CS 188 Discussion 6: Probability and Bayes Nets

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Administrivia

* HW6 due next Monday
* Project 3 due Friday!
* READ THE PROBABILITY NOTE ON THE SECTION SITE. Also under the resources tab on EdX.
* http://sniyaz.weebly.com/uploads/3/7/4/6/37467787/probability.pdf

Administrivia

* READ THE PROBABILITY NOTE ON THE SECTION SITE.

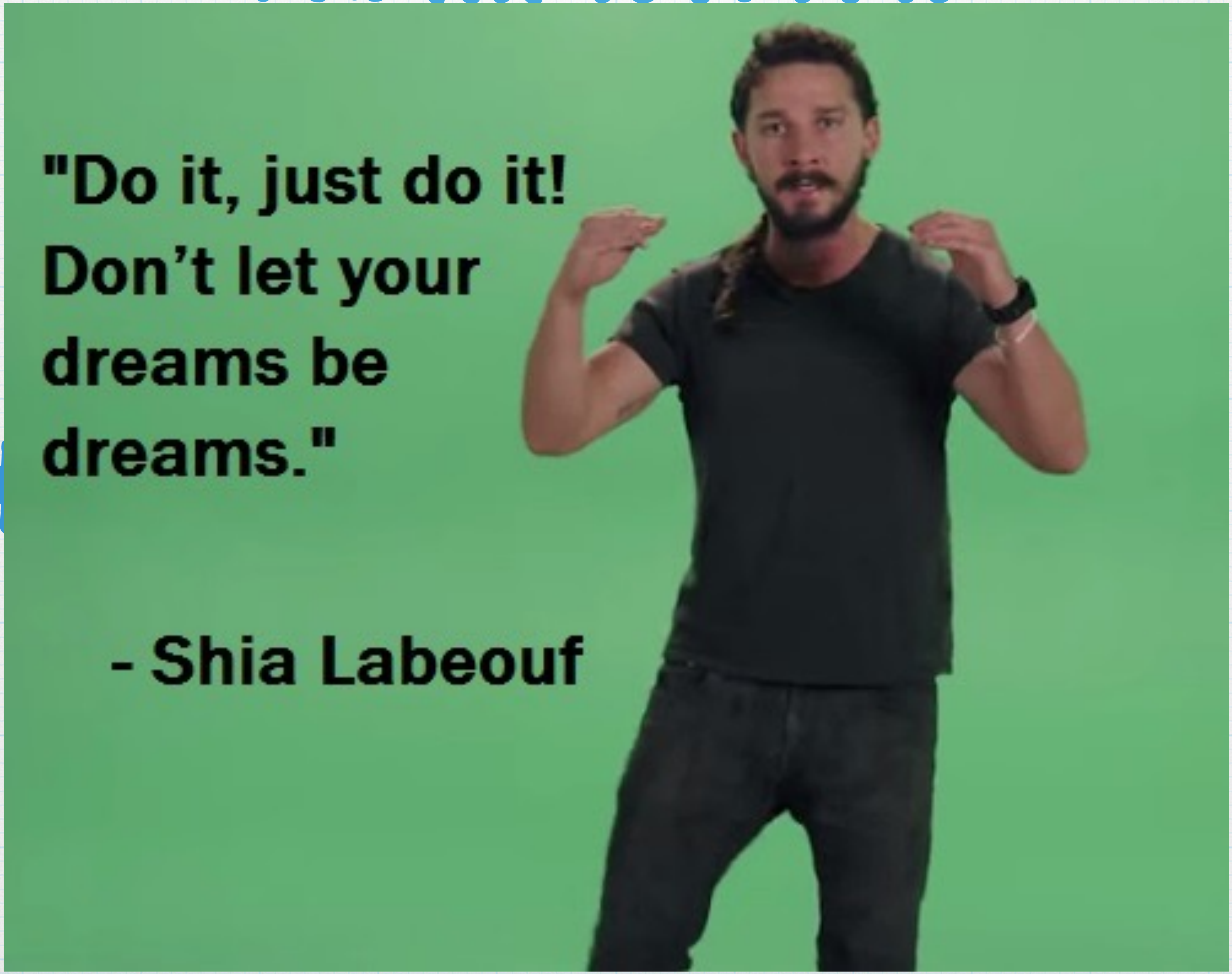
Administrivia

* READ THE PROBABILITY NOTE.

