MEDICAL COLLEGE OF WISCONSIN

Neural Network Analysis of Medical Student Burnout as Impacted by Emotion

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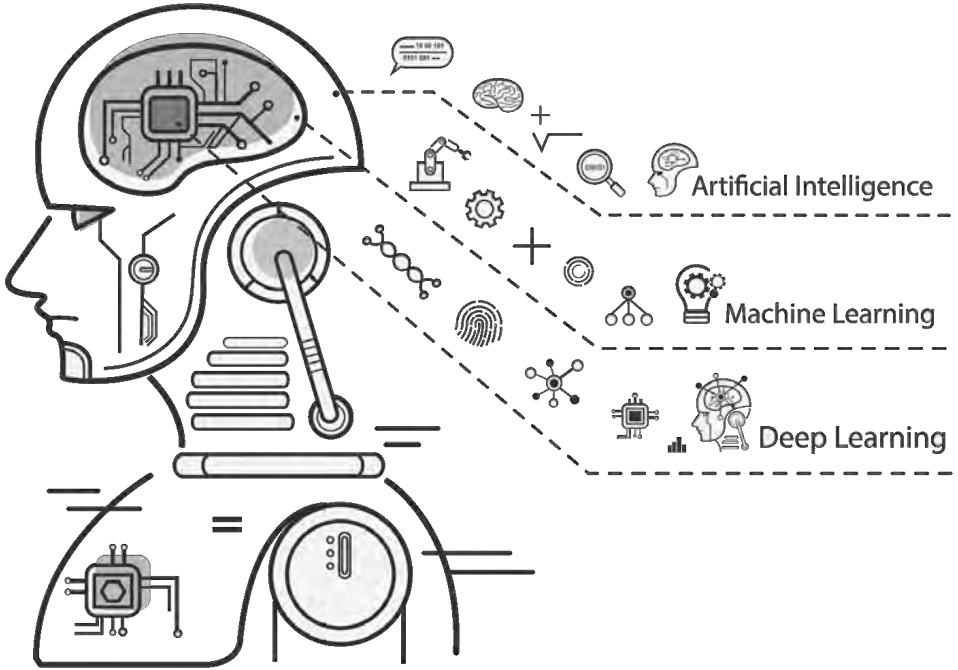
I affirm that all persons involved in the planning/content development do not have relevant financial relationships with pharmaceutical companies, biomedical device manufacturers or distributors, or others whose products or services may be considered related to the subject matter of the educational activity.

"All you need is lots and lots of data and lots of information about what the right answer is, and you'll be able to train a big neural net to do what you want."

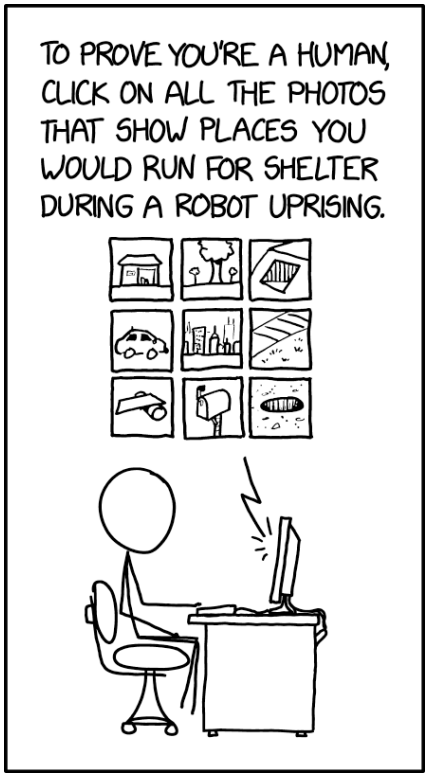
- Geoffrey Hinton, Cognitive Psychologist and Computer Scientist

What is Neural Network Analysis? How is it used to solve problems from . . .



- Artificial Intelligence (AI) is a science devoted to making machines think and act like humans.

