Continual Causality Bridge

Causality Tutorial

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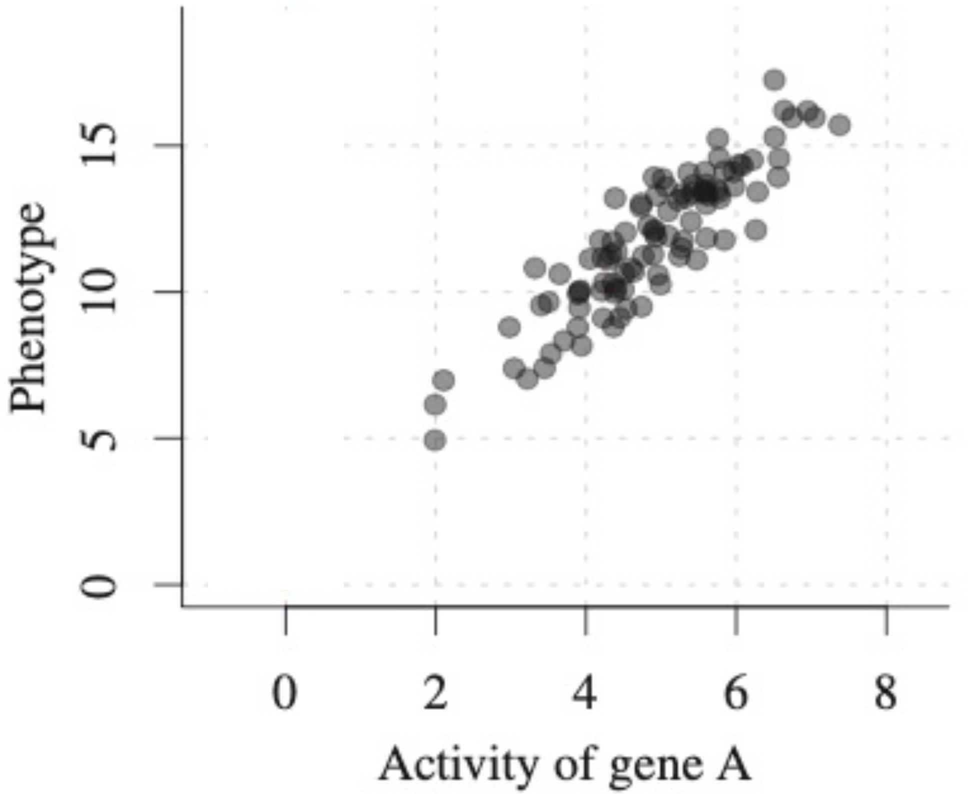
Why do we care about causality in AI & ML?

