Semi-automated Estimation of Reliability Measures from Maintenance Work Order Records

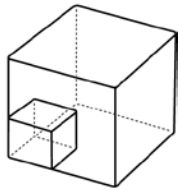
Tyler Bikaun, PhD Candidate (UWA)

TLP Community of Interest Workshop, 2021 Model-Based Enterprise Summit, NIST, April 12 - 16, 2021

Motivation

Industry Challenges

Slow and Tedious



Not Scalable

Not Reproducible

Tacit Knowledge

Lacks Standardisation

Our Challenge

Acquiring reliability measures for assets is crucial for maintenance strategy validation and optimisation

Data Science Transforming Maintenance

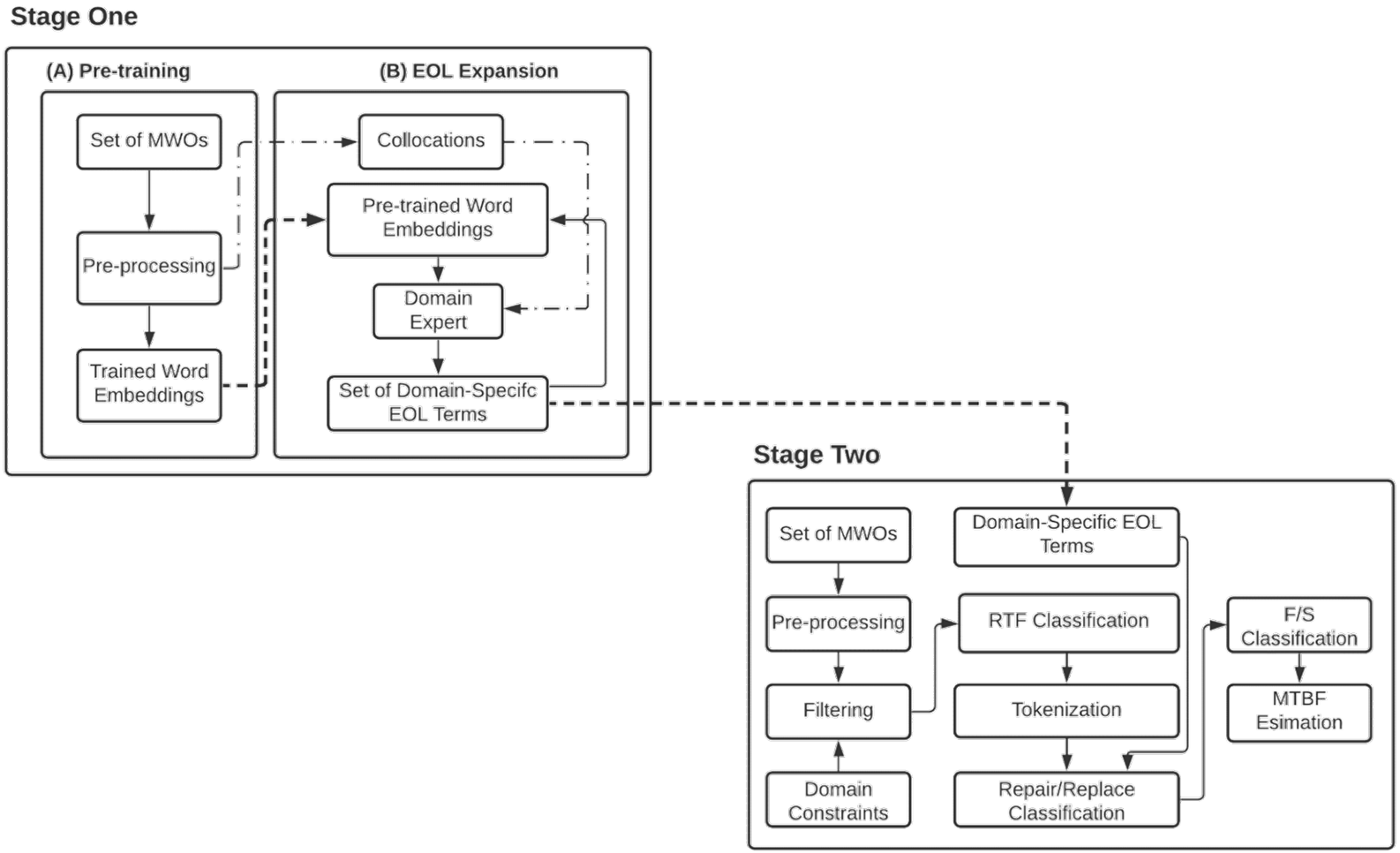
Context and Datasets

We use **technical language processing** to emulate a prototypical reliability engineer and **assess the impacts decisions** made when processing records have on resulting **reliability measures**

