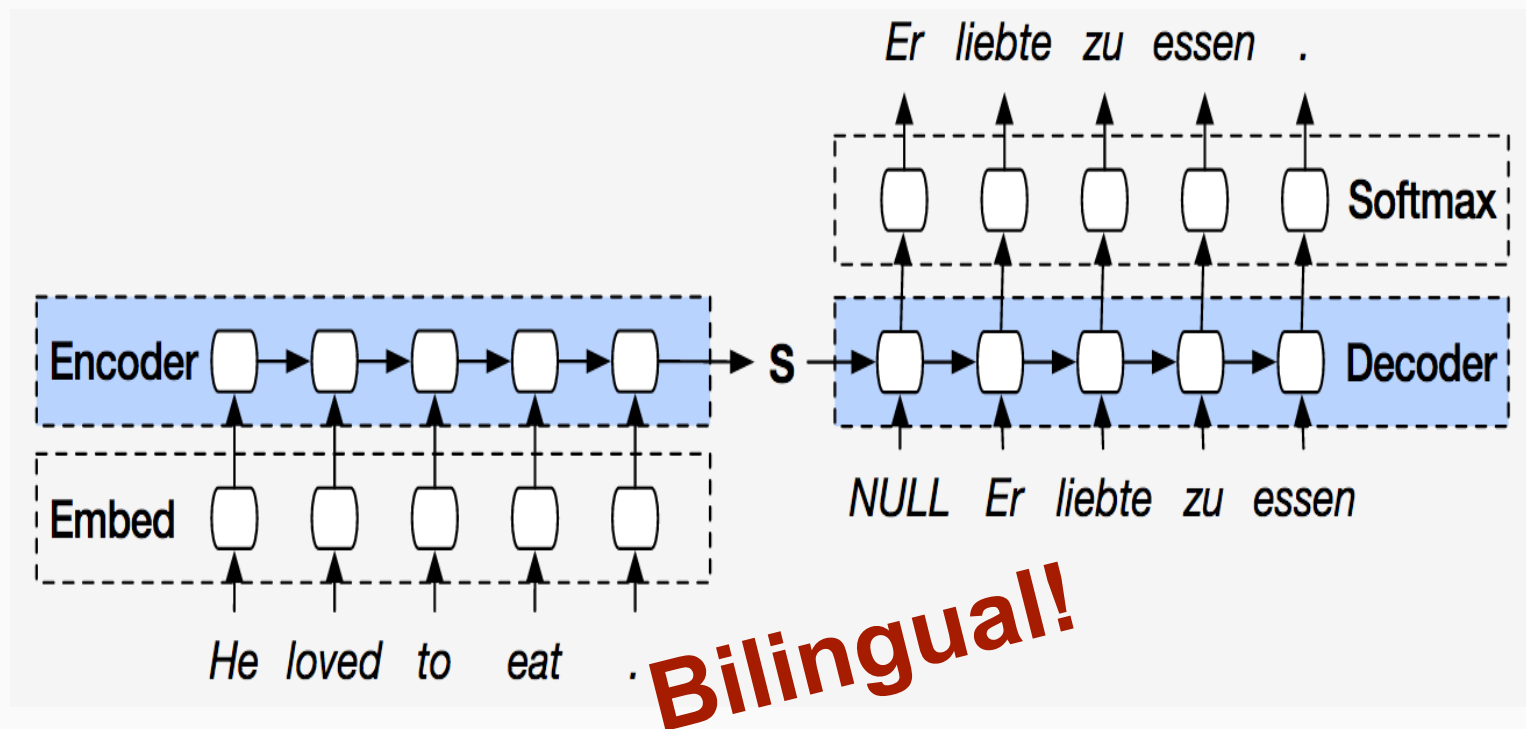


Google's Multilingual Neural Machine Translation System: Enabling Zero-Shot Translation

Melvin Johnson, Mike Schuster, Quoc V. Le, Maxim Krikun, Yonghui Wu, Zhifeng Chen, Nikhil Thorat, Fernanda Viégas, Martin Wattenberg, Greg Corrado, Macduff Hughes, Jeffrey Dean