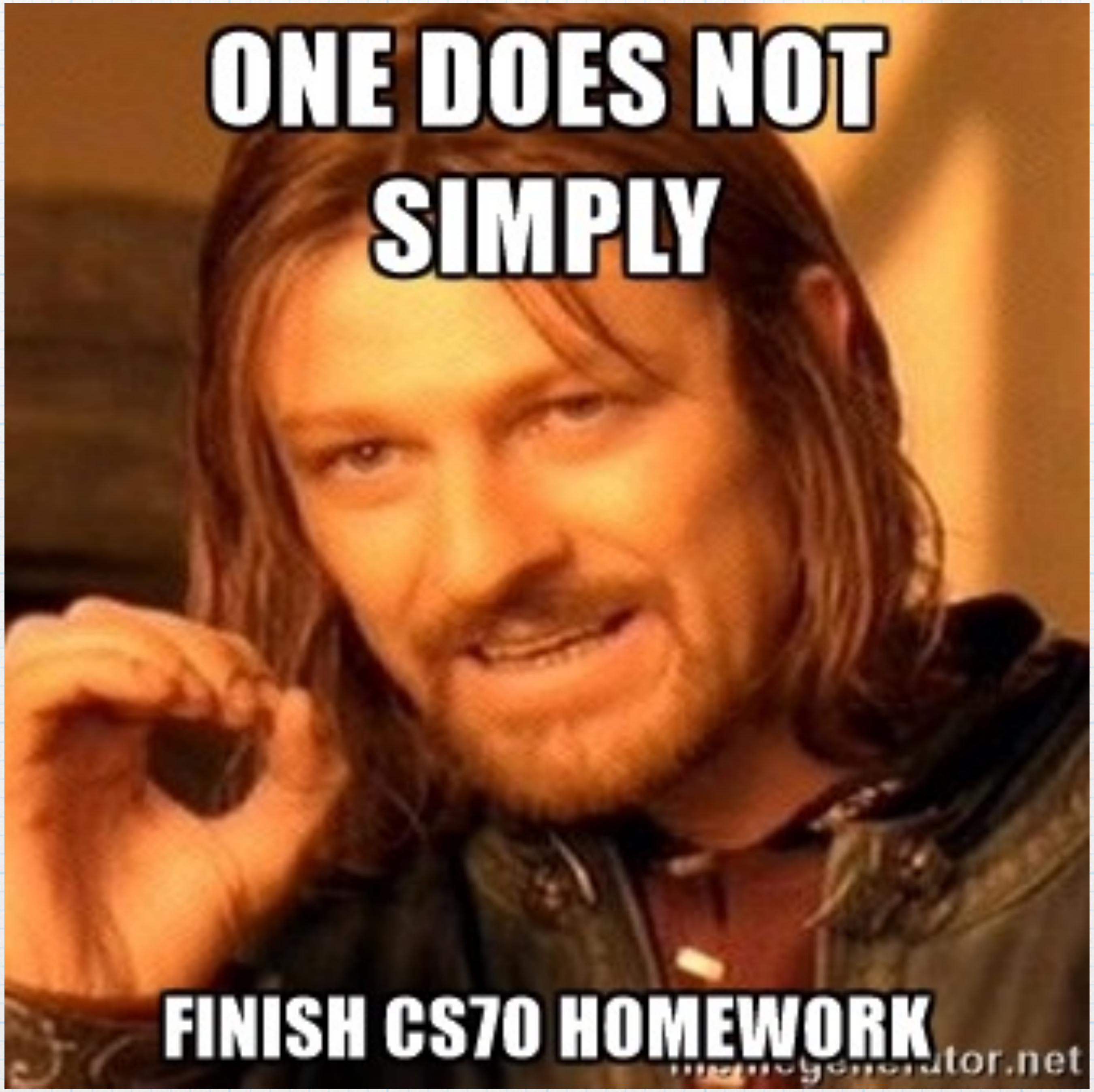
Administrivia

* DO IT.

