



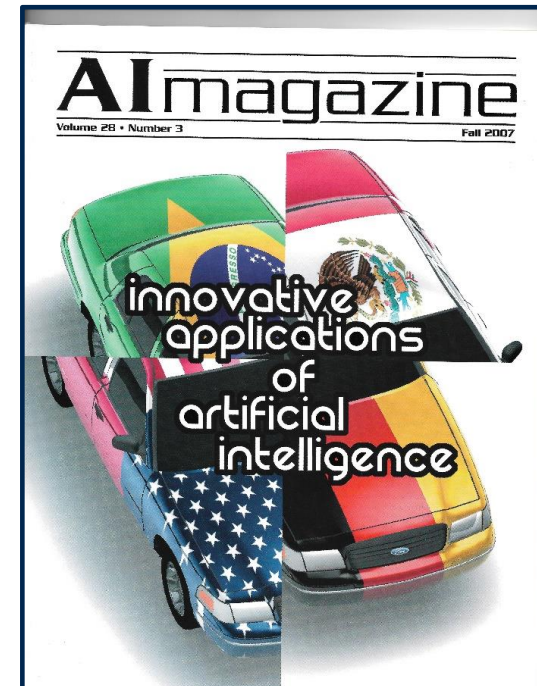
Neural Machine Translation at Ford Motor Company

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Global Data Insight & Analytics
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Background

- **Ford started using MT in 2000 for translation of manufacturing build instructions**
 - **Controlled Language input**
 - **Customization**
 - **Confidentiality**
- **Increased scope of MT:**
 - **Warranty Claims**
 - **Dealer Feedback**
 - **Customer Feedback, etc.**
- **Migrated to statistical/hybrid MT**
- **Started developing NMT in 2018**
- **Deployed NMT in 2019 for 4 languages**



NMT Current Status

- **Deployed in October of 2019**
- **Supports 31 language pairs**
 - **From English to -> German, Spanish, Chinese, Portuguese, French, Italian, Thai, Turkish, Vietnamese, Romanian, Russian**
 - **From German, Spanish, Chinese, Portuguese, French, Italian, Thai, Turkish, Polish, Dutch, Norwegian, Finnish, Swedish, Danish, Vietnamese, Arabic, Tagalog, Hindi, Chinese (Traditional), Romanian to -> English**
- **NMT is a service that is available throughout Ford**
 - **User Interface (www.translate.ford.com)**
 - **High-Speed Table-Driven Batch Translation (Warranty, Customer Feedback)**
 - **Legacy Batch Translation through API (Call Center Feedback, Dealers, Manufacturing/Powertrain)**
- **NMT is trained on a combination of Ford-specific data and general-purpose data and is deployed on Kubernetes and the HPC**



PROPRIETARY

Measuring Translation Accuracy

- **Human Evaluation of Machine Translation**
 - **Bi-Lingual Speakers with Domain Knowledge**
- **Automated Evaluation**
 - **BLEU (Bilingual Evaluation Understudy)**
 - **Widely-used to compare MT models**
 - **Range between 0 to 1 (short phrases skew higher)**
 - **Compares similarity to human-translated text**
- **Issued with BLEU & other metrics**
 - **Shallow understanding of language**
 - **Does not take alternate translations into account**
 - **Does not always correlate to better translation quality**

