

I. Bloodsmart.ai forecasts backstory

A. What did we create?

1. ML models to predict nutrient deficiencies, infections, toxic exposures, biological age and more.

B. Why were they created?

C. How were they created?

1. Supervised machine learning is a subfield of Artificial Intelligence. You can think of it as learning by example with data. In a nutshell, based on previous experience (historical data), what is this like?
 - a) Sometimes I get asked how bloodsmart.ai compares to other blood chemistry programs. I used the other programs for years before writing my own, and rather than ML, they use what I call “hand rolled algorithms.” For example, if alkaline phosphatase is low, then it must be a zinc deficiency. Unfortunately, biology is WAY more complicated than that, and supplementing with zinc with just one indicator never helps.
 - b) Our thoughts, feelings and pain are generated much the same way. “Pain is all about protecting our body tissues. A danger detector -- the amazing protectometer” (Lorimer Moseley via Abel Romero). “Your brain is a model of the environment in which it inhabits. A statistical organ. The goal is to minimise free energy (surprise).” (Karl Friston).
2. Two examples from the eLife journal and podcast
 - a) Embryology [Performance of a deep learning based neural network in the selection of human blastocysts for implantation](#)
 - (1) A CNN trained to assess an embryo’s implantation potential directly using a set of 97 euploid embryos capable of implantation outperformed 15 trained embryologists (75.26% vs. 67.35%, $p < 0.0001$) from five different fertility centers.
 - b) Prostate cancer [Identifying prostate cancer and its clinical risk in asymptomatic men using machine learning of high dimensional peripheral blood flow cytometric natural killer cell subset phenotyping data](#)
 - c) Think about the implications for developing countries where there are no doctors, let alone the best in the world.
3. [An interpretable machine learning model of...](#)
4. How do we know the models have skill? [A Gentle Introduction to k-fold Cross-Validation](#)
 - a) Cross-validation is a statistical method used to estimate the skill of machine learning models. The general procedure is as follows:
 1. Shuffle the dataset randomly.
 2. Split the dataset into k groups
 3. For each unique group:

1. Take the group as a hold out or test data set
2. Take the remaining groups as a training data set
3. Fit a model on the training set and evaluate it on the test set
4. Retain the evaluation score and discard the model
4. Summarize the skill of the model using the sample of model evaluation scores

II. What the forecasts are and what they're not

- A. NOT a *definitive* diagnosis
- B. Don't replace critical thinking
 1. Beware automation bias. GPS and self-driving cars as examples.
- C. "Cloudy crystal ball" (Annie Duke)

III. Using forecasts in clinical practice

- A. Critical thinking
 1. Outcome bias. Job hopping as an example.
 2. The Archer's Mindset
 - a) It's okay to acknowledge that you're not usually going to hit the bull's-eye; the important thing is to take aim. Aiming for that bull's-eye by making an educated guess gets you closer to a precise hit because it motivates you to assess what you know and what you don't know. It motivates you to learn more. Recognizing the value in taking aim is the archer's mindset. Recognizing that guesses aren't random, that all guesses are educated guesses, is the archer's mindset. Otherwise, your decision-making will more closely resemble a game of pin the tail on the donkey. You'll be purposely blindfolding yourself to the target.
"All life is an experiment. The more experiments you make the better." — Ralph Waldo Emerson
 3. Going beyond the pro/con list, and assigning likelihood and payoff attributes to interventions
 - a) [How to do better at darts – and life](#)
 - (1) Most players, even ungifted amateurs, aim for the triple-20, because that's what professionals do. However, for all but the best darts players this is a mistake. If you are not very good at darts, or if you are drunk, your best opening approach is not to aim at triple-20 at all. Instead aim at the south-west quadrant of the board, towards 19 and 16. No, you won't get 180 that way, but nor will you score 3.
 4. Understanding the explanations. You get points for showing your work.
- B. Health history
- C. Symptoms
 1. Importance of the HAQ
- D. Use the bar charts!
 1. Is one category overwhelmingly high?

2. Look at groups of similar forecasts
 - a) Ex metabolic health: homocysteine, OGTT, c peptide, insulin
3. Always ask “is there a reason this might be a true positive prediction?”
- E. Food journaling
 1. Does a specific nutrient deficiency make sense given what someone is eating?
 - a) Confounding factors like gut health / malabsorption
 - b) Antinutrients like phytates
- F. Environmental toxins and heavy metals: past or current exposures
 1. Hg amalgams
 2. Sushi
 3. Occupational exposures
 4. Plastic usage
 5. Conventional personal care products
- G. What may be happening when there is a discrepancy between a prediction and actual marker?
 1. Examples
 - a) Homocysteine / B12 / methylation
 - b) Hormone resistance (estrogen, thyroid, cortisol)
 - c) Bacterial, parasitic, viral infections
- H. Some forecasts are often seen together
 1. Ex. Nutrient deficiencies and heavy metal exposures
 2. Doesn't mean they're both right!
 3. One prediction can make your blood pattern look like another prediction so the ML algorithms pick that up
- I. Potentially catching issues before they manifest
- J. “Learn More” feature
 1. What input markers give the most weight to a given prediction?
- K. Power of the Forecast Detail View
 1. Tracking predictions over time with interventions
 - a) If something stays elevated, ask yourself / your client “is there a good reason to believe this is actually an issue?”
 - (1) If not, why might the ML algorithms still think it is?
- L. At the beginning if we have a lot of low hanging fruit (Q1) to address, I might not even mention the predictions during the consult with a client but we may return to them later
 1. [The 4 Quadrant Model \(the Ancestral Health therapeutic paradigm\)](#)
 - a) Some people aim for quadrant four because that's what professional athletes and biohackers do. But these people never forgo Q1-2. Those quadrants never make the news.