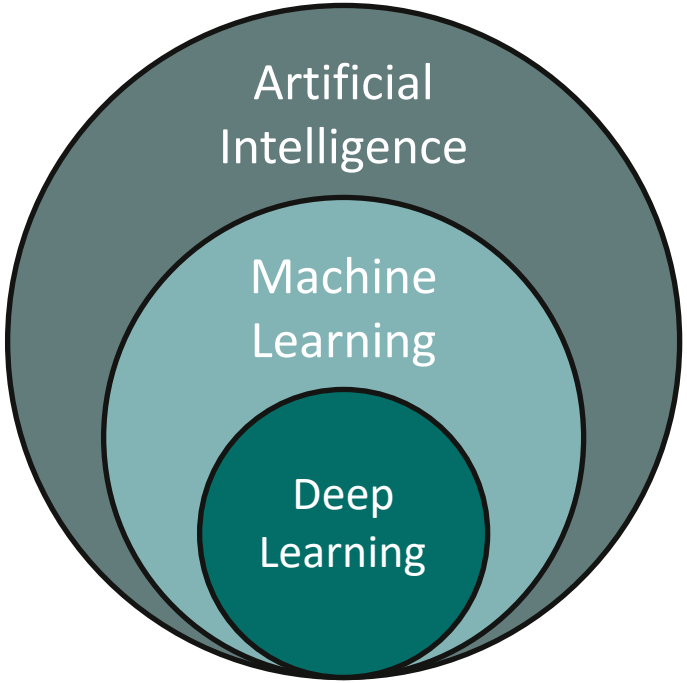
- AI uses computers and machines to mimic the problem-solving and decision-making capabilities of the human mind.



Introduction

- Machine Learning (ML) focuses on enabling computers to perform tasks without explicit programming.
  - Regression
  - Factor Analysis
  - Cluster Analysis
  - Classification
  - Random Forests
  - Support Vector Machine

- Deep Learning (DL) is a subset of machine learning in which artificial neural networks adapt and learn from large amounts of data.



- Neural network analysis (deep learning) as the name implies is an analytical tool inspired by the structure of the human brain.

- It has the advantage of greater predictive power over regression analysis (machine learning) to identify risk factors for important outcomes such as medical student burnout. [7]

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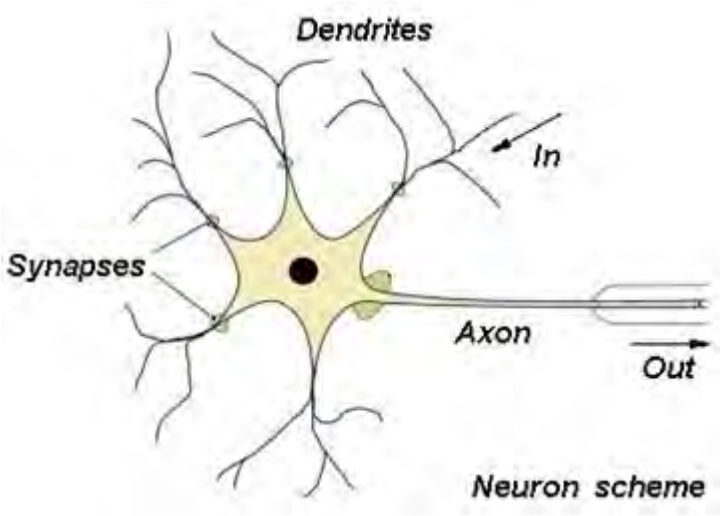
- Neural Networks are so powerful that they are used in commercial applications