Survey Q Line	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90	Q91	Q92	Q93	Q94	Q95	Q96	Q97	Q98	Q99	Q100
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90	Q91	Q92	Q93	Q94	Q95	Q96	Q97	Q98	Q99	Q100	
71	3	EVEREST	Other	Con	Some service centers have hands and equipment, including the service centers should be more productive, especially at the first time in the 15,000 km mileage. Oil change and filter are done but when I checked the car before leaving the service center, there appears that the lubricant paint is wrong black. Other times it is normal. There are no scratches on the tires but no scratches on the tires all the time. This is suspicious that caused by lead.	ศูนย์บริการบางแห่งเครื่องมือและอุปกรณ์ รวมทั้งบริการตรวจรับรถใหม่มีประสิทธิภาพมากขึ้น โดยเฉพาะครั้งแรกในระยะเวลา 15,000 กม. ถ้าน้ำมันเครื่องและไส้กรองเปลี่ยนแต่ตรวจดูตอนรถออกจากศูนย์บริการปรากฏว่าสีน้ำมันหล่อลื่นมีสีดำผิดปกติครั้งอื่นๆ เป็นปกติ จากการสังเกตยางล้อและสกรูหัววงล้อไม่มีรอยขูดขีดหรือรอยขีดข่วน แต่เสียด้านหัววงล้อแล้ว ทัศนียภาพคล้ายกับที่เคยเห็นมาโดยตลอด	70	For some service center, tools and equipment as well as service should be improve to be more efficiently. Especially the first time for 15,000 km check up. Oil and filter change but when checked the car before leaving the service center, I noticed that the color of the oil is darker than normal. Other time is was normal. For wheel balancing, there is no change in the wheel weight position but was charged for wheel balance. This has always been my suspicion	F8																																																																																											
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Assessment #4				Assessment #3				Assessment #2			
Accuracy	Total	Accuracy %	B/(W)	Accuracy	Total	Accuracy %	B/(W)	Accuracy	Original	New	B/(W)
ok	543	64%	4%	ok	281	60%	11%	ok	30%	49%	19%
90	99	12%	0%	90	56	12%	-4%	90	11%	16%	4%
80	73	9%	-2%	80	49	10%	-9%	80	12%	20%	7%
70	44	5%	0%	70	23	5%	1%	70	17%	4%	-14%
60	5	1%	0%	60	4	1%	1%	60	8%	0%	-8%
50	47	6%	-2%	50	34	7%	2%	50	16%	5%	-10%
30	10	1%	0%	30	4	1%					
20				20	1	0%		30/20	3%	5%	2%
ng	32	4%	1%	ng	14	3%		NG	2%	2%	0%
			-1%	n/a	5	1%					
Grand Total	853			Grand Total	471			Grand Total	1		
Acceptable		75%	4%	Acceptable		72%	7%	Acceptable	41%	64%	23%

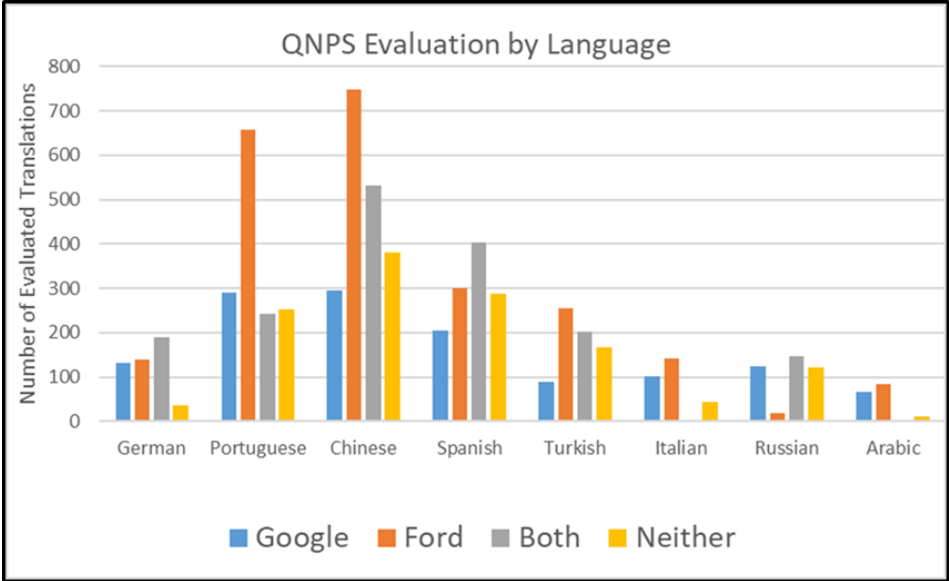
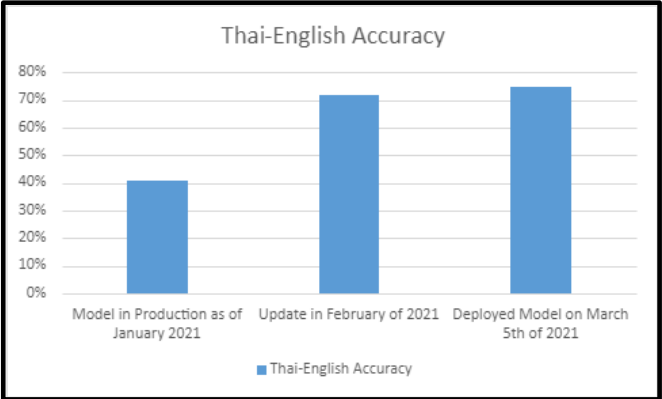
Human Evaluation and Feedback