Plant	A	B
Asset Type	Pump	Pump
MWOs	14,508	89,259
Mean Tokens	5.5	8.0

Work Order Descriptions	
H2G-33 damaged seal	48 DAY THROAT BUSH ROTATION and internal inspection to assess remaining life
SCE Pump Seized K2G36A	Change out motor
H11 Drive belts snapped	Please change out Electrical motor on #1 sump as it has been submerged in liquor
H11 High vibration, realign unit D2G62B	TIS Vacuum and clear scale from #1 Horizontal sump pit and discharge line . Pit is currently blocked and causing flooding.

Pipeline and Scenario Modelling



Scenarios

- **S1** Gazetteer with single EOL[1] term
- **S2** Expanded EOL gazetteer
- **S3** Expanded EOL gazetteer and structured fields

[1] *EOL refers to end-of-life*

Pipeline Results – Overall

	Plant A	Plant B
Assets	903	3079
Samples	3112	35170
Failures	1874	6746
Suspensions	14	2850
Eligible Assets[1]	93	669
Compute Time	22s	91s
F1 Score	79.3%	54.3%

Evaluation

Human evaluation of classifications on 20 assets sampled i.i.d from each data set

Performance

Minimal SME resources required and only minutes to compute

[1]*All experiments performed with $2000 or 8 hour threshold, and each asset required at least 5 pieces of evidence for MTBF estimation.*

Data Science Transforming Maintenance

Pipeline Results –Scenario Modelling

Scenario	Asset[2]	MWOs	MTBF (days)	Asset[2]	MWOs	MTBF (days)
S1		**58T/15F/0S**	**184.8**		134T/0F/23S	-
S2	**A1**	**58T/29F/0S**	**97.1**	B1	134T/0F/23S	-
S3		**20T/9F/0S**	**226.2**		115T/9F/16S	185.6
S1		90T/17F/0S	181.9		-	-
S2	A2	90T/30T/0S	101.9	B2	10T/7F/0S	318.8
S3		40T/14F/0S	209.9		15T/6F/2S	334.1
S1		31T/11F/0S	244.3		-	-
S2	A3	31T.15F/0S	191.7	B3	137T/1F/16S	-
S3		10T/7F/0S	408.5		114T/5F/11S	301.4

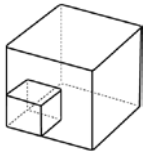
[1]All experiments performed with $2000 or 8 hour threshold, and each asset required at least 5 pieces of evidence for MTBF estimation.

[2]A1 – centrifugal pump, A2 – piston pump, A3 – peristaltic pump, B1 – Warman 8/6 FAH, B2 – Worthington 10LR15A, B3 – Warman 10/6 FM

Discussion

Fast

*Less than **10 min end-to-end time** for pipeline construction, validation and application*



Scalable

*Process 1,000s of assets with 10,000s of records in minutes **without significant SME resources***

Reproducible[1]

***Transparent** pipeline construction and application with configurable parameterisation*

Standardised

***Consistent** adherence to industry standard statistical life time estimation*

Code will be available at: https://code-ittc.csiro.au/tyler.bikaun/mtbf_from_mwo

Caveats, Limitations and Future Work

Caveats and Limitations

- Need structured fortuitous data fields and expert rules to reason about EOL events
- Currently only applicable to individual assets not sub-systems/systems

Future Work

- Increase applicability to systems/sub-systems
- Improved reasoning over unstructured data fields
- Further reduce SME resource requirements

Thank You

This research is funded by the ARC Training Centre for Transforming Maintenance through Data Science and the Mineral Research Institute of Western Australia

Data Science Transforming Maintenance

For More Information:

ARC Training Centre for Transforming Maintenance through Data Science

Email | tyler.bikaun@research.uwa.edu.au
Web | http:www.maintenance.org.au

All Icons in this presentation were source from Noun Project: Expand (*IconMark*), Speed (*sandiindra, Adrien Coquet*), Recycle (*emka angelina*), Expert (*Becris*), Standard (*Justin Blake, US*), AI (*Waleed Elagamy, EG*)