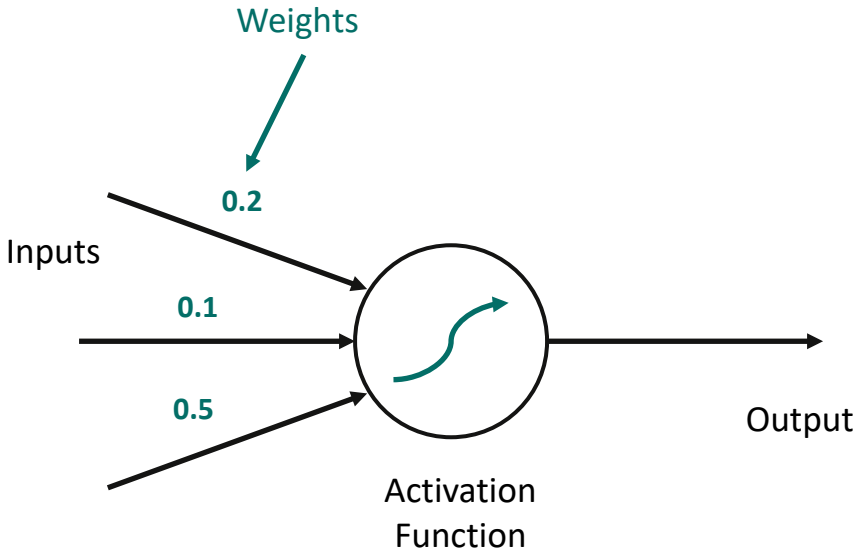
Commercial Application	Software
Facial Recognition	Amazon Rekognition, Betaface
Voice Recognition	Dragon, Siri, Cortana
Language Translation	Google Translate, Bing Translator

- Neural Networks are also used in healthcare applications

Healthcare Application	
Retinal scans [1]	Breast cancer screening [4]
Colonoscopy findings [2]	Clinical drug response [5]
Liver disease detection [3]	Emergency room discharge [6]

