Class 2: Vocabulary Exercise

Hey CogSci'ers :)

Today we'll finish the vocabulary exercise from last time. If you finish early, continue with the conceptual exercises, they are nice too :)

Exercises on the next pages.

Challenge tasks are optional and go a bit beyond the readings.  
They are cool though, and not necessarily so difficult.

# Exercise 1: Getting a vocabulary

Lots of terms and words are being used in statistics (and beyond). Sometimes they don't mean the same thing. Sometimes they mean something more specific than what we think. Sometimes people don't explain them, they just use them; usually it takes a bit of time (well spent!) to get comfortable with them.

Below, you find a list of terms and concepts. In Study Groups, talk about them one at a time and make sure you know what they mean, maybe make a little definition. Some will be harder than others, and some will be harder than they seem at first.

You have 15+- minutes. We will go through them quickly together afterwards. Continue with next exercise if you're done early

*What is:*

**Inference**

*What is:*

**Statistical inference**

*And how can statistics be used for inference?*

*What is:*

**Statistics**

*What is the difference between*:

**Descriptive statistics** *and*

**Inferential statistics**

*What is:*

**A model**

*Consider different kinds of models. Here are some examples that are not necessarily mutually exclusive. What are their differences?*

**A conceptual model**

**A statistical model**

**A causal model**

**A computational model**

**A verbal model**

**A business model**

**A LEGO model**

*Given a model (usually a statistical or computational one), what is:*

**A variable**

*What's the difference between*

**An observed variable** *and*

**An unobserved variable**

*What's a*

**A hidden variable**

*How about a*

**Input variable***and a*

**Outcome variable**

*What is then a*

**Parameter**

*And how is it different from a variable? Give an example from a statistical model, and from a causal model.*

*What does it mean to*

**Estimate model parameters**

*And what is it to*

**Fit a model to data**

*What does it mean to say that?*

**A model is 'true'**

*What is meant by the ancient saying?*

**'All models are wrong, but some are useful'**

*What does it mean to say that? => it is never more than a simulation (small world), and never an objective picture of the real world*

**A model is useful**

*McElreath distinguishes between the*

**'Large world'** *of reality and the*

**'Small world'** *of the model*

*What's the difference? When is it important to remember?*

* *Assumptions are often made in and of the small world*

Challenge

*Are these points valid for statistical and mathematical models only, or for models in general?*

*What does P***robability mean***?*

* Lack of knowledge/information – uncertainty we try to model anyway
* Real stochastic phenomenon … some things maybe is just stochastic / probabilistic by nature

*Given a set of different types of observations, why do you* **Divide by the total number of observations** *to get the probability for each type?*

* Garden analogy of forking data
* Probability is just counting

*What must be the* **sum of the probabilities of each possible outcome**

* *1*

*What does probability have to do with*

**Uncertainty**

*Richard McElreath quotes Bruno Finetti:*

**PROBABILITY DOES NOT EXIST**

*Then he says probability is a*

**Device for describing uncertainty from the   
perspective of an observer with limited knowledge**

*Explain that.*

Challenge

*What is the difference between*

**Epistemic uncertainty** *and*

**Ontological uncertainty**

*and which one does McElreath seem to believe in?*

*What is a*

**Distribution** => frequency count?

*What is the difference between a*

**Discrete distribution** *and a*

**Continuous distribution**

*In a continuous distribution, what is the*

**Density**

*What defines a*

**Probability distribution**

*Consider both a*

**Discrete probability distribution** *and a*

**Continuous probability distribution**

*What is*

**Probability density**

*What is on*

**The axes of common visualizations of probability distributions**

*What is a*

**Probability density function**

*How does it*

**Relate to a probability distribution =>** the distribution is a visualization, where the function is more of a mathematical description

*What are a probability density function's*

**Input variables** *and*

**Output variables**

*What then are its*

**Parameters**

*We can have distributions with and without* **Probability density functions** *This is also called with and without* **A functional form** *What is the difference?*

* A distribution we cannot describe and predefine, them it is without a functional form (we haven’t pre-specified the type of distribution, maybe because the ‘type’ of distribution is out there.)

*Name a few* **different probability density functions** *that you know, and their corresponding*

**Probability distributions** *Also name their* **Parameters:**

* Gaussian, uniform, binomial

*Here are some familiar examples:*

**Uniform distribution**

**Gaussian distribution / Normal distribution**

**Binomial distribution**

Challenge

*And a few more:*

**t-distribution**

**Poisson distribution**

**Beta distribution**

**Gamma distribution**

Challenge

*What would be a*

**Probability distribution in multiple dimensions**

*Why is it also known as a*

**Multivariate probability distribution**

*What is the difference between the*

**Prior probability distribution** *and the*

**Posterior probability distribution**

*for parameter estimates, and the*

**Predictive prior distribution** *and the*

**Predictive posterior distribution**

*for an observable variable ?*

*What does it mean to*

**Summarize a distribution**

*What is a*

**Point estimate**

*Why is it useful? Why is it problematic?*

*Explain these three examples:*

**Mean**

**Median**

**Mode**

Challenge

*Why is the latter related to*

**Maximum likelihood estimates (MLE)**

*and*

**Maximum a posteriori probability estimates (MAP)**

*What is a*

**Loss function**

*How does it relate to making*

**Point estimates**

*Why does it make sense that the*

**Expectation of a distribution**

*is its***Probability-weighted average**

*What is the*

**95% confidence interval**

*of a distribution (in Bayesian statistics)?*

*What is the difference between computing it as a*

**Percentile interval**

*and a*

**Highest posterior density interval**

*What does it mean to***Sample from a (probability) distribution**

*McElreath points out three ways inference can go wrong. We can have*

**Bad software**

**Bad models**

**Bad data**

*Give examples of each.*

**Challenge**

*What is*

**Bayes' Theorem**

*What are its four components, the:*

**Prior probability P(p)**

**Likelihood P(d|p)**

**Marginal Likelihood P(d)**

**Posterior probability P(p|d)**

*(Where P means 'probability of',*

*| means 'given some',*

*p means 'parameter value' and*

*d means 'data' or 'observations')*