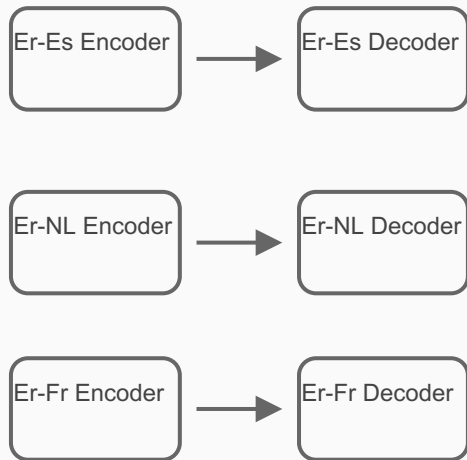
Presented by: Emma Peng

State-of-the-art: Neural Machine Translation (NMT)

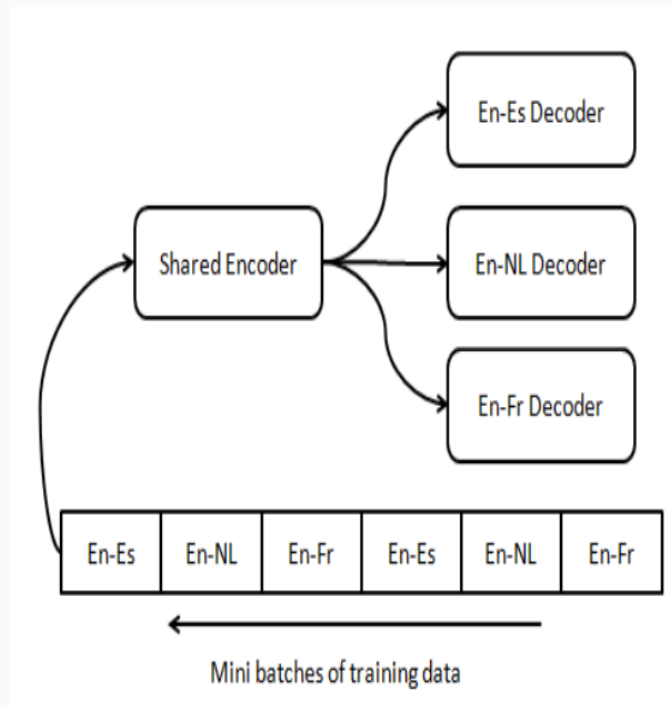


Multilingual NMT? Previously...

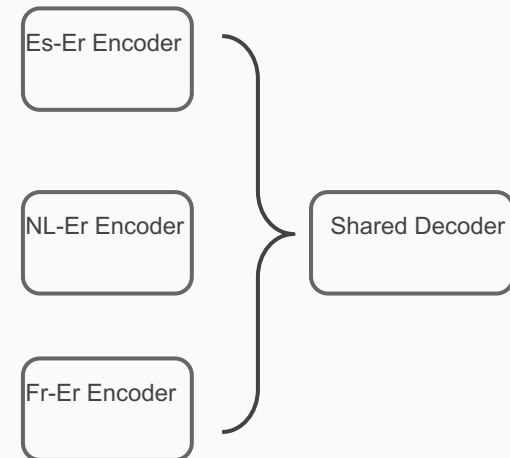
Multiple Encoders → Multiple Decoders [1]



