

NuclearN

We develop and distribute
Nuclear-Ready AI software

<https://nuclearn.ai>

*Roses are red
violets are blue,*

the remainder of this poem was generated with Nuclear AI,
and it has been sent to the NRC for review.

Applicability of large language models in Nuclear



Previously started Palo Verde's
Data Science Team in 2017

Prior Work at Palo Verde:

Auto PO&C Labeling, Equipment
Anomaly Detection, DIANA
Network Analysis, CAP
AutoScreening, Supply Chain
Forecasting & Optimization

Recipients of 2020 Nuclear
Energy Institute's Top Innovative
Practice Award for *Process
Automation using Machine
Learning*



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B.S. Business Economics

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10 years in Utility Data Science
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B.S. Materials Science &
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6 years Nuclear Engineering &
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What are Large Language Models?

Specialized neural networks for modeling general natural language trained on HUGE amounts of data

Broad (English), domain specific (Medical) or task specific (Q&A)

Single model can answer questions, generate novel passages, classify text, perform translations, summarize content

Token sequence

$$p(t_1, t_2, \dots, t_N) = \prod_{k=1}^N p(t_k | t_1, t_2, \dots, t_{k-1})$$

Sequence probability Conditional probabilities



Approximate volumetric difference
proportional to learning capacity
difference from traditional
machine learning techniques

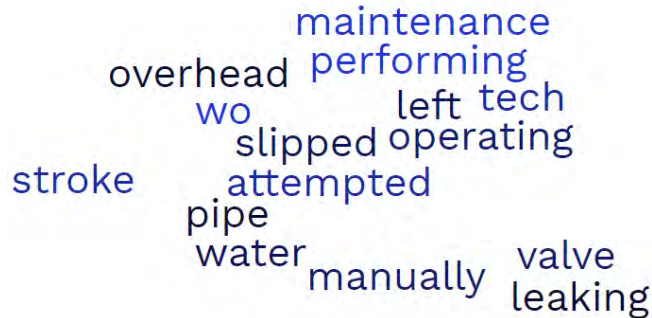
Revolution in Natural Language Approaches

Move data pipeline complexity and feature engineering into the language model

Old School

- Manually clean text to reduce number of extraneous words and identify “phrases” and “keywords” that matter
- Train Naive Bayes/Boosted Tree/Simple Neural Network on features
- Accuracy is lower than humans

stroke
overhead
pipe
water
manually
valve
leaking
stroke
attempted
slipped
operating
left
tech
performing
maintenance
wo



