

Advancing Machine Learning and Al with Geography and GIS



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GIS is expected to do more, faster.

see where

locate, connect

predict where

route where

map the unmapped

machines can be "trained" to do more for us



Emerging Geo Al Business Cases

Geo-enabling Machine Learning Landscape and Factory

Notable Geo AI challenges and limitations

Emerging Geo Al Business Cases

Accidents, Anomaly Prediction





Landcover Landuse Classification

Predictive Asset Allocation







Predictive Routing, ETA, Traffic



Predictive GeoMarketing



Advanced Feature Extraction



Object Detection





Protection



Pollution

Risk Management



Exposure



Augmented Reality (AR)

Industry Advancing Fast (with Geo)









Organizations



Platforms, **On-premises**

Apache SINGA A General Distributed Deep Learning Platform



"Gives computers the ability to learn without being explicitly programmed"

AI > ML > DL

Artificial Intelligence



Machine Learning





Unsupervised Learning Reinforcement Learning

Deep Learning



Dog



ML Algorithms

regression	think big data	
Ordinary Least Squares Regression (DLSR) Locat Regression Logistic Regression Weinversion Adapts Rearbins Weinversion Adapts Rearbing (LOESS) Jacknote Regression regularization	bayesian Naira Baya Katalan Matanali Naira Baya Matanali Naira Averaged one-Dependence Estimation (JODR) Bayasian Beller Nateva (JODR) Bayasian Beller Nateva (JODR) Bayasian Beller Nateva (JODR) Bayasian Beller Nateva (JODR) Bayasian Beller (Nateva (JODR))	
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instance based also called cake-based, memory-based Learning Visity Gualistation (LVG) Beil Organization (LVG) Beil Organization (LVG)	Classification and Represention Three (CART) CAS and CS3 (different versions of a powerful represent) Chi-squared Automatic Invariant, China (Casting Casting	
dimesionality reduction Principal Component Analysis (PCA) Principal Component Regression (PCR) Partial Least Square Regression (PCR) Sommon Marging Multidemensional Scaling (MOS) Proyetime Paradi Discriminant Analysis (LDA, MDA, CDA, FDA)	Clustering Mains Mains Mains Mainsator Expection Mainsator Farzy clustering OBCAN OFFICE algorithm Non Negative MMFCE algorithm Latent Dirichter allocation (CA)	
deep learning Deep Bedrawer Michine (DBM) Deep Bedrawer (DBM) Deep Be	neural networks	
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the world of machine learning algorithms - a summary

Machine Learning Algorithms Cheat Sheet





Data + ML -> Models -> Predictions -> AI (algo's)

(statistics)

AR decisions understanding insights classify

ML changes things in exciting ways for GIS

evidence based models ... faster ... automated ... data driven ... accurate ... tunable ... platforms ... pervasive

Machine Learning Capabilities





Today

Emerging



Geo ML:		Geostatistical Analyst Tools Interpolation
Spatial Analytics, Geosta Spatial Statistics, Surface	atistics,	 Diffusion Interpolation With Barriers Empirical Bayesian Kriging Global Polynomial Interpolation IDW Kernel Interpolation With Barriers
Spatial Statistics, Sunac	Spatial Analyst Tools	 Local Polynomial Interpolation Moving Window Kriging Radial Basis Functions Sampling Network Design
 Analyzing Patterns Average Nearest Neighbor High/Low Clustering (Getis-Ord General G) Incremental Spatial Autocorrelation Multi-Distance Spatial Cluster Analysis (Ripleys K Function) Spatial Autocorrelation (Morans I) Mapping Clusters Cluster and Outlier Analysis (Anselin Local Morans I) Grouping Analysis Hot Spot Analysis (Getis-Ord Gi*) Optimized Hot Spot Analysis Optimized Vot Spot Analysis Similarity Search Measuring Geographic Distributions Central Feature Directional Distribution (Standard Deviational Ellipse) Linear Directional Mean Mean Center Standard Distance 	 Density Distance Extraction Generalization Groundwater Hydrology Hydrology Interpolation Local Map Algebra Math Multivariate Neighborhood Overlay Raster Creation Reclass Segmentation and Classification 	 Create Spatially Balanced Points Densify Sampling Network Simulation Extract Values To Table Gaussian Geostatistical Simulations Utilities Cross Validation Neighborhood Selection Semivariogram Sensitivity Subset Features Working with Geostatistical Layers Areal Interpolation Layer To Polygons Create Geostatistical Layer GA Layer To Contour GA Layer To Grid GA Layer To Points
 Modeling Spatial Relationships Spatial Relationships Exploratory Regression Generate Network Spatial Weights Generate Spatial Weights Matrix Geographically Weighted Regression Ordinary Least Squares 	 ↔ Solar Radiation ↔ Surface ↔ Zonal 	Set Model Parameter

Geo-enabled ML or Geo-centric ML

ML Landscape, Factory and Pattern



Geo ML Landscape, Factory and Pattern ... geo-enabling and advancing



Demo: CAFO Detection

Using TensorFlow CNNs to Detect CAFO sites from Satellite Imagery + Consuming the model from ArcGIS Pro

Demo Code: https://github.com/Qberto/ML_ObjectDetection_CAFO

Please notice process details

- Geo Data Preparation
- Model Training Duration
- Integrating Model Across GIS Platform
- Augmented Reality (AR)
- Recent Demo at Esri (ignore some references)

... imagine your business problem, your data, your model

Some Challenges & Limitations

It's complex. Let's simplify it

technology, automation, platforms, computing, etc.

Look past hype ... it's distracting



prevent another "Machine Learning Winter"

$Pred = w_1A_1 + w_2A_2 + \dots + W_{loc}(Location)$

not fully integrated ... yet



Limited expertise among Geo Community in training and tuning models ... math, statistics, spatial statistics

Introduce Geo Data Science into industry

Limited exposure to Geo in academia ... Data Science, Computer Science Proving Model Trustworthiness, Authoritativeness

(Geo) Data Bias

Next Steps

Machine Learning needs human analysis to succeed.

GIS Community, People, Professionals, Academia.

Advancing Geo Al

Build on Emerging Business Cases and Geo-enabled ML Patterns

Find your place in ML landscape and factory

Together, let's continue to overcome Geo AI challenges and limitations

