiGRU + Concat + 100% TF	Tonight, my lord?
Best Model	**Tonight, my lord?**
Target	**Tonight, my lord?**

Sample Translation 3

Model	Sentence
Source	**What say you, propn?**
RNN	What, you,
GRU	What do you, propn propn?
BiGRU	What do you say, propn?
BiGRU + General + 100% TF	What do you say, propn?
BiGRU + Concat + 100% TF	What do you say, propn propn?
Best Model	**What do you say, propn?**
Target	**What do you say, propn?**

Sample Translation 4

Model	Sentence
Source	**Propn thou not see her paddle with the palm of his hand?**
RNN	don’t
GRU	Will n’t storms; his his his the??
BiGRU	Propn n’t with you like the the the the hand hand?
BiGRU + General + 100% TF	Might don’t see the his dying hand, might see about the?
BiGRU + Concat + 100% TF	Don’t you see her for the scripture of his body?
Best Model	**Didn’t go see her close with the same of his hand?**
Target	**Didn’t you see her play with the palm of his hand?**

Sample Translation 5

Model	Sentence
Source	**Some wine, ho?**
RNN	What, ho!
BiGRU	And, ho!
BiGRU + General + 100% TF	Some three, a blessing in like a!
BiGRU + Concat + 50% TF	Let me fight!
BiGRU + Concat + 100% TF	Some whiskey, hello!
Best Model	**Some wine, ho!**
Target	**Some wine, ho!**

Sample Translation 6

Model	Sentence
Source	**Down, strumpet!**
RNN	oh,
GRU	Hey, hey prostitute
BiGRU + General + 100% TF	prostitute!
BiGRU + Concat + 50% TF	Peace, prostitute!
BiGRU + Concat + 100% TF	Down, prostitute!
Best Model	**Down, prostitute!**
Target	**Down, prostitute!**

Sample Translation 7

Model	Sentence
Source	**Let each man render me his bloody hand.**
BiGRU + General	Let me, where where to his..
BiGRU + General + 50% TF	Let me leave his hand away.
BiGRU + Concat	Let give they give me me his hand hand.
BiGRU + Concat + 50% TF	Let the man from give me his honorable.
BiGRU + Concat + 100% TF	Let go get saying any man.
Best Model	**Let me shake his beard hand.**
Target	**Let each man give me his bloody hand.**

Future Work

- **Batch Annealing**
  - **Adaptive batch sizes**, starting small and gradually increasing in size
- **English to Shakespeare Modeling**
  - Reverse training to turn English sentences with a Shakespeare twist
- **Local Attention with Window**
  - Implement local attention to focus model on **local** instead of the **global** context
- **Data Preprocessing**
  - Using more SMT toolkits to perform better preprocessing
  - Using **BPE tokenization** to reduce vocabulary size
  - Sample train/dev/test to **reduce unknown tokens** in test

Questions?

References

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