PROPRIETARY

NMT Accuracy

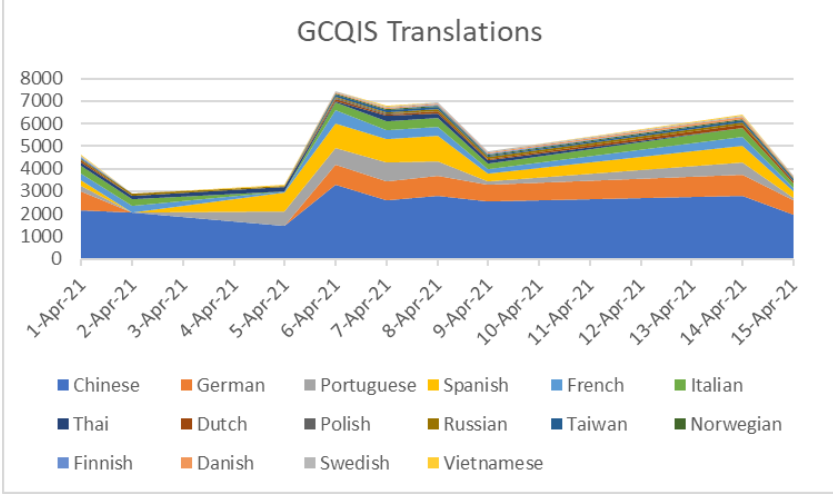
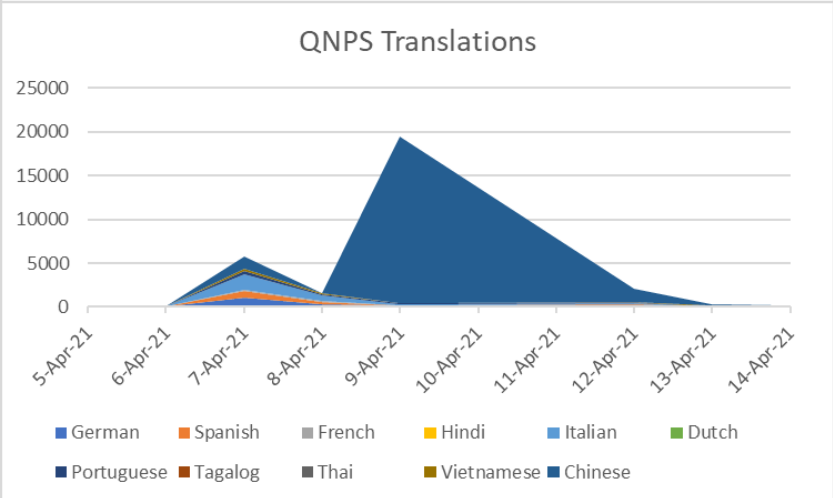
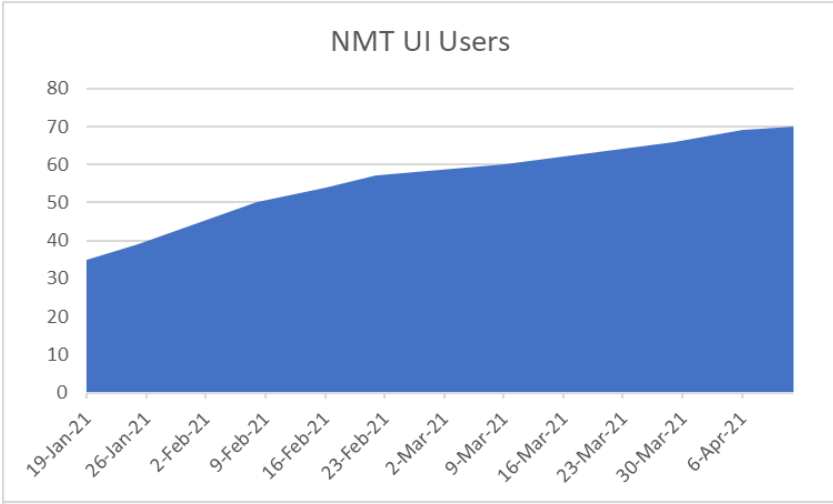
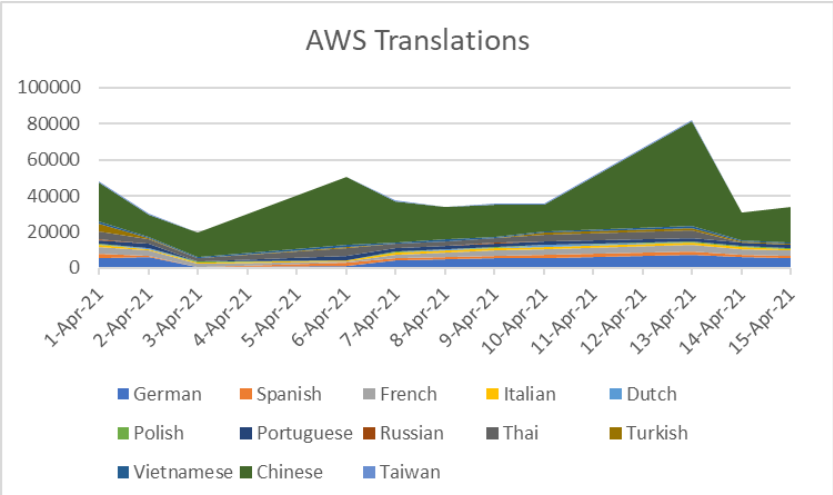
- BLEU Scores – automated industry standard
- Manual human evaluation