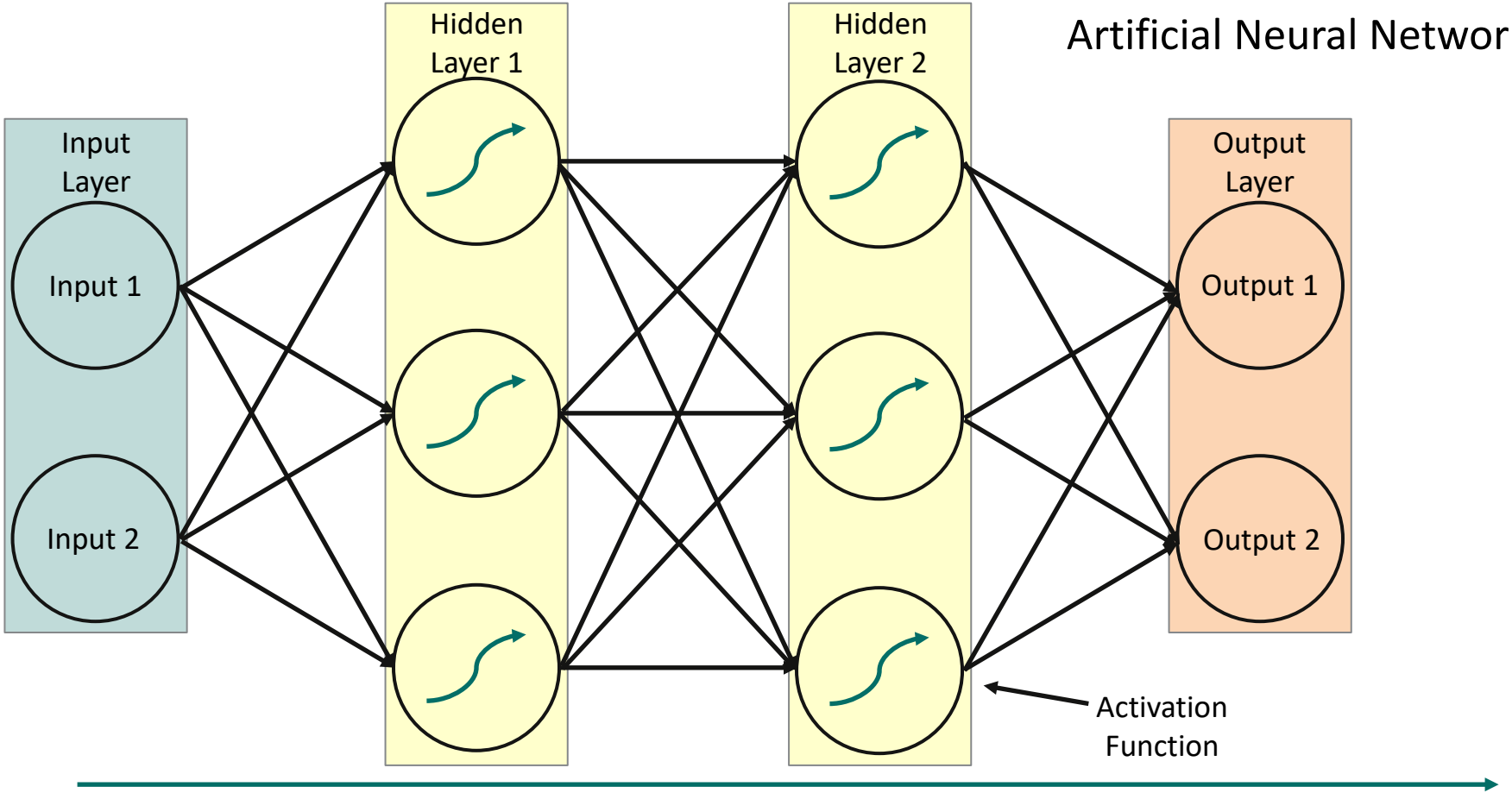
1. O'Byrne, Ciara, Abbas, Abdallah, Korot, Edward, Keane, Pearse. Automated deep learning in ophthalmology: AI that can build AI. *Current Opinion in Ophthalmology*. **2021**;32(5):406-412. doi:10.1097/ICU.0000000000000779.
2. Lovejoy, Christopher, Alqahtani, Saleh. AI in colonoscopy and beyond: On the cusp of clinical implementation? *United European Gastroenterology Journal*. **2021**;9(5):525-526. doi:10.1002/ueg2.12076.
3. Vaidyanathan, A., Widaatalla, Y., Ibrahim, A., et al. A novel AI solution for auto-segmentation of multi-origin liver neoplasms: 4MO. *Annals of Oncology*. **2020**;31:S246. doi:10.1016/j.annonc.2020.08.157.
4. Meyer-Base, Anke, Morra, Lia, Tahmassebi, Amirhessam, Lobbes, Marc, Meyer-Base, Uwe, Pinker, Katja. AI-Enhanced Diagnosis of Challenging Lesions in Breast MRI: A Methodology and Application Primer. *Journal of Magnetic Resonance Imaging*. **2021**;54(3):686-702. doi:10.1002/jmri.27332.
5. de Jong, Johann, Cutcutache, Ioana, Page, Matthew, et al. Towards realizing the vision of precision medicine: AI based prediction of clinical drug response. *Brain*. **2021**;144(6):1738-1750. doi:10.1093/brain/awab108.
6. Cheng N, Kuo A. Using Long Short-Term Memory (LSTM) Neural Networks to Predict Emergency Department Wait Time. *Stud Health Technol Inform*. **2020**;272:199-202. doi:10.3233/SHTI200528, 10.3233/SHTI200528





Biological Neuron

Artificial Neuron


Artificial Neural Network
Hidden Layer 1
Hidden Layer 2
Input Layer
Output Layer
Input 1
Input 2
Output 1
Output 2
Activation Function

- Medical student burnout has received increasing attention in recent years due to greater acceptance of psychological and emotional vulnerability in the healthcare profession.

- Given the significant investment of personal and financial resources in this demanding profession, continued evaluation of factors contributing to burnout in medical training is necessary.

- Given the implications of medical student burnout and its association with depression, loneliness, and depersonalization,[8] it is necessary to identify emotional predictors that may influence this phenomenon.[9]

- The purpose of this study is to determine the predictive relationship of medical student burnout from trait-affect using neural network analysis.