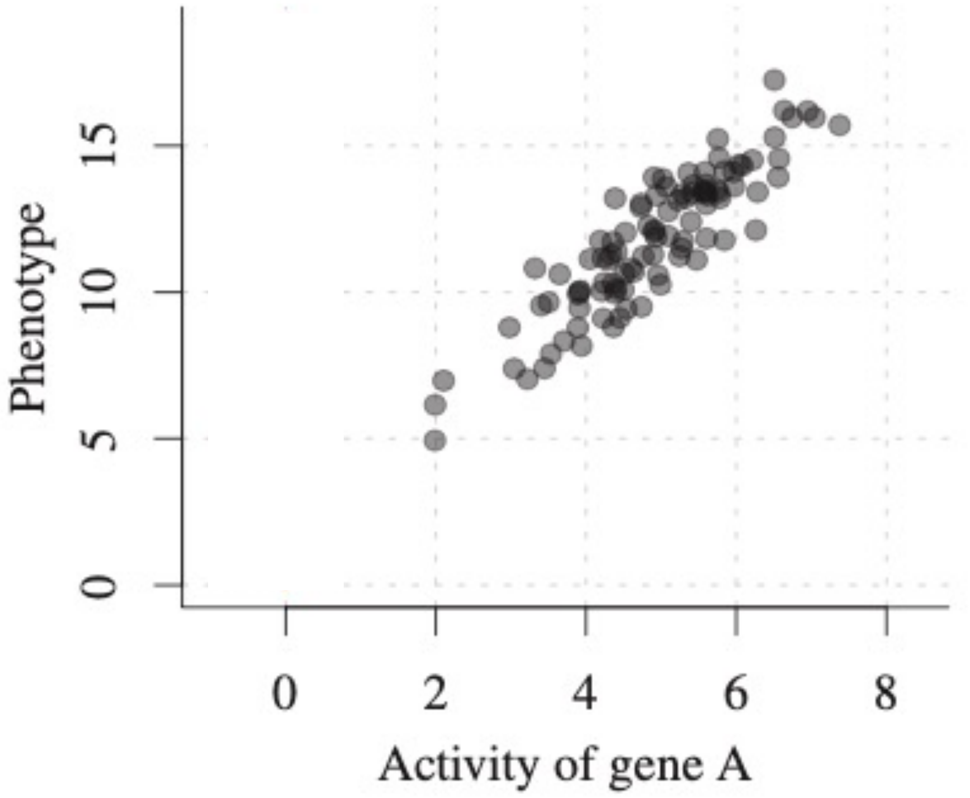
Example

Pharma gives you a data set, telling you they want to be able to predict phenotype expression



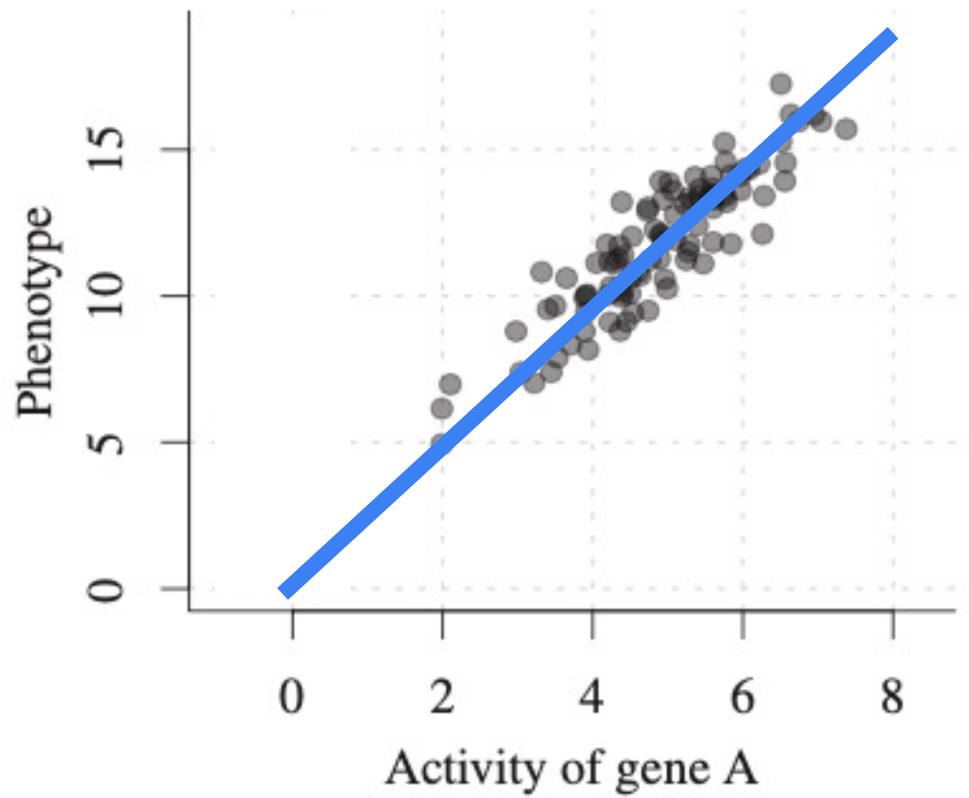
My question to you:

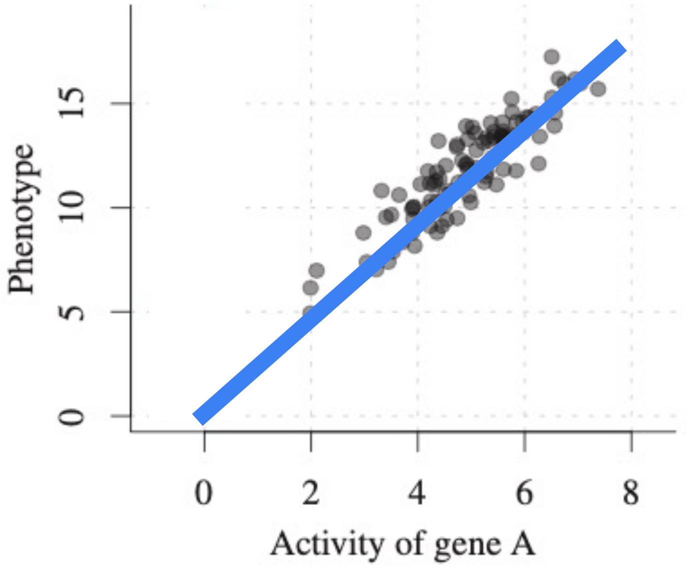
"How would you do it?"