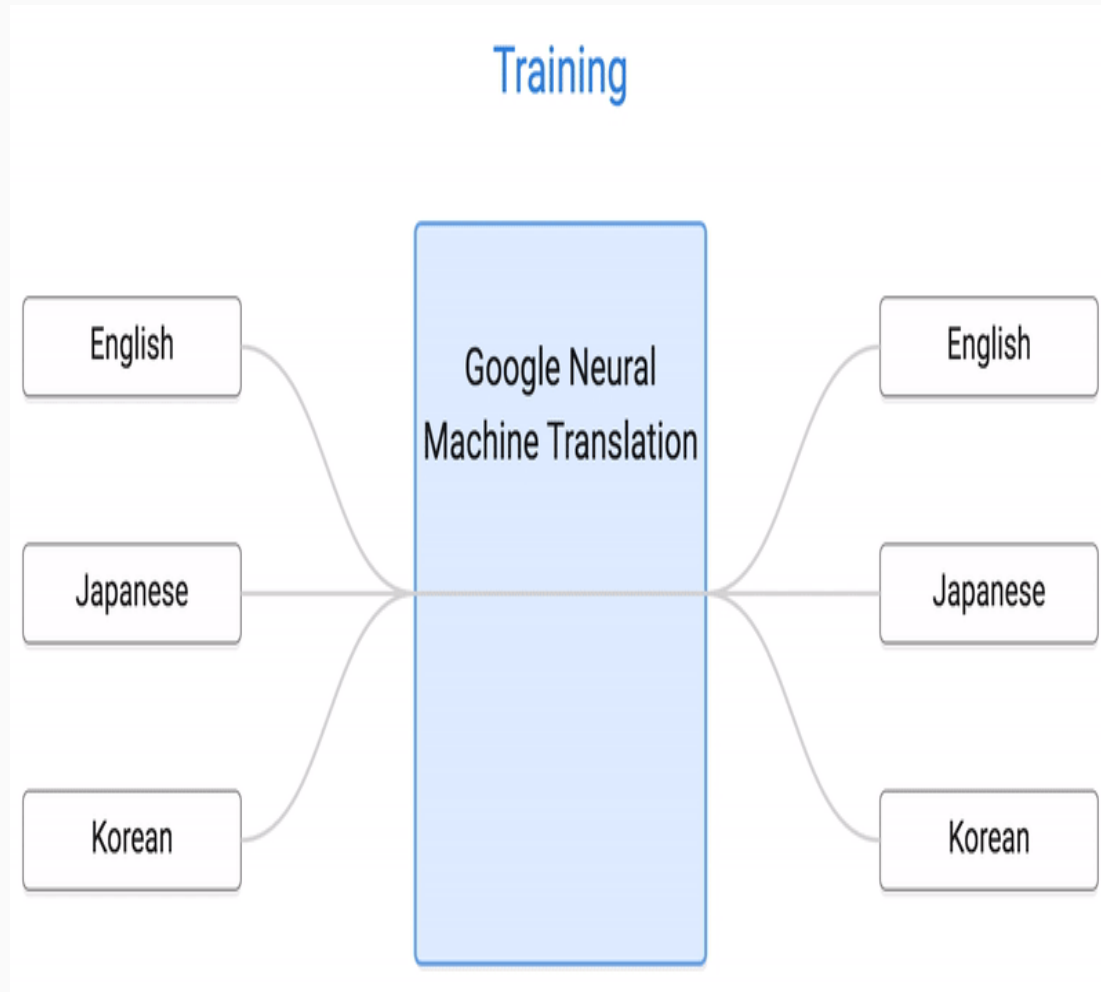
Shared Encoder → Multiple Decoder [2]



Multiple Encoders → Shared Decoder [3]