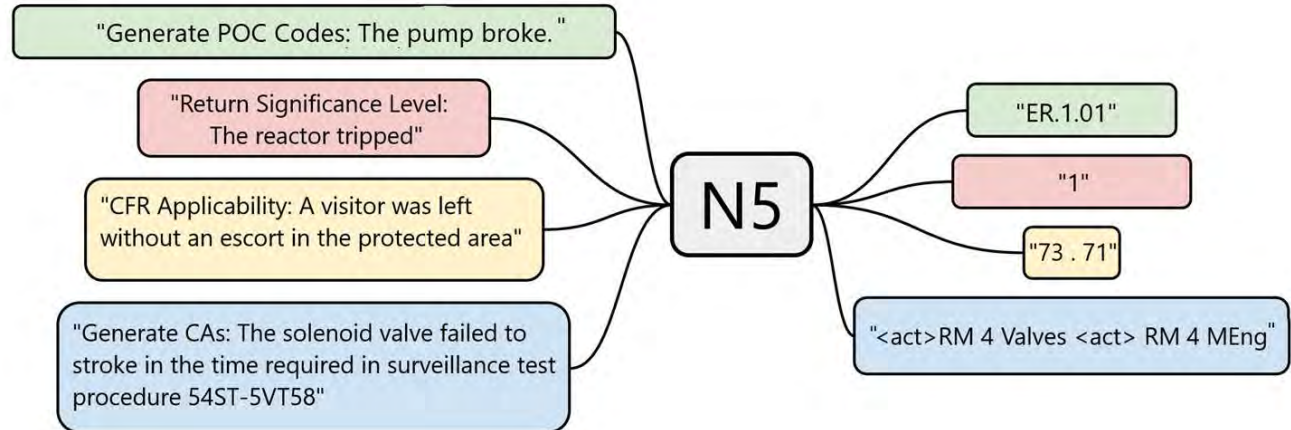
Large Language Model Era

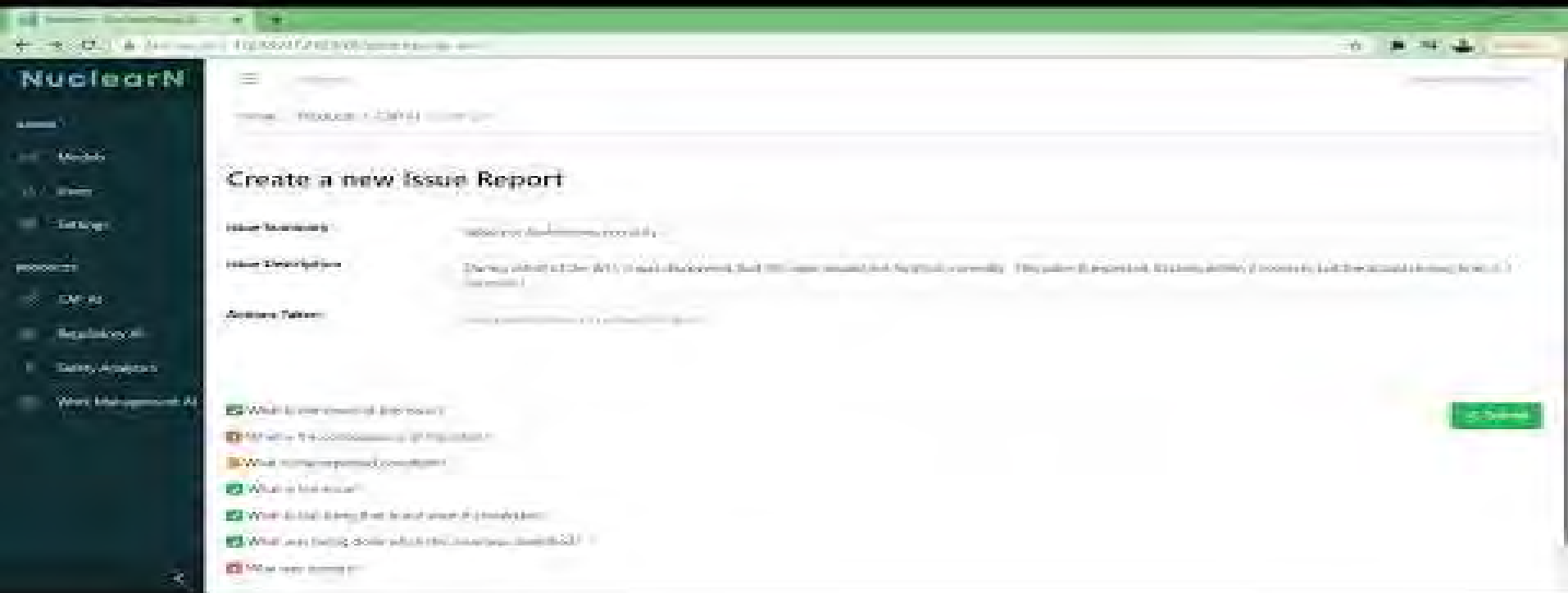
- Pre-trained models can perform many tasks without any additional training
- Models can be “fine-tuned” to specific problems to achieve superior performance
- Models “read” an entire passage, and use the entire context to “understand” the natural language
- 4.3x reduction in number of errors¹

After performing WO 1234567, maintenance tech attempted to stroke the valve. While manually operating the valve, the tech slipped on water left from a leaking overhead pipe.

What can we do with these models?