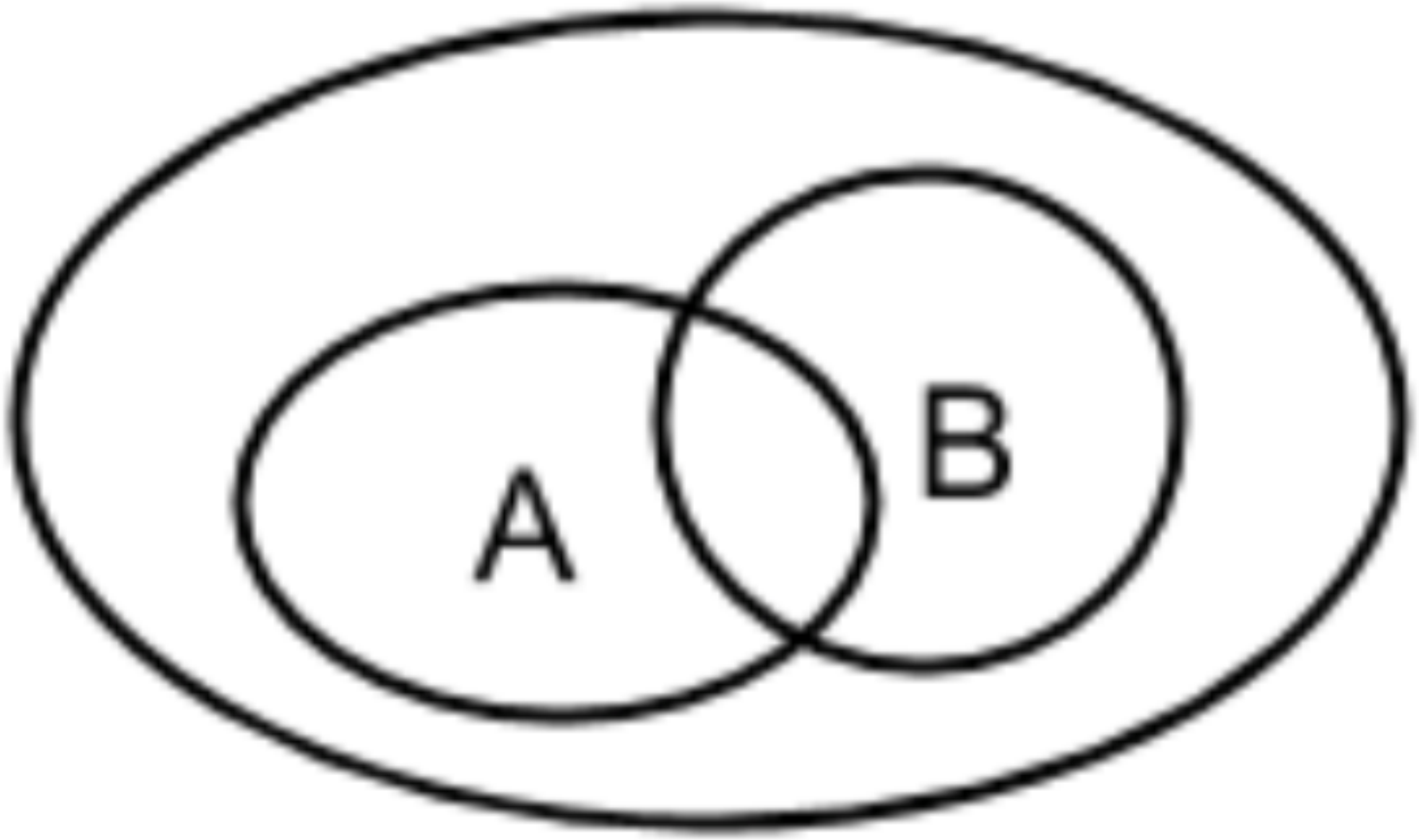
Administrivia



CS70 Review



Conditional Probability



$$\Pr[A|B] = \frac{\Pr[A \cap B]}{\Pr[B]}.$$

Product Rule

$$Pr(X = x, Y = y) = Pr(Y = y|X = x)Pr(X = x)$$

The general version of this is called the **chain rule**

Chain Rule

$$Pr(X = x, Y = y, Z = z)$$

How to split this up?

