Lecture 000

Why are we here?

Edward Rubin

05 January 2020

Admin

Admin

In-class today

- **Course website:** https://github.com/edrubin/EC524W21/
- Syllabus (on website)
- In person?

TODO list

- **Assignment** in-class Thursday (finish outside of class)
- Upcoming readings:
  - ISL Ch1–Ch2
  - Prediction Policy Problems by Kleinberg *et al.* (2015)

What's the goal?

What's the goal?

What's different?

We've got a whole class on **prediction**. Why?

Up to this point, we've focused on causal **identification/inference** of β, *i.e.*,

$$\text{Y}_i = \mathbf{X}_i \beta + \boldsymbol{u}_i$$

meaning we want an unbiased (consistent) and precise estimate $\hat{\beta}$.

With **prediction**, we shift our focus to accurately estimating outcomes.

In other words, how can we best construct $\hat{\text{Y}}_i$?

What's the goal?

... so?

So we want "nice"-performing estimates $\hat{y}$ instead of $\hat{\beta}$.

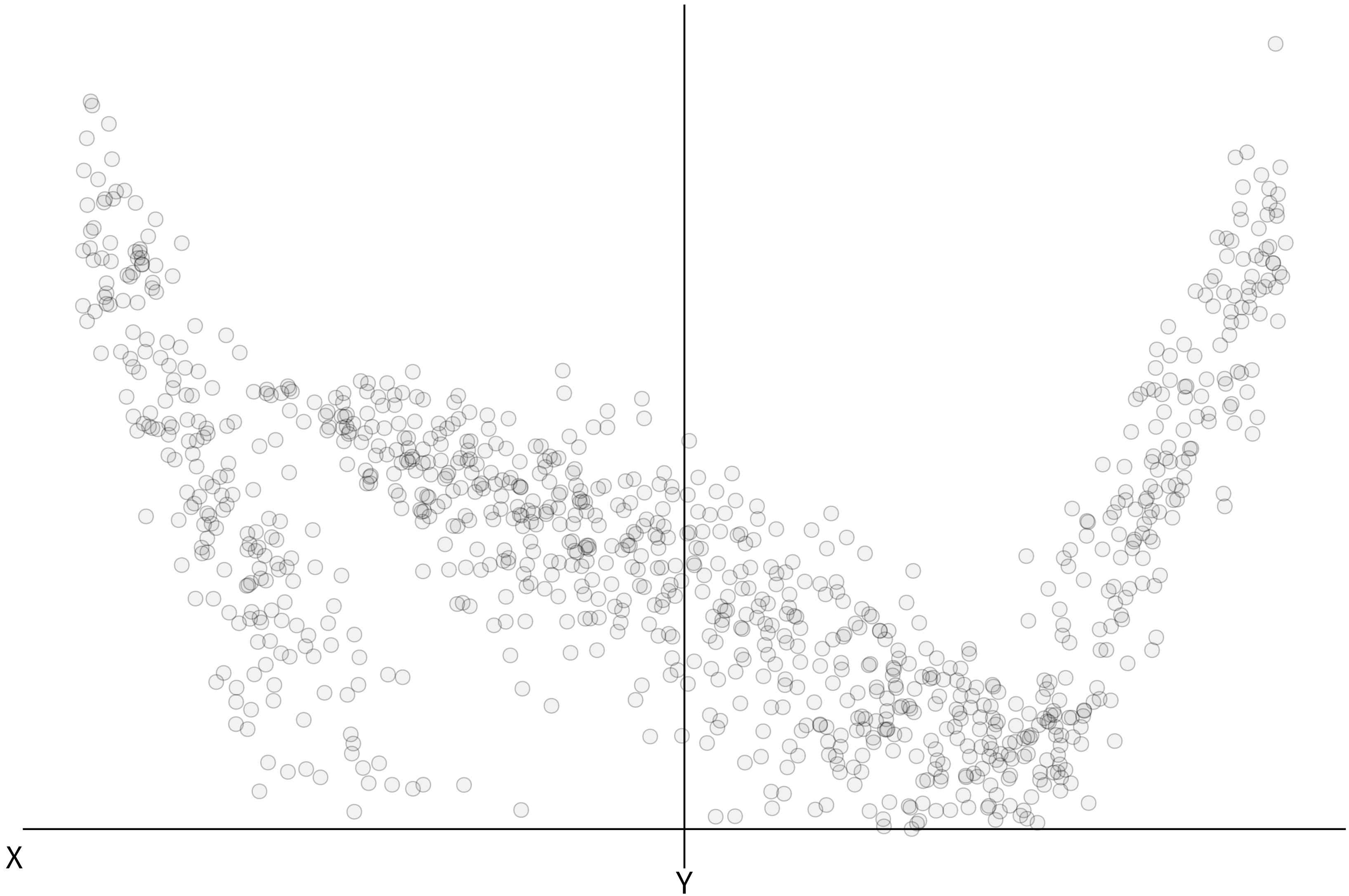
Q Can't we just use the same methods (*i.e.*, OLS)?