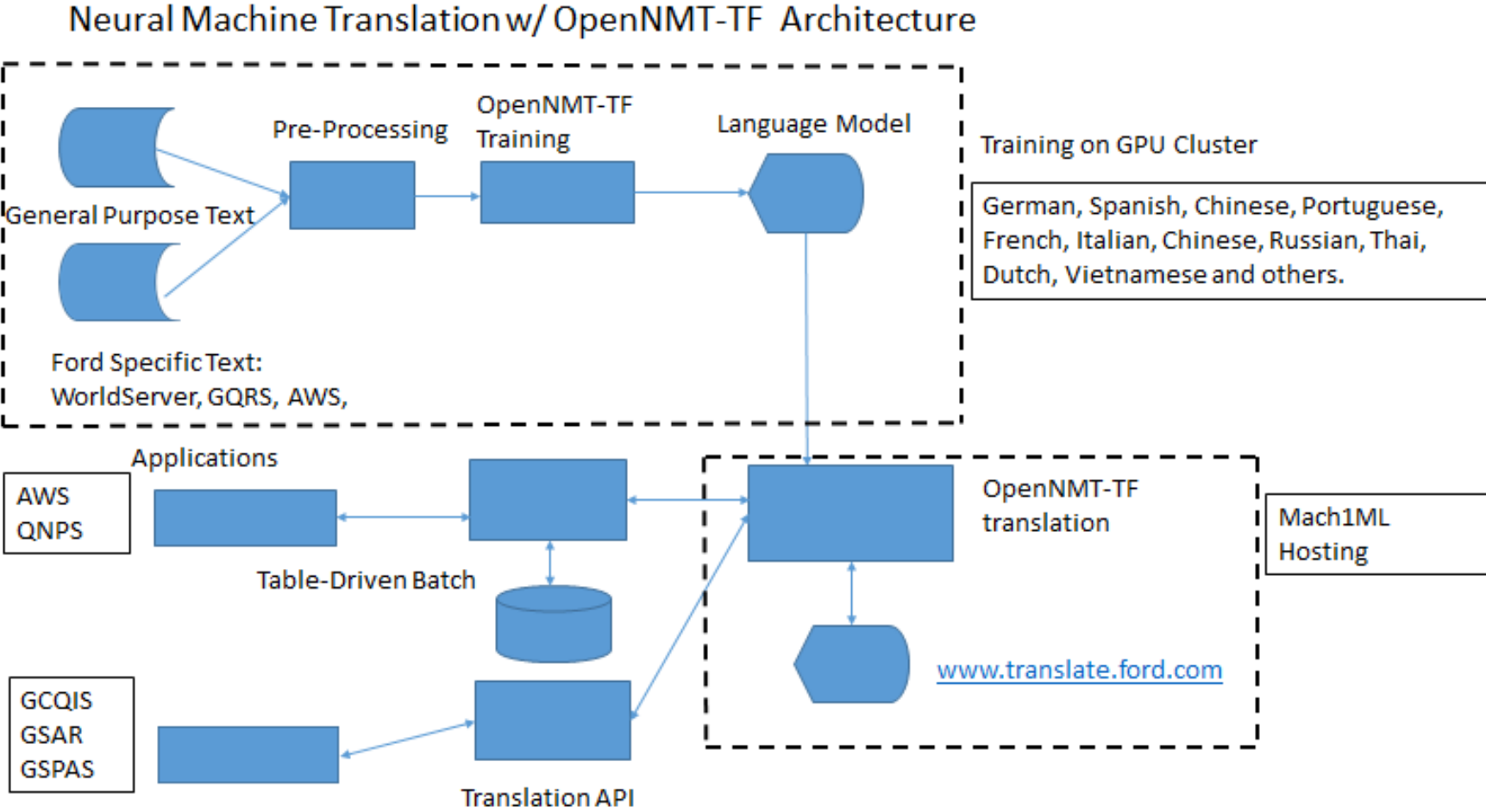
Compared our results vs. Google Translate on Ford internal QNPS (Quality Net Promoter Score) (2020)