Chain Rule

$$Pr(X = x, Y = y, Z = z) = Pr(X = x | Y = y, Z = z) Pr(Y = y, Z = z)$$

$$Pr(Y = y | Z = z) Pr(Z = z)$$

We can keep recursively applying the product rule to get the **chain rule**

Chain Rule

$$Pr(x_1, x_2, ...x_n) = Pr(x_1)Pr(x_2|x_1)...Pr(x_n|x_1, ..., x_{n-1})$$

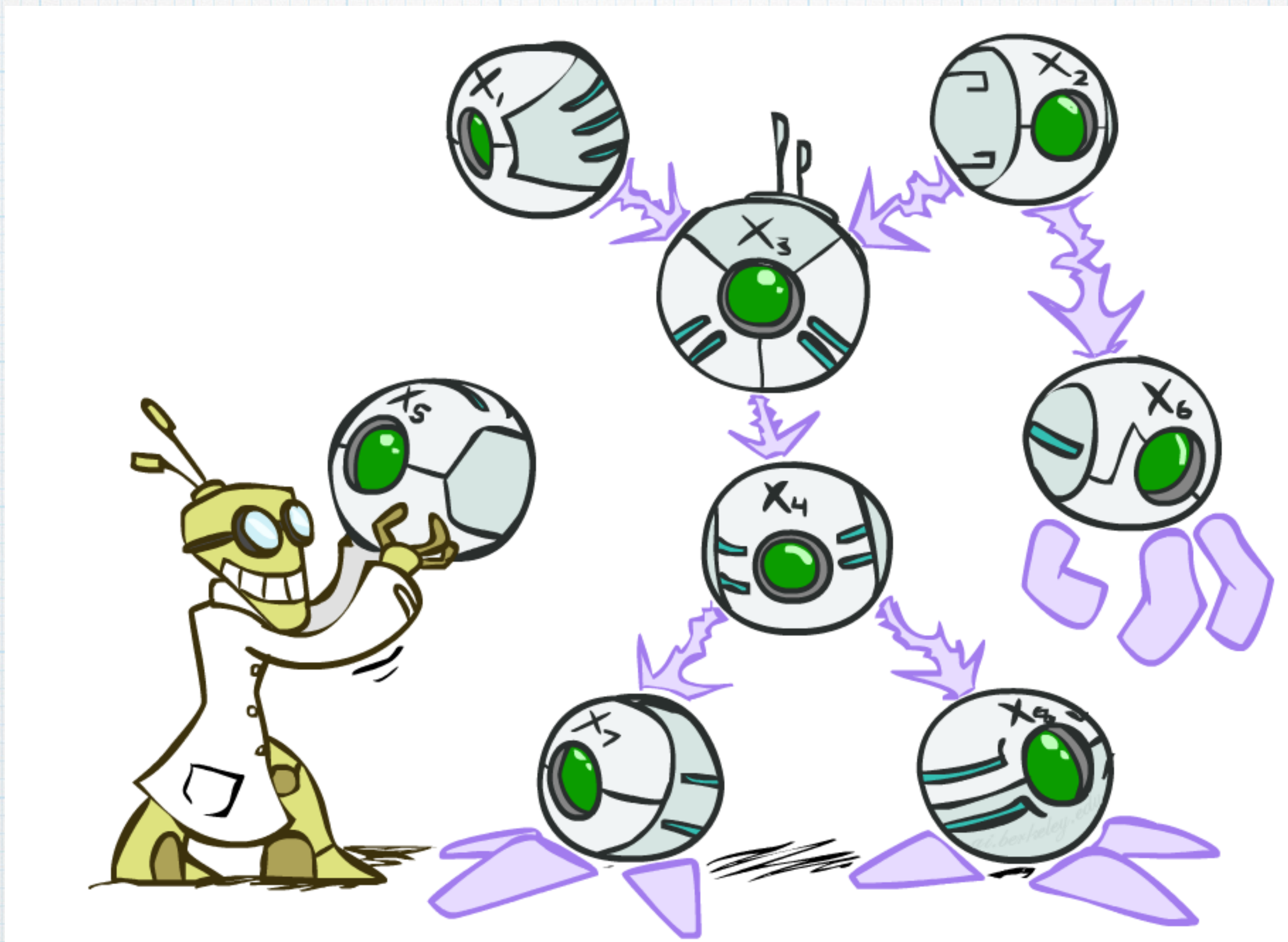
Bayes Rule

$$Pr(X = x|Y = y)$$

$$\frac{Pr(Y = y|X = x)Pr(X = x)}{Pr(Y = y)}$$

This lets us "flip" conditional probabilities in a sense

188 New Stuff



Joint Distributions

W	S	$Pr(W, S)$
sun	yes	0.2
sun	no	0.5
$rain$	yes	0.2
$rain$	no	0.1

A table of **every single possibility** that can happen in our world, along with its probability.