Learn a Model

Model learns a *linear* function





Pharma is really happy now, since, wow, they have full control now

Now they know things like:

Phenotype = 5 at Activity = 2,

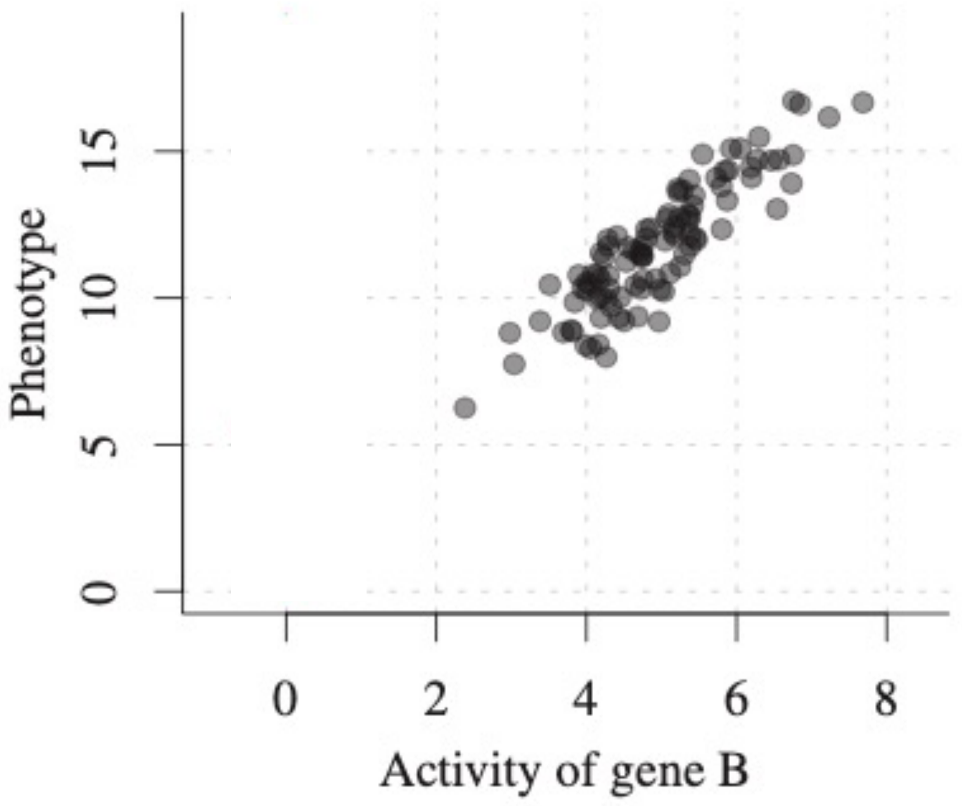
Phenotype = 15.8 at Activity = 6.1, or

Phenotype = 0 at Activity = 0

You’re hired!