A It depends. How well does your **linear**-regression model approximate the underlying data? (And how do you plan to select your model?)

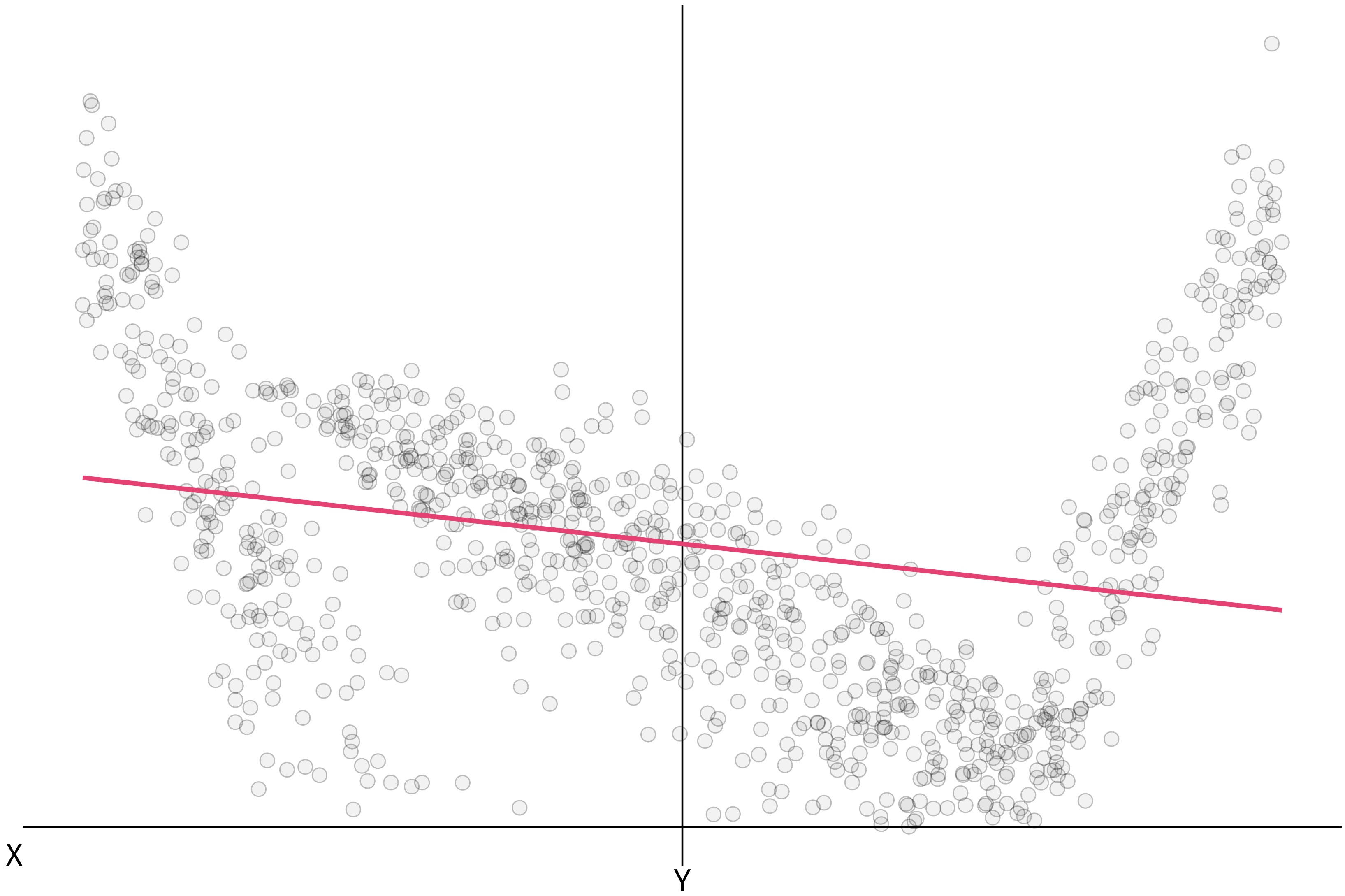
Recall Least-squares regression is a great **linear** estimator.

