

Learning to drive

A geologist's guide to machine learning



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Maptek DomainMCF

Machine learning assisted domain modelling



Changing the way mining is done forever



Dictionary

Definitions from Oxford Languages · Learn more



noun

the use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyse and draw <u>inferences</u> from patterns in data.

"the application of machine learning to biological databases has increased"

Machine learning for Geology?

Is it applicable to generating models?

Learn and adapt without following explicit instructions.

Draw inferences from patterns in data.

▲ Black box?

▲ Loss of geological control?



Machine learning for Geology?

Is it applicable to generating models?

Learn and adapt without following explicit instructions.

Draw inferences from patterns in data.

Open box!

✓ Lots of geological control!



Machine learned geology models are amazing!

They excel where:

- > Data is rich.
- > Complexity is represented in data.
- > Time is poor.
- > Bias is unwanted.



What if we don't have all of that?

How do we control things when:

- > Data quantity is poor?
- > Complexity is not shown in the data?
- > We want the best model?
- > We want control?



Throw it all in the box and see?



Throw it all in the box and see?





Pack up and try something else?



Step back and reassess

Have we given the machine all our data?

- > Regional geology?
- > Related lithology?
- > Relationships within the domains?
- > and between our chosen domains?



Doesn't this sound like explicit control?

the use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyse and draw inferences from patterns in data.

V B

Destin

No

Output Point Types	✓ Use default triangle size			44 BD01	* Truncates against	* BD03	 Hanging wall
Use average LAS value for the interval		Solo - 70	-	43 BD04	* Truncates against	* BD01	* Footwall
🔘 Use instantaneous LAS values at point de		Maximum snapping distance 50.00 © %		42 HD09	* Truncates against	* BD04	* Footwall
Use the first associated LAS file only (rec		Min and max thickness From	0.200 m To	41 FR04		- HD01	▼ Footwall
Assign LAS Data as Attributes		Pinch out surfaces		40 BD02	* Truncates against	* HD02	* Footwall
Default Defisity 1.00 •		Solid generation		39 BD02	* Truncates against	- HD01	 Hanging wall
Default Density 100				38 BD06	* Truncates against	* BD02	* Footwall
		Use advanced processing for folded surfaces		37 BD04	→ Truncates against	- BD03	▼ Hanging wall
		_		36 HD08	* Truncates against	* HD02	* Footwall
				35 HD06	* Truncates against	* HD02	 Hanging wall
				34 HD06	* Truncates against	* HD01	 Hanging wall
•				33 FR02	* Truncates against	* HD11	* Footwall
1 Lith 👻		Anisotropic control		32 HD03	* Truncates against	* HD02	✓ Hanging wall
lable		Flip drillhole hanging wall and footwall		31 HD03	* Truncates against	* HD01	
Table Al				30 HD11	* Truncates against	* HD01	▼ Footwall
		O Control with custom surface		29 HD08	* Truncates against	* HD01	▼ Hanging wall
Assign Attributes from Additional Tables		Control with guide point surface		28 HD07	* Truncates against	* HD02	✓ Hanging wall
_		Control with trend plane		27 HD07	* Truncates against	* HD01	* Hanging wall
Interval Table GEOLOG		Show trend plane		26 HD02	* Truncates against	* HD01	* Hanging wall
		Surface generation		25 BD06	 Truncates against 	* HD01	* Hanging wall
Extract Points				24 HD04	* Truncates against	* HD01	* Hanging wall
		Keep ignored drillhole midpoints		23 FR04	* Truncates against	* FR02	* Hanging wall
	Auvanceu	on the surface boundary () inside the surface	1 1	22 BD07	* Truncates against	* BD06	 Footwall
	Advanced	A matching interval at the bottom of the hole is:		21 FR03	* Truncates against	* FR02	* Hanging wall
	Controls	ontrois		20 5804	 Truncates against 	* 6803	 Footwall Hanging wall
	CAD data	• on the surface boundary • inside the surface		10 5002	Truncates against	* HD01	Tanying wai
	Vein Contacts	A matching interval at the top of a hole is:		10 0000	 Truncates against 	* HD04	 Hanging wait Use size wall
	Drillhole data	Drillhole ends		16 BD07	 Truncates against 	* HD09	+ Footwall
			15 FR03	 Truncates against 	* HD01	* Footwall	
	Vein Modelling Specifications for 'Main'		14 BD08	* Truncates against	* HD01	 Hanging wall 	
				13 FR07	* Truncates against	* BD04	 Hanging wall
				12 BD05	 Truncates against 	* BD02	 Hanging wall
				11 HD09	* Truncates against	* BD06	* Footwall
				10 BD07	 Truncates against 	* BD04	* Footwall
				9 BD08	 Truncates against 	* BD04	▼ Footwall

Vein Network Specifications for 'veins'

O Maintain senarate solids Merge to a single solid

- n x

Hanging w

Provide all geological data

The machine learning can determine the pattern in the data

- > We only need to provide the data, not the relationships.
- > Machine learning is predicting the best match for our domains as it models all connected geology data together.



Domains + Structure

Guided by surfaces/solids



- > Domains follow regional dip where data is sparse.
- > Structural surfaces are a guide and not hard boundaries



Domains + Structure



Domains + Lith

Guided by trends in geological units



- > Domains follow geological units where there is strong correlation.
- > Domains do not follow other units were there is no correlation.



Domains + Lith



Domains + relationships

Guided by parent daughter relationships

- > Domains merge and split from their expected units.
- > Position of units is controlled.





Domains + relationships



Summary

- > New technology requires us to think differently.
- > A model can be built by adding the same geological controls that define the orebody.
- > No explicit definition of the relationships needs to be made.
- > Machine learning is not black box, it behaves exactly how you expect by making spatial correlation of the data provided.





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Thank you!