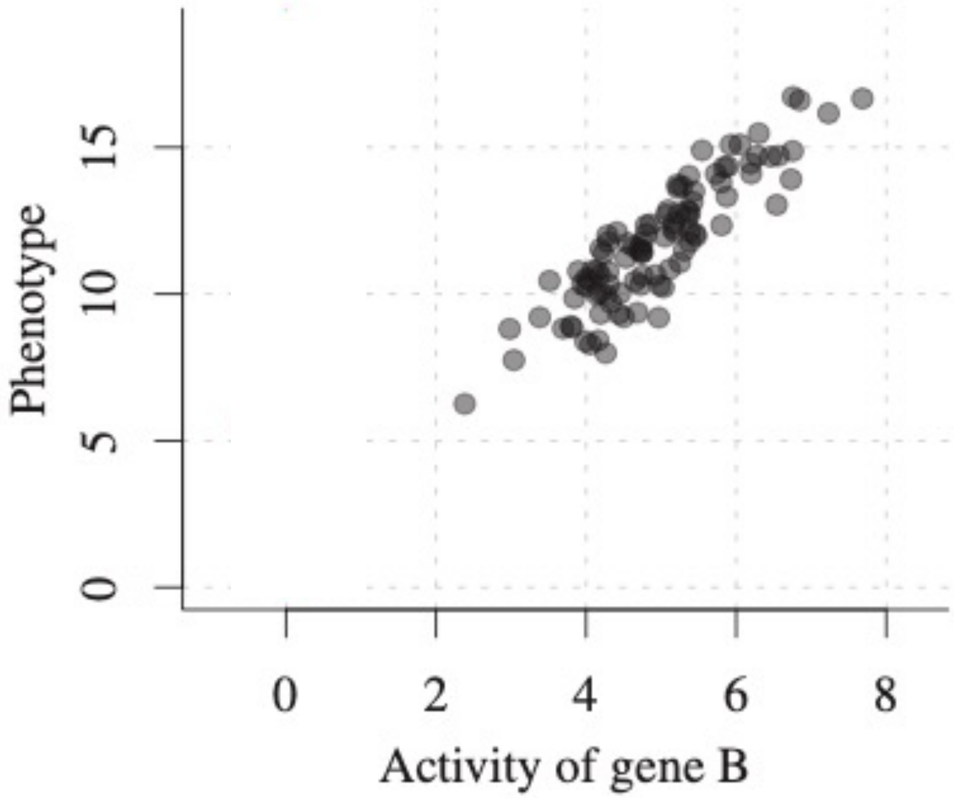
Example

Pharma has more for you!
Another data set.
Same game, different data set



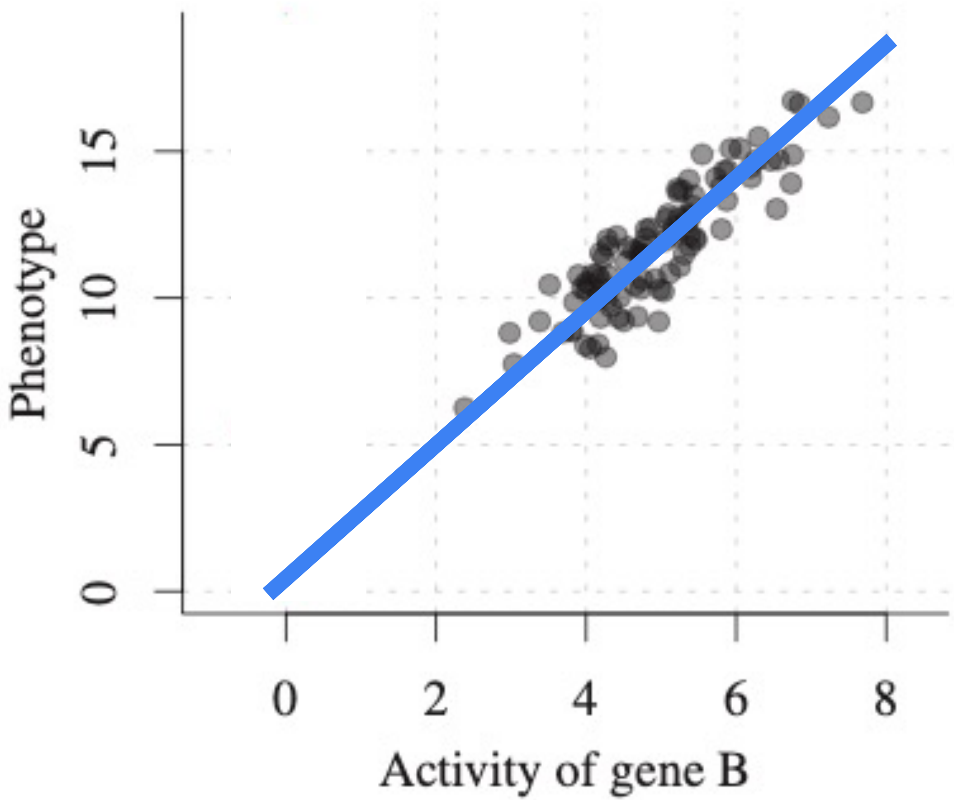
Again, my question to you:

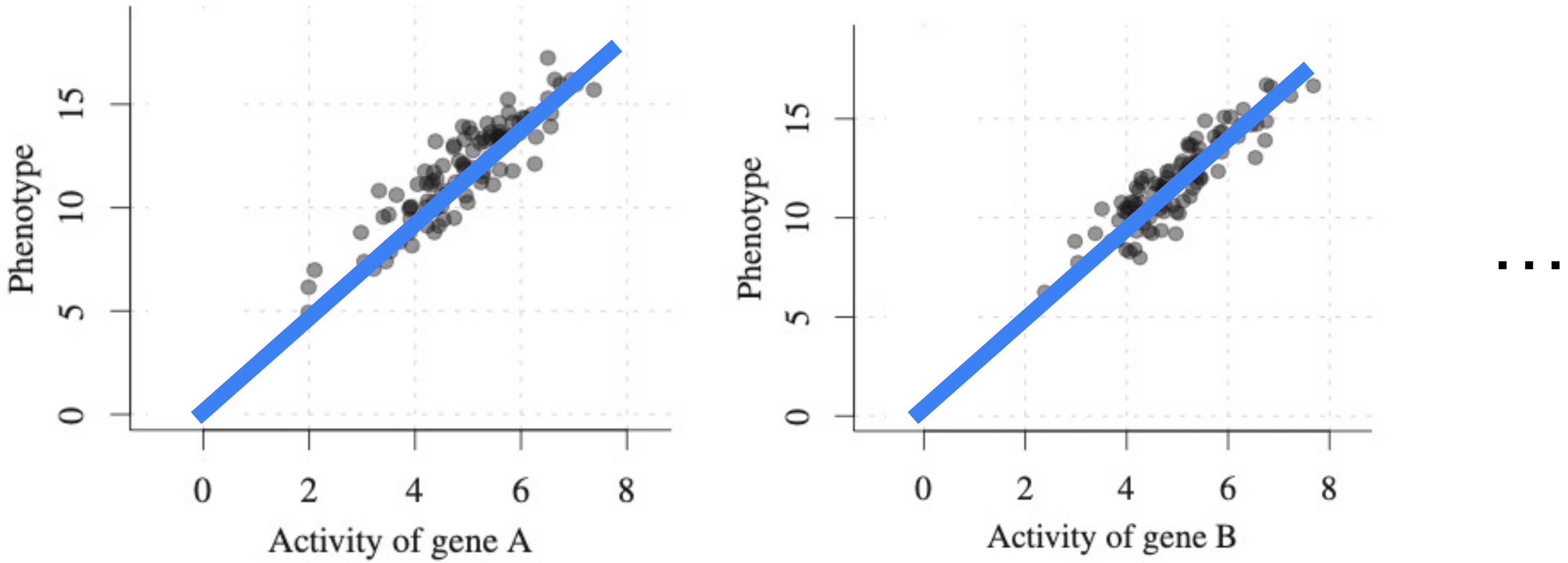
"How would you do it?"



Learn a Model

Model learns a *linear* function





Pharma loves you.
You give them all the answers they want!

Pharma will deploy now!

They have a **1B $ experiment** inline.

Based on **your predictions**,
they can cut off phenotype expression by suppressing the genes.

Many plagued american lifes will be changed for the better now that their symtpoms will finely vanish after this procedure…

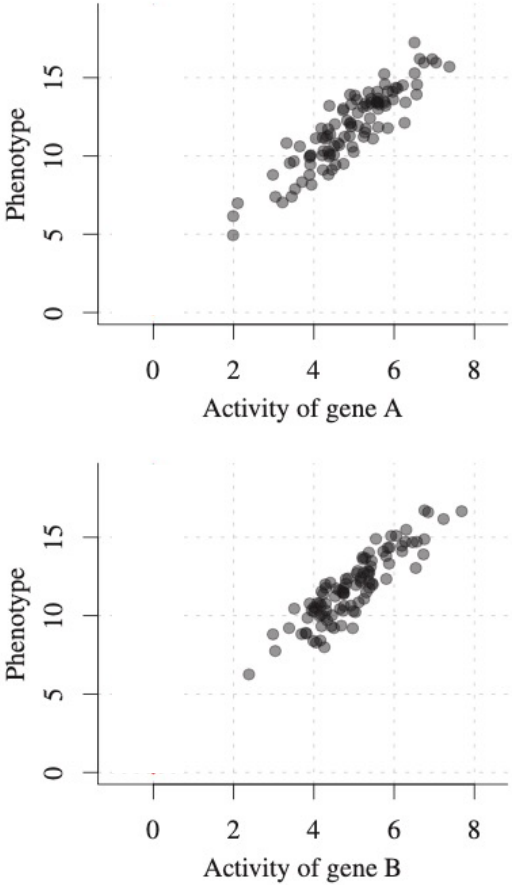
Experiments on Gene A were successful!