8. Silva V, Costa P, Pereira I, Faria R, Salgueira AP, Costa MJ, et al. Depression in Medical Students: Insights from a Longitudinal Study. *BMC Medical Education* 2017;17(1):184-9.
9. Obregon M, Luo J, Shelton J, Blevins T, MacDowell M, Assessment of Burnout in Medical Students using the Maslach Burnout Inventory-Student Survey: A Cross-sectional Data Analysis, *BMC Medical Education* 2020;(20)376, doi:10.1186/s12909-020-02274-3

Introduction

- In 2017/18, 205/500 medical students completed these online self-reported surveys

Table 1: List of Study Surveys				
Factor	Survey	# Elements		Scale
		Factors	Items	
Burnout	Maslach Burnout Inventory (MBI-SS) [10]	3	15	1=never, 7=every day
Affect	Positive and Negative Affect Schedule [11]	11	60	1=Very slightly or not at all, 5=extremely

10. Maslach C, Jackson SE, The Measurement of Experienced Burnout, *Journal of Occupational Behavior* 1981;2:99-113.
11. Watson D, Clark LA. (1994). The PANAS-X: Manual for the Positive and Negative Affect Schedule-Expanded Form. Ames: The University of Iowa.

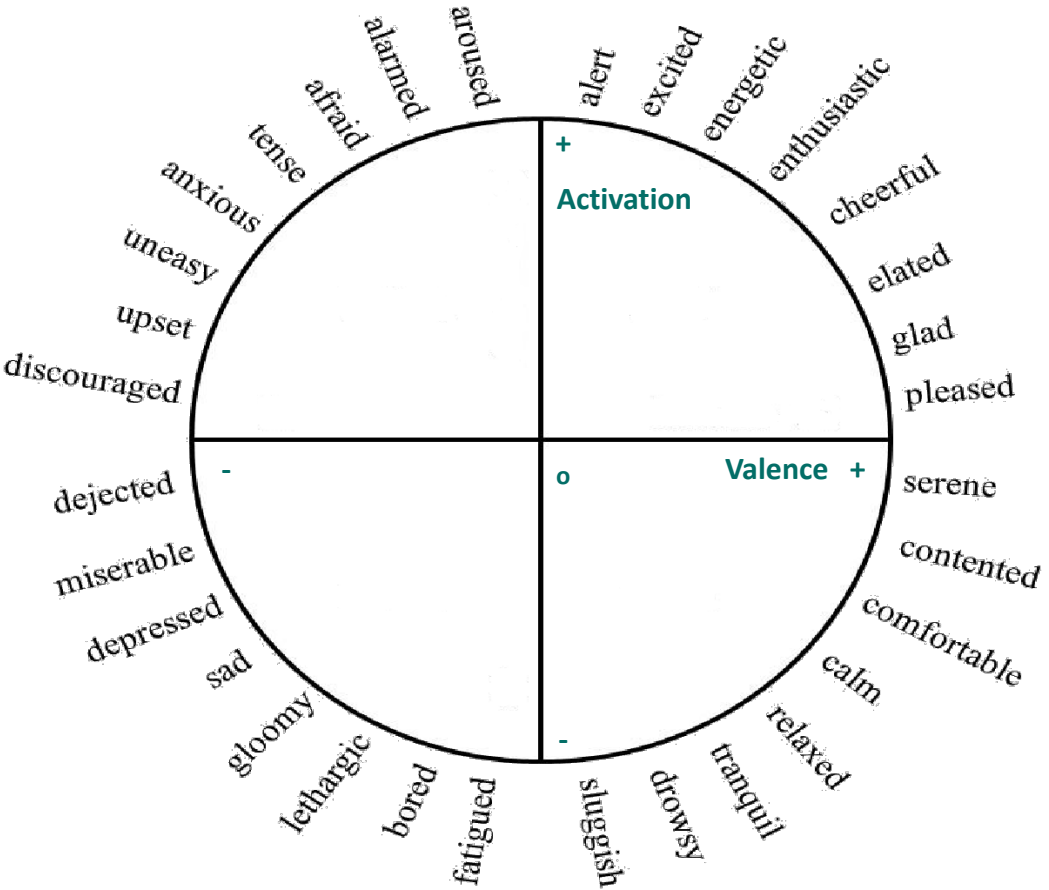
Methods: Surveys

- Relational Tests
  - Machine Learning: Binomial Logistic Regressions
  - Deep Learning: Neural Network Analysis
    - Multilayer Perceptron

- Software: Quantitative
  - IBM® SPSS® 26 used for analysis

- Human Research Protection
  - This research approved by the school's IRB.