Data data be tricky[†]—as can understanding many relationships.

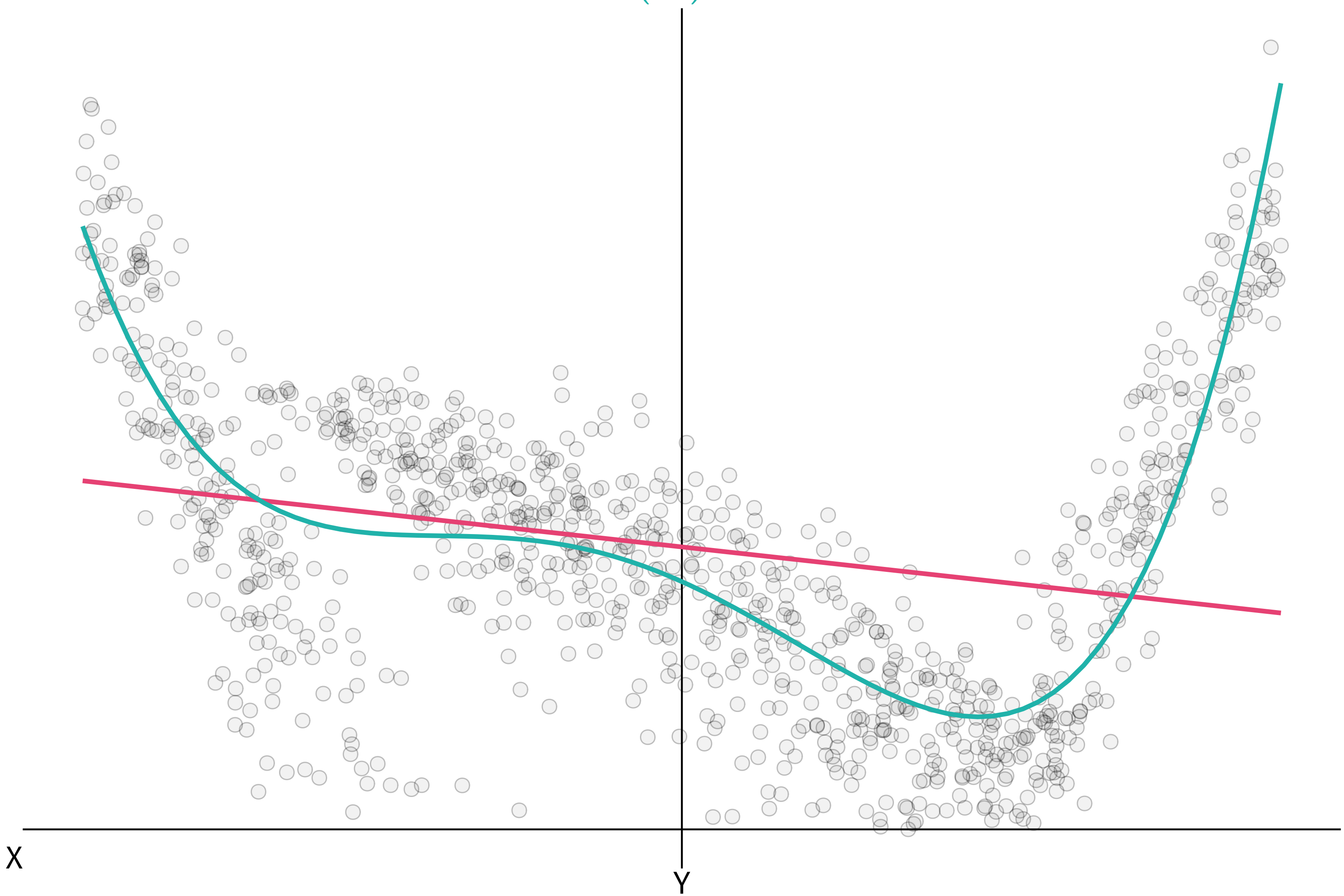
† "Tricky" might mean nonlinear... or many other things...