Differences between 70 and 188

* 70: **Build up** probabilities from other probabilities.
* 188: Sometimes, we just calculate the joint (so **all the things**) first.
* **Then**, we get specific probabilities from that giant table (**marginalization!**)

Marginalization

* **Find the relevant probabilities** in the table for the events that we want, and add them together.
* Example: if you want P(a+, b+) (that A is true and B is true) find **all events in the joint table where** A and B are both true.
* Add the probabilities of all such events together.

W	S	$Pr(W,S)$
sun	yes	0.2
sun	no	0.5
$rain$	yes	0.2
$rain$	no	0.1

$$Pr(S = yes) = \sum_{w} Pr(W = w, S = yes)$$

Problems with Joint Tables

* How many entries are there in the table representing a joint distribution involving n different random variables?

Problems with Joint Tables

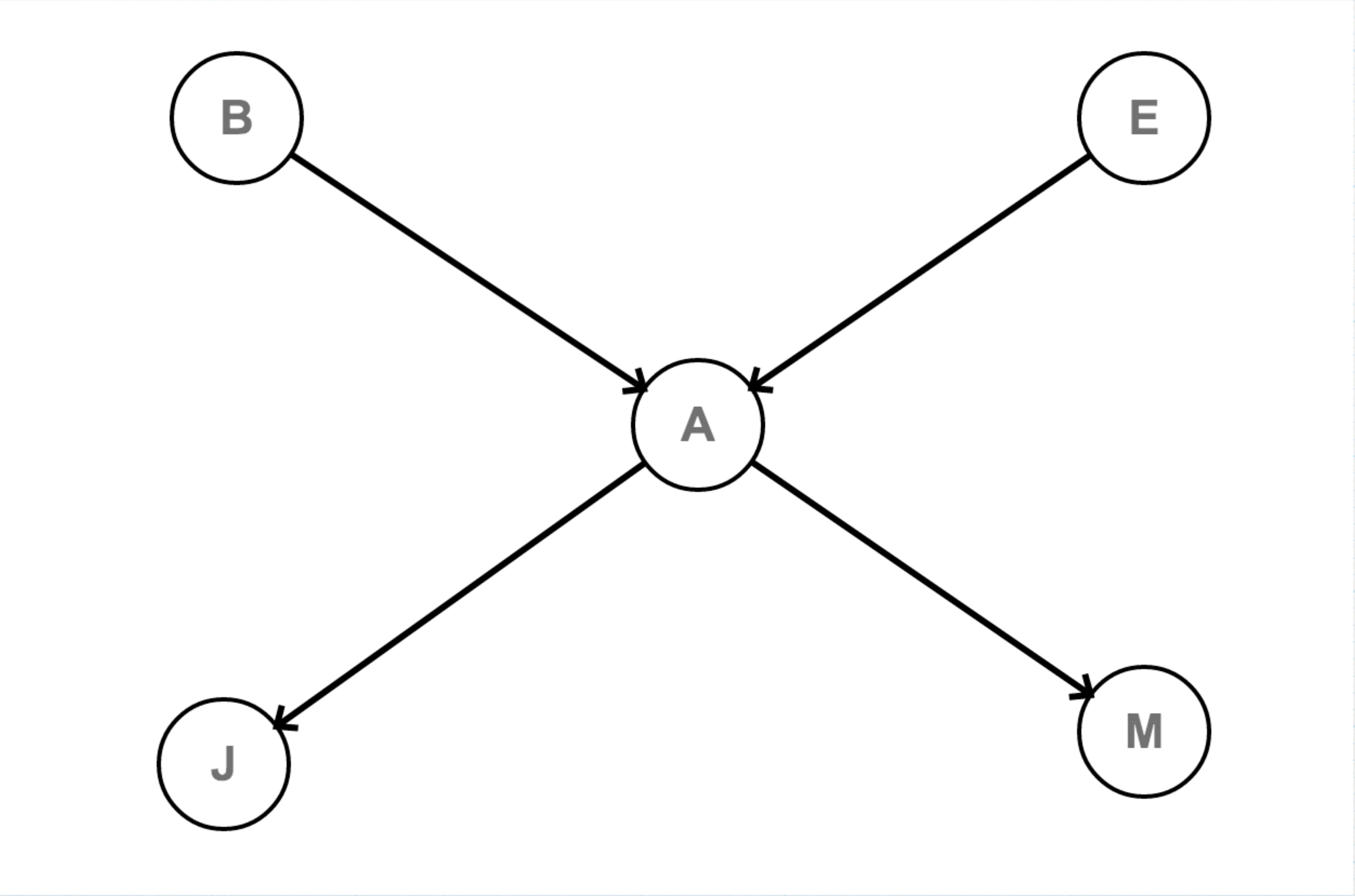
are there in the table
distribution
t random variables?

$$2^n$$

Problems with Joint Tables

* These tables are **huge**. Exponentially huge in the number of variables, in fact.
* There is a much more **efficient** representation of the same joint distribution: **Bayes Nets**.