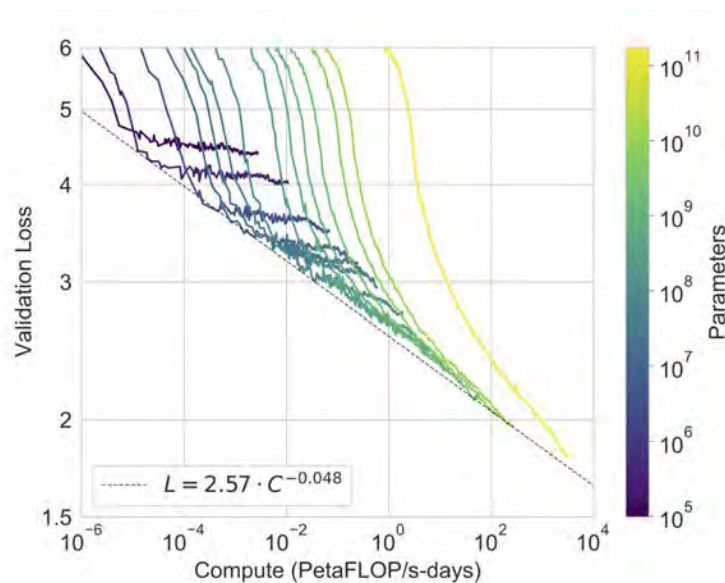
- More accurately auto-screen a higher proportion of issues utilizing improved classification abilities
- Improve the quality of reports using intelligent autocomplete with Nuclear-specific terms and phrases
- Evaluate whether an issue report contains sufficient information as it is being written





Large Language Models are still improving.

- Next generation predicted to be 200x size of current generation
- Models will achieve superhuman performance on a broad range of natural language and general AI tasks
- Services such as Github Copilot already leverage advanced auto-complete functionality for millions of users
- Gartner predicts that by 2025 generative AI will account for 10% of all data produced worldwide



For the first time in the history of Machine Learning, there is no evidence of decreasing returns from increasing model size. The only limiting factor is compute resources.

Future Use Cases and Research



- Intelligent auto-completion of procedures and work instructions, including generation of entire work steps
- “Query” large Nuclear texts for answers (e.g. FSAR, design documents, etc.)
- Chatbots for creating Issue Reports, Work Orders, Scheduling
- Automatic summarization of site schedules and daily issues
- We plan to release a Nuclear-specific Large Language Model in the future

Large Language Models are used in Nuclearn platform and products

- CAP Screening Automation
- Automated Trend Coding
- CAP Trending Dashboard
- 10CFR50 Section Applicability

Nuclearn CAP AI

The CAP AI module helps you automate many incident tagging and screening tasks, enabling you to automate significant portions of your CAP processes.

- Automated Trend Coding
- CAP Screening Automation
- CAP Trending Dashboard

CAP SYSTEM

Safety Category	Output	Confidence	Est Accuracy	Enabled
A	100%	100%	100%	<input type="checkbox"/>
B	100%	100%	100%	<input type="checkbox"/>
C	100%	100%	100%	<input type="checkbox"/>
D	100%	100%	100%	<input type="checkbox"/>

Manual Sample Rate

Manual Sample Rate: 10%

Not Automated - Manual Sample	Stat	Result
Stat	100%	100%
Stat % Not Automated	0%	0%

Automated

Stat	Result
Est. Automated %	88.4%
Est. Automated Accuracy	88.4%

Type of records automated:

Resolution Category	Significance Level	Proportion Of Risk	Estimated Accuracy	Observed Accuracy
D	4	35.5%	100.0%	99.0%
D	3	2.9%	84.2%	97.5%
C	2	0.1%	0.0%	0.0%

Effort Level

Output	Confidence	Est Accuracy	Enabled
1	100%	100%	<input type="checkbox"/>
2	100%	100%	<input type="checkbox"/>
3	100%	88.8%	<input type="checkbox"/>
4	100%	88.8%	<input type="checkbox"/>

Not Automated

Stat	Result
Est. Not Automated %	22.4%

Type of records not automated:

Resolution Category	Significance Level	Proportion Of Risk	Estimated Accuracy	Observed Accuracy
A	4	87.2%	0.0%	0.0%
B	3	23.6%	0.0%	0.0%
C	2	23.6%	0.0%	0.0%
D	1	0.1%	0.0%	0.0%

Type or copy below a text-snippet you would like to receive predictions for:

During performance of 51-012222, auxiliary freshwater pump B failed to trip on overspeed signal.

[Pinpoint Now](#)

Results:

POC	Confidence
ER-1.01	88.02%
WM-1.28	67.34%
OP-1.05	61.27%
BR-1.05	87.11%

Questions?

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