Methods: Analysis



- Emotions (trait affect) are visualized in a circumplex

  - o Valence on horizontal axis
    - ✓ Positive (+)
    - ✓ Neutral (o)
    - ✓ Negative (-)

  - o Activation on vertical axis
    - ✓ High Intensity (+)
    - ✓ Moderate Intensity (o)
    - ✓ Low Intensity (-)

Trait Affect

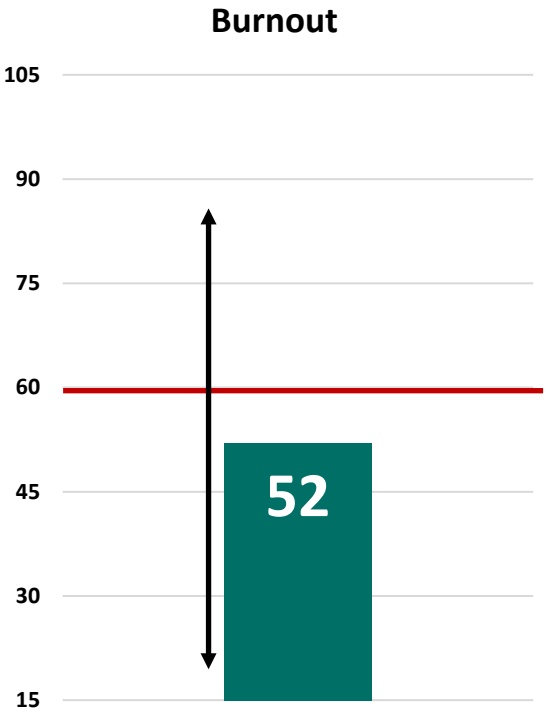


Fig 1: Burnout Mean Score

- Medical student burnout
  - Mean (sd) = 52 (±15)
  - Range = 18-85
  - Reliability: alpha = 0.7
- 35% at midline or above (≥60)
- Dichotomized as high/low along the median (53).