Bayes Nets



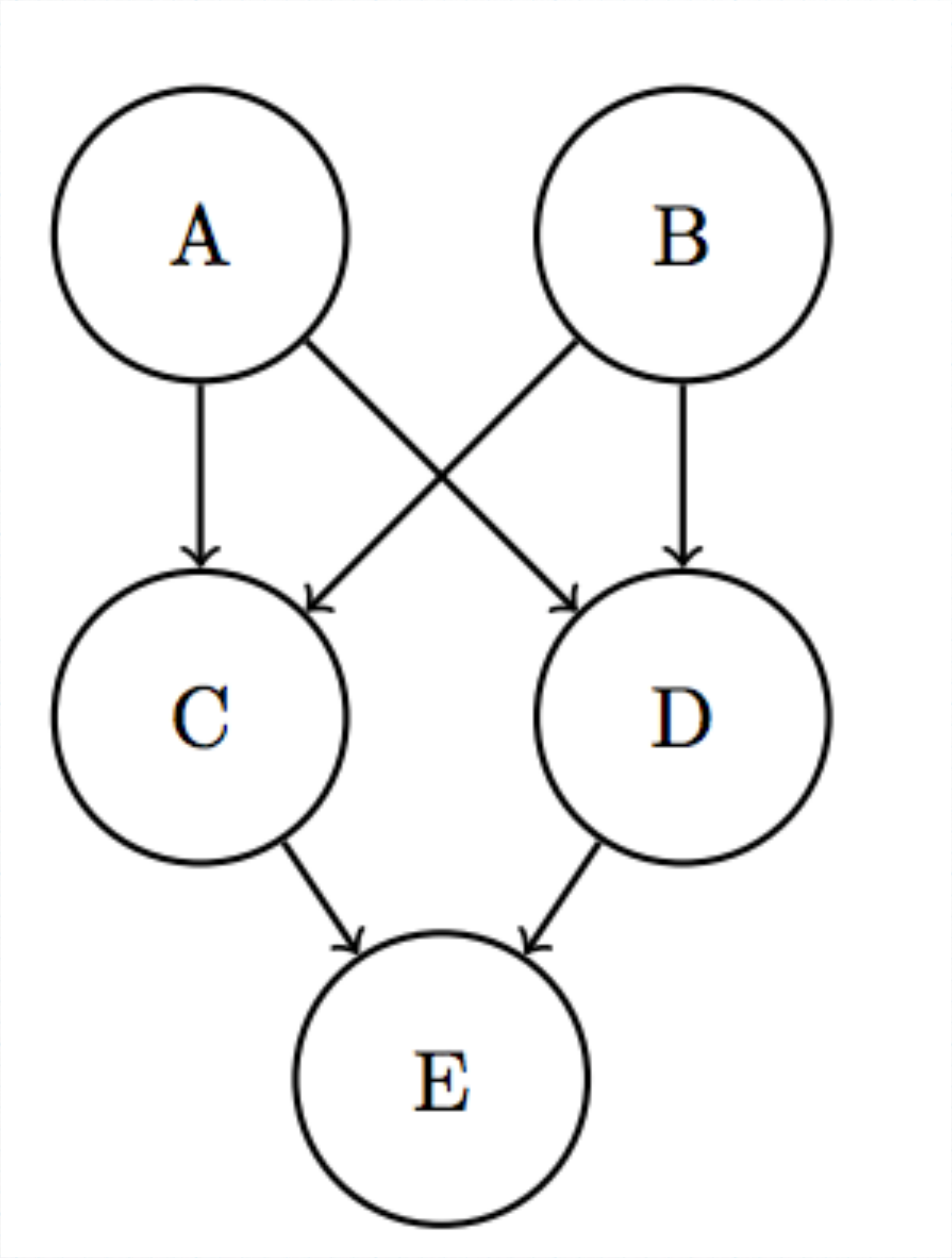
Random variables = nodes

Each variable conditioned on its parents!