You saved many lives
by providing predictions that turned out to be true!

Experiments on Gene B were a total disaster!

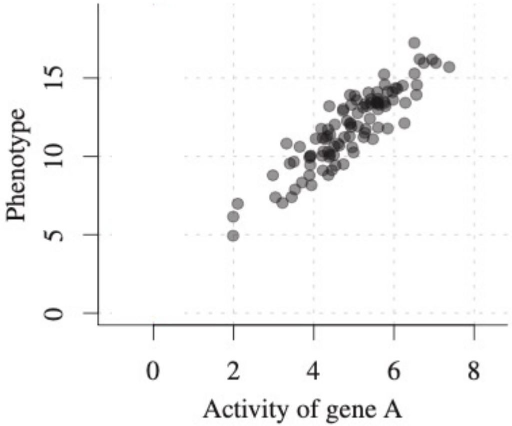
Shit… what do we do now? Who is responsible?
Well, you did this, you devil!

Let’s go back in time, shall we?

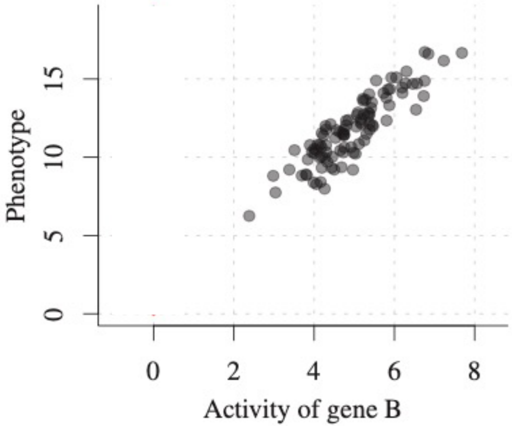


In ML for instance, we'll encounter data sets like on the left…

Dataset I

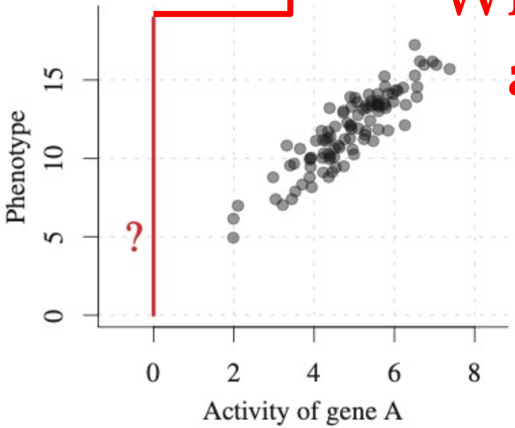


Dataset II



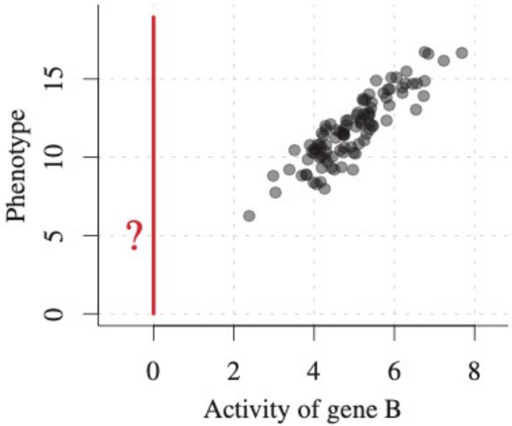
But, what is the difference between datasets I & II w.r.t. learning?

Dataset I



What if we kill the activity of the gene?