Results

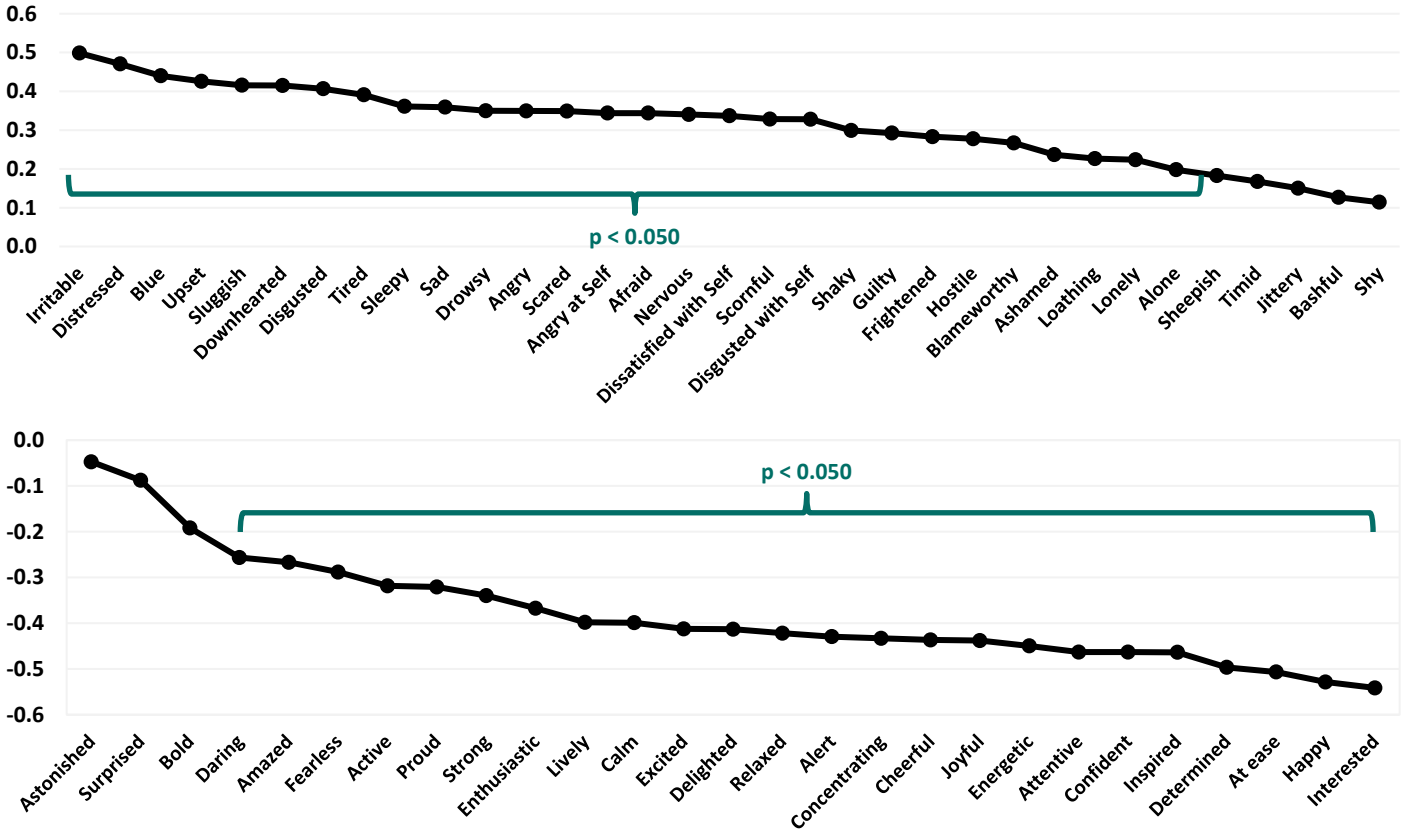


Fig 2: Spearman Correlations of Burnout with Trait Affect

Results

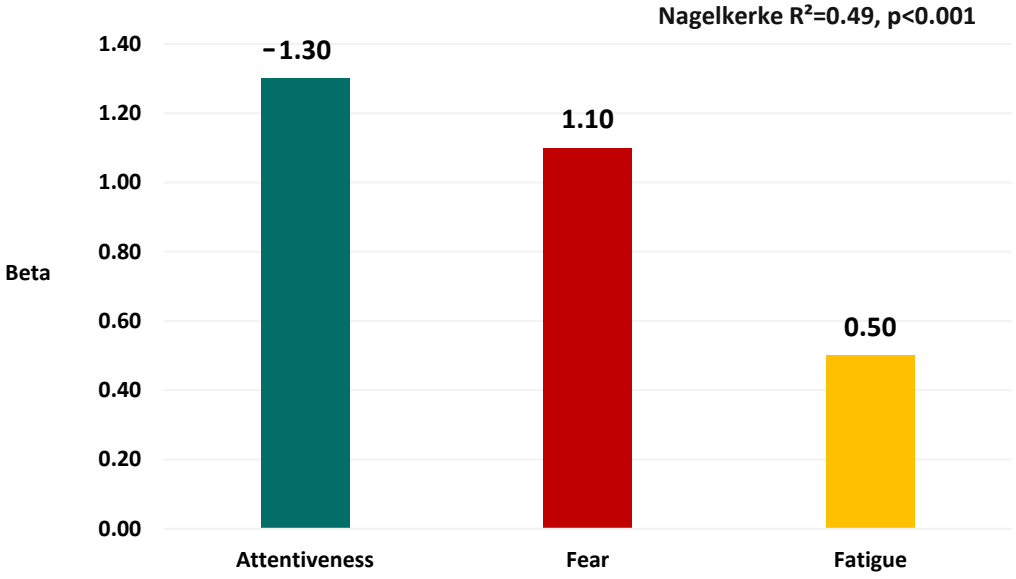


Fig 3: Trait Affect Predictors of Burnout (Regression)