Customer Feedback	Acceptable	Not Acceptable	PCT Correct
Chinese Feedback - Sep 2020	2484	386	86.55%
Thai Feedback - October 2020	2304	286	88.96%

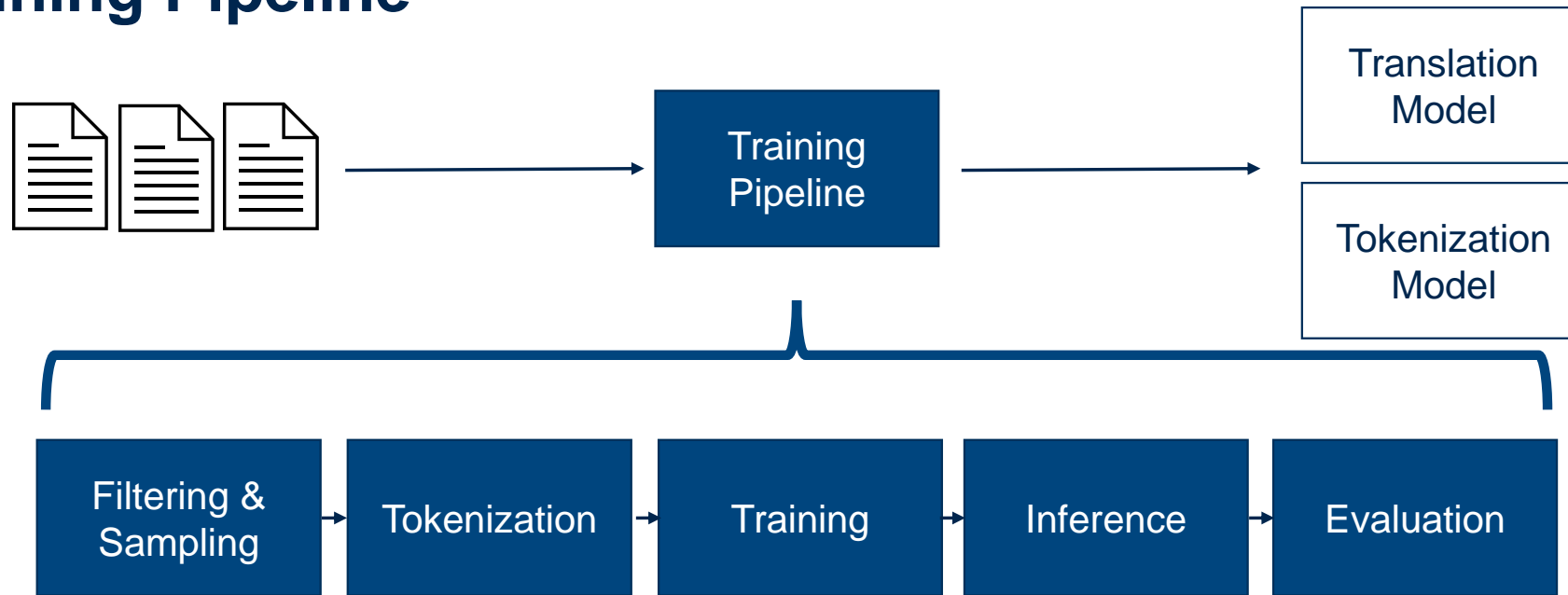
NMT Usage



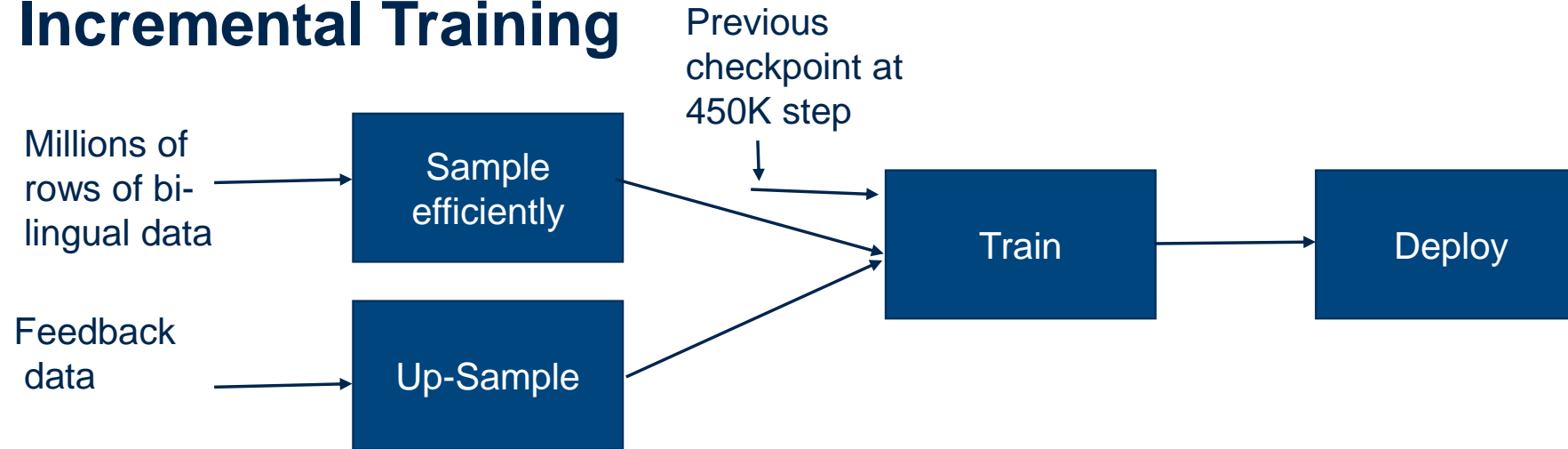
NMT Architecture



Training Pipeline



Incremental Training



- Incremental training takes < 5000 steps i.e. 2-3 hrs on a single V100 GPU
- Even after searching through various sampling strategies and learning rates, model is available for deployment in a day.

Q&A

Thank
you!