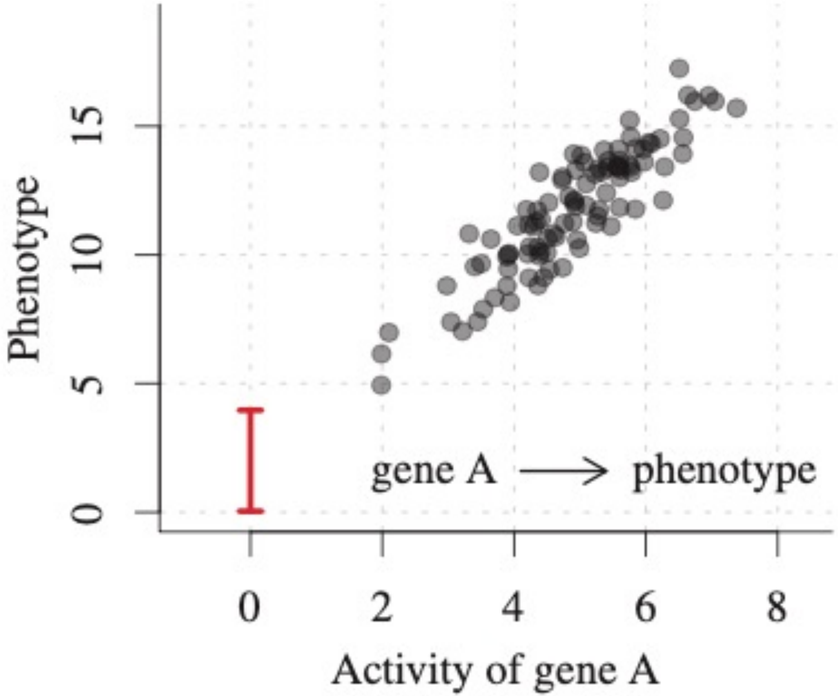
Dataset II



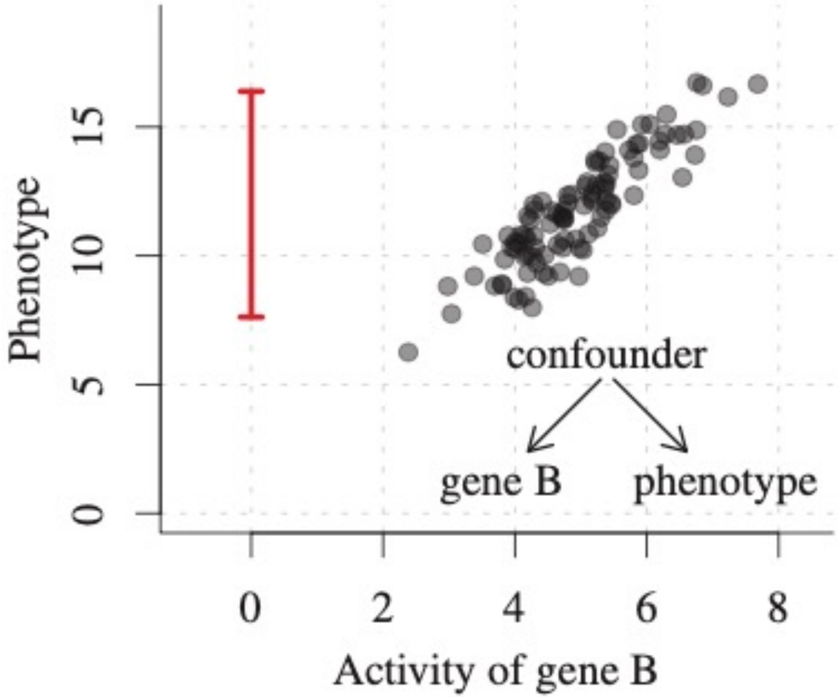
We might ask about the difference w.r.t. **generalization**!

That is, looking *outside* the original sample!

Changing gene A *will change* the phenotype, that is **why** our 1st experiment worked!



Changing gene B *will not change* the phenotype, that is **why** our 2nd experiment failed!