- Attentiveness is strongest emotional predictor with positive valence
- Positive emotion has greater impact on burnout than negative emotion
- Higher burnout from
  - Lower attentiveness
  - Greater fear
  - Greater fatigue

Results: Regression

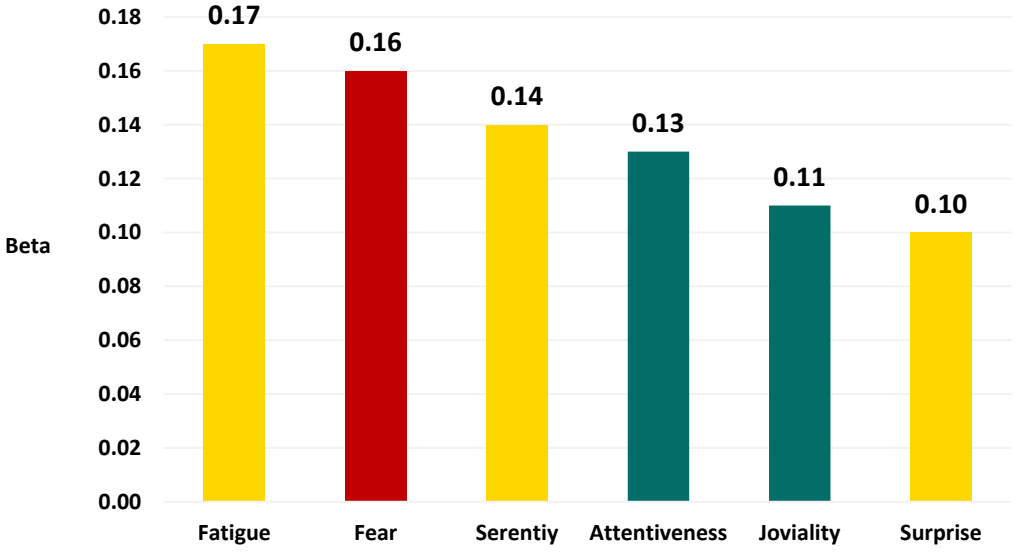


Fig 4: Trait Affect Predictors of Burnout (NNA)

- Fatigue is strongest emotional predictors with neutral valence
- Negative emotion has greater impact on burnout than positive emotion
- Strongest and most frequent emotional predictors have neutral valence

Results: NNA

- Neural network analysis provided a more comprehensive list of emotional risk factors of burnout than logistic regression analysis

- However, both techniques included the full spectrum of emotional valence (positive, negative, and neutral).

Conclusions

- Participation rate limitations decreases student representation and reduces validity

- Self-reported values of psychological factors are complementary to but not identical to actual values
  - Dispositional trait affect ≠ Actual emotions

Limitations

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

Deep learning techniques provide a more powerful predictive model of medical student burnout from trait affect than machine learning.

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1. O'Byrne, Ciara, Abbas, Abdallah, Korot, Edward, Keane, Pearse. Automated deep learning in ophthalmology: AI that can build AI. *Current Opinion in Ophthalmology.* 2021;32(5):406-412. doi:10.1097/ICU.0000000000000779.

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References

Table 1: Neural Network Analysis: Burnout on Trait Affect			
Activation	**Valence**	**Trait Affect Predictor**	**Coefficient**
Low	o	Fatigue	0.17
High	-	Fear	0.16
Low	o	Serenity	0.14
High	+	Attentiveness	0.13
Moderate	+	Joviality	0.11
Moderate	o	Surprise	0.10

Results