

Applicability of Artificial Neural Networks (ANN) for equilibrium state prediction in tunnel excavation

Alec Tristani, Lina-María Guayacán-Carrillo, Jean Sulem, Sebastián-Ariel Donzis

Laboratoire Navier/CERMES, Ecole des Ponts ParisTech, Université Gustave Eiffel, CNRS, 77455 Marne la Vallée, France





The use of AI an its possible contribution to tunnel design:

- Efforts are needed to improve the robustness of numerical models
- The development of new analysis methods is required
- Optimizing tunnel design



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Examples: convergences



Convergences at St Martin Laporte – Matthieu, 2008





Stress and displacement predictions

- → Predict short and long term
- Develop a tool based on machine learning
- Synthetic dataset
- Application to real cases studies
 - \rightarrow Reduce computation time



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Tunnel modeling



Axisymmetric numerical model







Ground : Mohr-Coulomb elastic perfectly plastic. Support : linear elastic.



Synthetic dataset

5 inputs :



Reference : De La Fuente et al. Rock Mech and Rock Eng 52, nº 7 (1 juillet 2019): 2361-76. https://doi.org/10.1007/s00603-018-1694-8.





Synthetic dataset

R^*	E^*	φ	ψ	Ν
10, 12.5, 15	0.05, 0.025, 0.5, 0.75, 1	20°, 25°, 30°, 35°	0°, φ/3, φ	1, 2, 5, 10

Reference : De La Fuente et al. *Rock Mech and Rock Eng* 52, nº 7 (1 juillet 2019): 2361-76. <u>https://doi.org/10.1007/s00603-018-1694-8</u>.





Bias-variance tradeoff







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Bagging





Reference : Breiman, L. Bagging predictors. Mach Learn 24, 123–140 (1996). https://doi.org/10.1007/BF00058655



Results







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Results







Conclusions

- ML tool is running faster than 3D numerical modeling
- Works only within the range defined during training
- Accurate predictions are obtained with few data points
- Bias and variance are reduced when using bagging
- A practicle tool for engineers usable in the field



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Deep tunnels – Artificial intelligence – Numerical modeling – Ground-support interaction – Excavation method

Thank you for your attention!