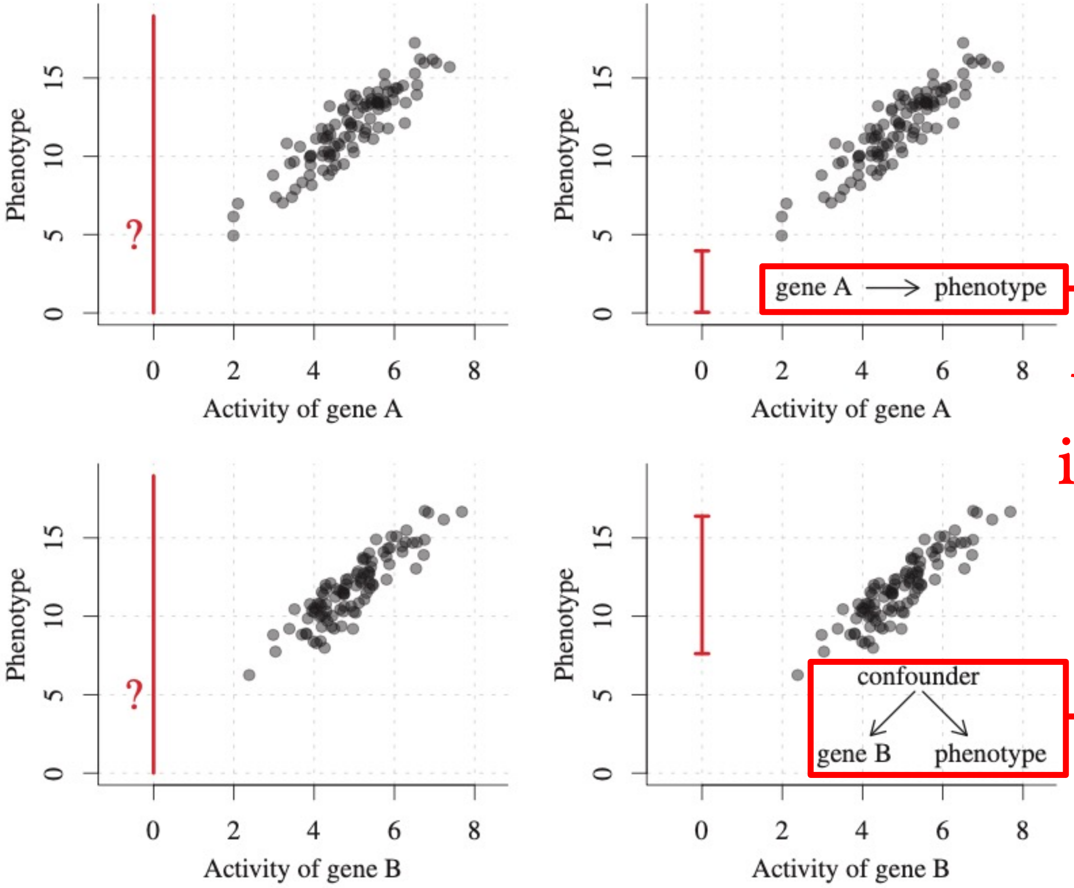


What if we kill the activity of the gene?

Then we expect the following range

Dataset I

Dataset II



the difference is in the underlying **Causality!**

If you had considered **causality**, then those lives could’ve been saved maybe…

Causal Inference

modelling assumptions **outside** the data
identification & estimation
graph learning
etc.

Reichenbach's principle

Identification

Simpson's Paradox

Disentanglement

CHT

Interventions

DAGs

dHSIC

Pearl's Hiearchy

ATE

Confounder

Counterfactuals

Causal Effects

CXPlain

Counterfactual Fairness

Granger causality

d-separation

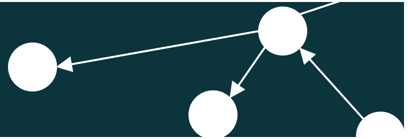
Potential Outcomes

NCM

Ignorability

Fundamental Problem of CI

Causality is Alive!



Causal Representation Learning

GES

"Clever Hans" Fallacies

Structural Causal Model

Actual causality

RFVs

but-for

Bayesian Network

Causal Discovery

RCT

Counterfactual Distance

DCD-FG

Causal Parrots

ANMs

Adjustment Set

Faithfulness

FCI

Markovianity

do-calculus

Weak Sufficiency

Exogenous

PC

interventional SPNs

Next up: **Code Tutorial**

Go to

`continualcausality.org/program/`

to access the code