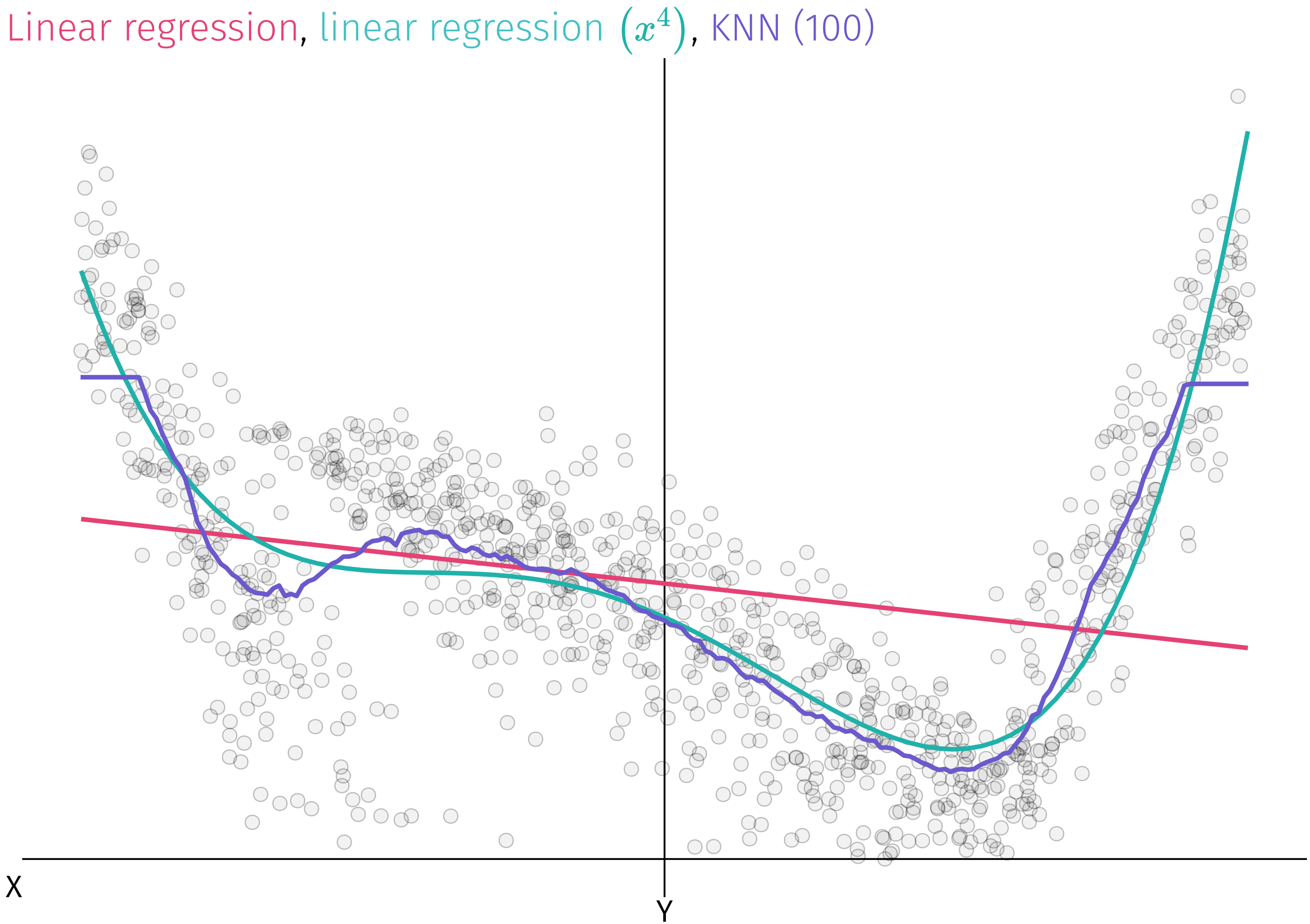

X
Y