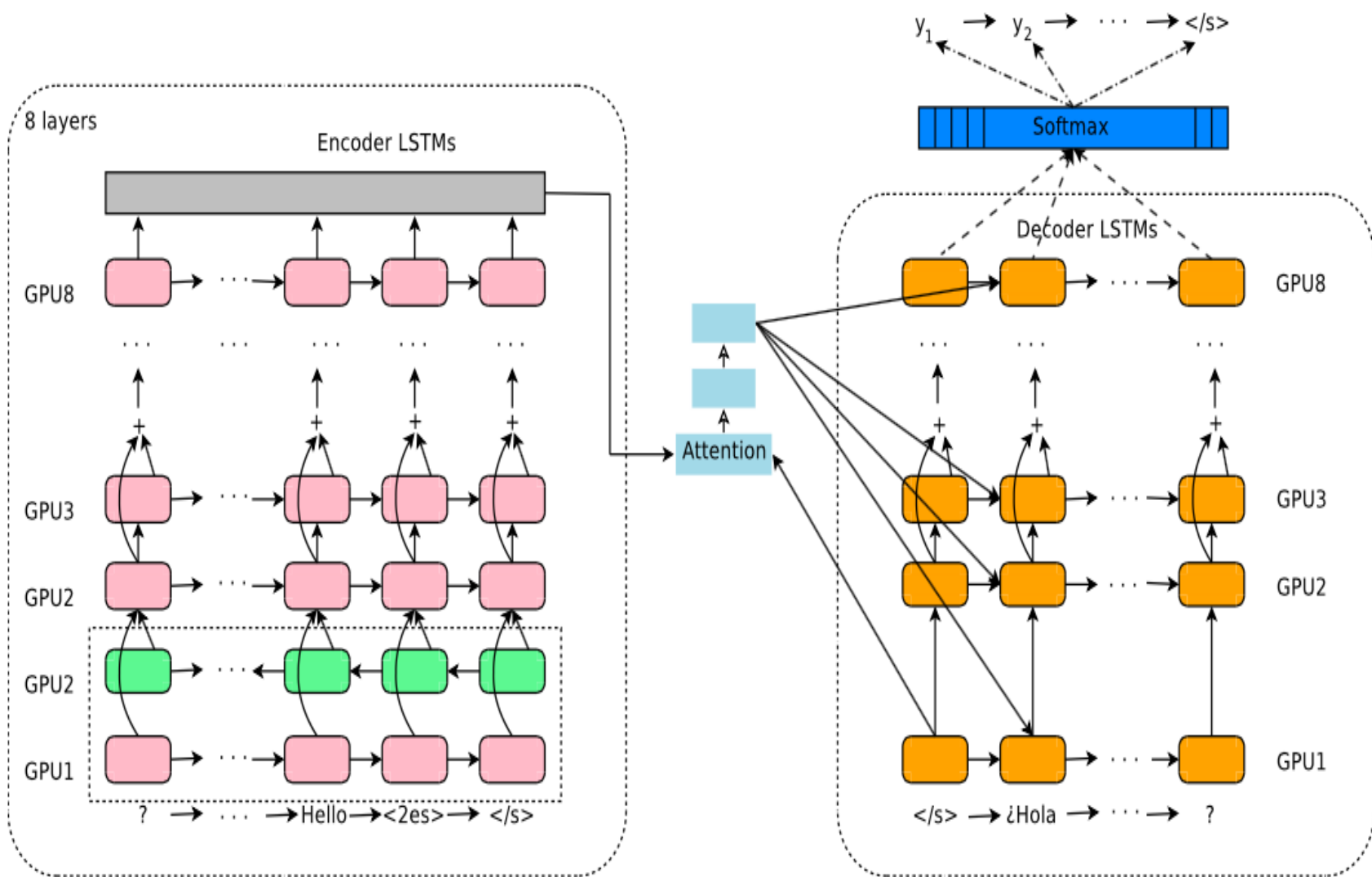


Google's Multilingual NMT System Benefits



- **Simplicity:** single model
- **Low-resource language improvements**
- **Zero-shot translation**

Google's Multilingual NMT System Architecture



Google's Multilingual NMT System Architecture

Artificial token at the beginning of the input sentence to indicate the target language

Hello, how are you? -> ¡Hola como estás?

Add <2es> to indicate that Spanish is the target language



<2es> Hello, how are you? -> ¡Hola como estás?

Google's Multilingual NMT System Experiments

- WMT'14:
 - Comparable performance: English → French
 - State-of-the-art: English → German, French → English
- WMT'15:
 - State-of-the-art: German → English

Google's Multilingual NMT System Zero-Shot Translation

Table 5: Portuguese→Spanish BLEU scores using various models.

	Model	BLEU
(a)	PBMT bridged	28.99
(b)	NMT bridged	30.91
(c)	NMT Pt→Es	31.50
(d)	Model 1 (Pt→En, En→Es)	21.62
(e)	Model 2 (En↔{Es, Pt})	24.75
(f)	Model 2 + incremental training	31.77

- **Train:**
 - Portuguese → English, English → Spanish (Model 1)
 - Or, English ↔ {Portuguese, Spanish} (Model 2)
- **Test:**
 - Portuguese → Spanish **Zero-Shot!**

Thank you!