How to recover full Joint Table?

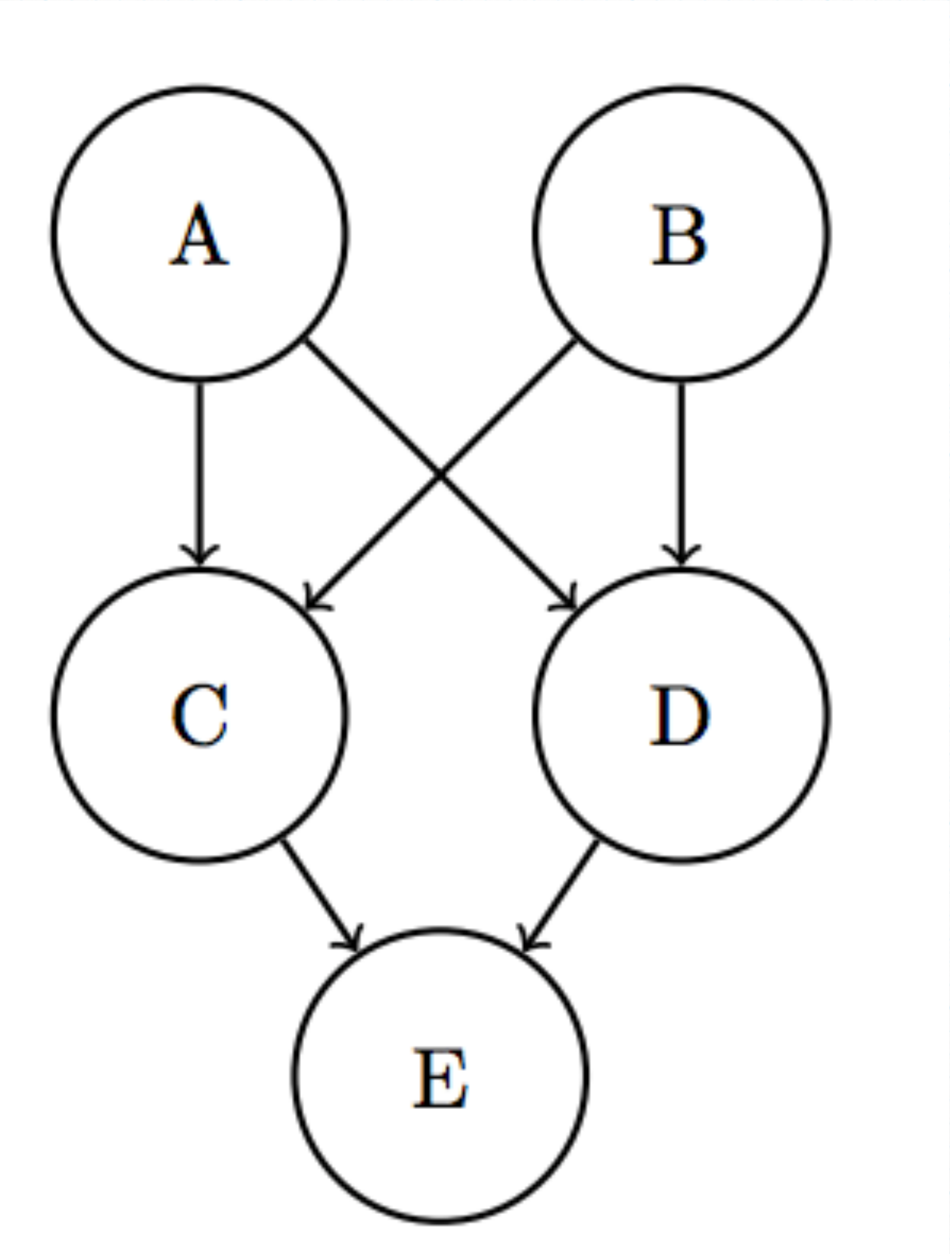
$$P(x_1, x_2, \ldots x_n) = \prod_{i=1}^{n} P(x_i | parents(X_i))$$

Try it!



How do I get P(A, B, C, D, E), where A through E are arbitrary outcomes of my random variables?

Try it!



$$P(A)P(B)P(C|A,B)P(D|A,B)P(E|C,D)$$