Neural Network Analysis of Medical Student Personality, Gender, and Perspective Taking

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Declaration of Conflicts of Interest







Machine Learning

Supervised learning: Train a model with known input and output data to predict future outputs to new data.



Unsupervised Learning: Segment a collection of elements with the same attributes (clustering).



K-means, k-medoids fuzzy C-means

Hidden Markov models

Neural Networks

Gaussian mixture



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- An <u>artificial neural network</u> (ANN) is a computational system consisting of a circuit of neurons that solves problems
- Tries to mimic the structure and function of a <u>biological neural network</u> (BNN)
 - Not realistic, but relevant to the structure and function of brain
 - o Hard to interpret, but helps to explain complexity of brain







Regression analysis

- o Simple linear or linearized relationships
- Calculations are simple and quick





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- Neural network analysis (NNA) is a powerful predictive alternative to regression analysis when there . . .
 - o are non-linear relationships
 - is low statistical power.¹



1. Jordan, Henry, Navarro, Daniel, Stringer, Simon, The formation and use of hierarchical cognitive maps in the brain: A neural network model, Network: Computation in Neural Systems, 2020;31:1-4, 37-141, doi:10.1080/0954898X.2020.1798531.



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Some types of Artificial Neural Networks (ANNs) . . .

ANN	Purpose	Applications	BNN Equivalent
Convolutional	Analyze spatial data	Facial recognition Medical image analysis	Human vision
Recurrent	Analyze temporal data	Speech recognition Handwriting recognition	Human speech



Types of ANNs



Pixels in an Image used in Input Layer

Forward Propagation (Information) ----->

<----- Backward Propagation (Error Correction)



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Neural Network Structure

- Neuroimaging studies of empathy and NNA have been reported,^{3,4} and this is typically the types of images used in convolutional neural networks.
- Fan³ and Timmers⁴ reported different regions of the brain could be identified for
 - Perspective taking (cognitive aspect of empathy)
 - Empathic concern (affective aspect of empathy)



cluster-level corrected to p < .05

3. Fan Y, Duncan NW, de Greck M, Northoff G. Is There a Core Neural Network in Empathy? An fMRI Based Quantitative Meta-Analysis. *Neuroscience Biobehavioral Review*. 2011 Jan;35(3):903-11. doi: 10.1016/j.neubiorev.2010.10.009. Epub 2010 Oct 23. PMID: 20974173.

4. Timmers I, Park AL, Fischer MD, Kronman CA, Heathcote LC, Hernandez JM and Simons LE (2018) Is Empathy for Pain Unique in Its Neural Correlates? A Meta-Analysis of Neuroimaging Studies of Empathy. *Frontiers in Behavioral Neuroscience* 12:289. doi: 10.3389/fnbeh.2018.00289



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Neuroimaging

The literature is sparse when using NNA to examine the impact of medical student personality and gender on perspective taking.²

Purpose: To analyze the impact of medical student personality and gender on perspective taking using neural network analysis.

2. Fuochi, Giulia, Voci, Alberto. A deeper look at the relationship between dispositional mindfulness and empathy: Meditation experience as a moderator and dereification processes as mediators. Personality and Individual Differences. 2020;165. doi:10.1016/j.paid.2020.110122.



Background and Purpose

Sample: 2017/18, 205 of 500 M1/M2 medical students (106 M/99 F)

➢Instruments

- 50-Item Five Factor Personality Inventory^{5,6} (5-pt scale)
- 28-Item Interpersonal Reactivity Index⁷ (5-pt scale)

➤Analysis via IBM[®] SPSS[®] 26.0

- Deep Learning with Neural Network Analysis: Multi-layer perceptron
 - ✤ 70% Training Data | 30% Testing Data
 - Activation Functions: Hyperbolic tangent (hidden layer), Softmax (output layer)
 - Error (Loss) Function: Cross-entropy
- Machine Learning: Binary logistic regression

5. Lewis R. Goldberg. (1999). Mervielde, I.; Deary, I.; De Fruyt, F.; Ostendorf, F. (eds.). "A Broad-bandwidth, Public Domain, Personality Inventory Measuring the Lower-level Facets of Several Five-factor Models." Personality Psychology in Europe, 7:14-17.

6. Costa, Paul T.; McCrae, Robert R. (1985). "The NEO Personality Inventory Manual". Odessa, FL: Psychological Assessment Resources.

7. Davis MH. A Multidimensional Approach to Individual Differences in Empathy. JSAS Catalog of Selected Documents in Psychology, 1980;10:85.





Fig 1: Histogram of Perspective Taking Scores

Table 1: Distribution Statistics



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Results



Personality Factor	Correlation (r)	
Agreeableness	0.5*	
Conscientiousness	0.4*	
Openness	0.3*	
Extraversion	0.3*	
Neuroticism	-0.3*	

* All Pearson correlations (r) of personality factors with perspective taking are statistically significant (p<0.050)

Fig 2: Scatterplot of Perspective Taking on Agreeableness (Personality Factor) Table 2: Pearson Correlations of PerspectiveTaking and Personality Factors



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Fig 3: NNA Prediction Model of Perspective Taking from Personality Factors (Importance Coefficients)

Conscientiousness: Top predictor of perspective taking for females, bottom for males.

- Extraversion and Openness: Better predictors for males than females.
- ><u>Agreeableness</u>: Only predictor identified with NNA and regression for both gender.





Female medical student's perspective taking benefitted from greater <u>conscientiousness</u> due in part to taking obligations to others seriously.

➢<u>Male</u> medical student's <u>extraversion</u> and <u>openness</u> increased perspective taking suggesting that enjoying human interactions and being enthusiastic, assertive, and gregarious helps empathize with others.





If you only remember one thing from this session it could be that . . .

Neural network analysis was a better predictive analysis over logistic regression for medical student's perspective taking from personality and gender.