Linear regression

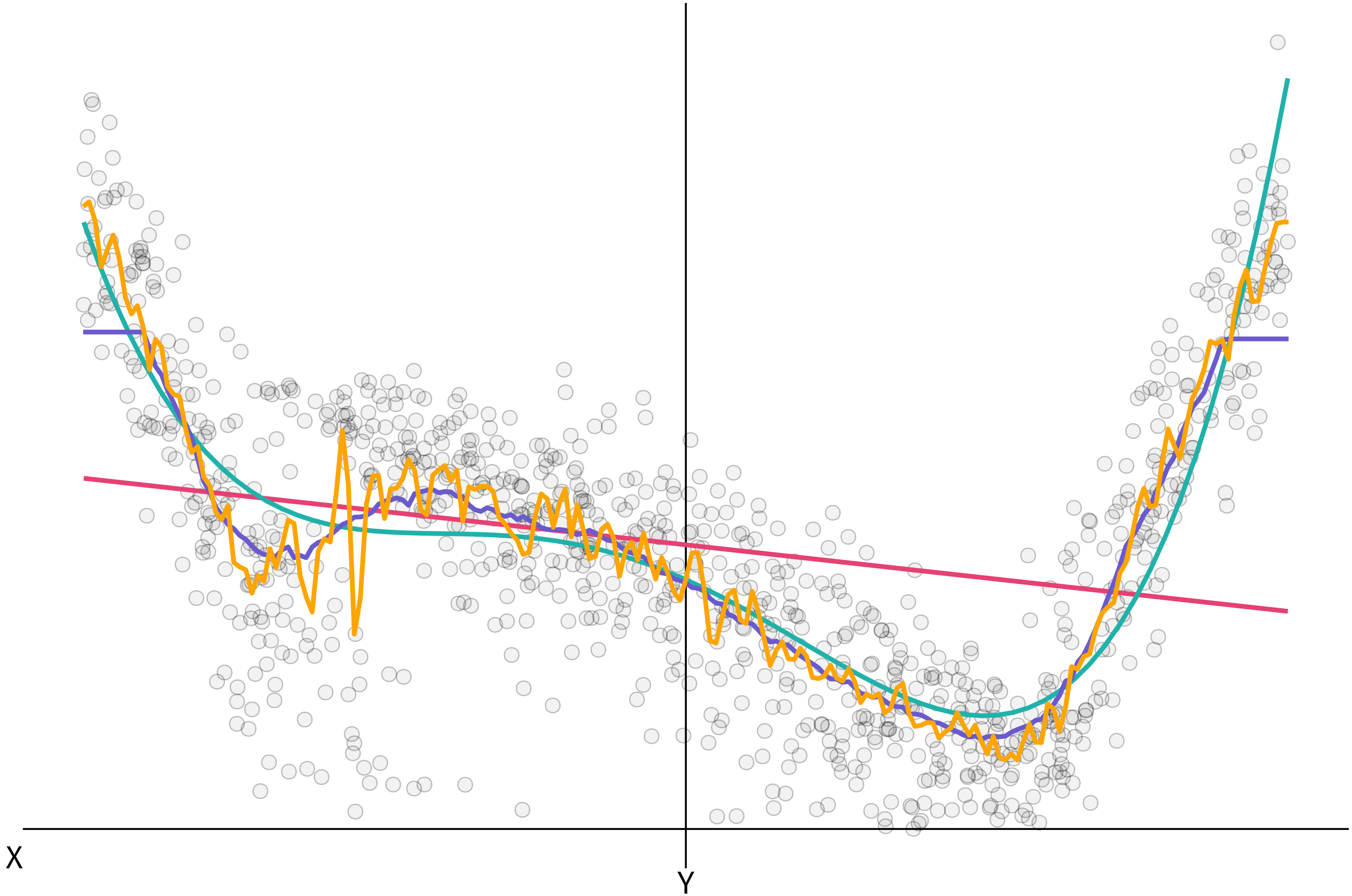


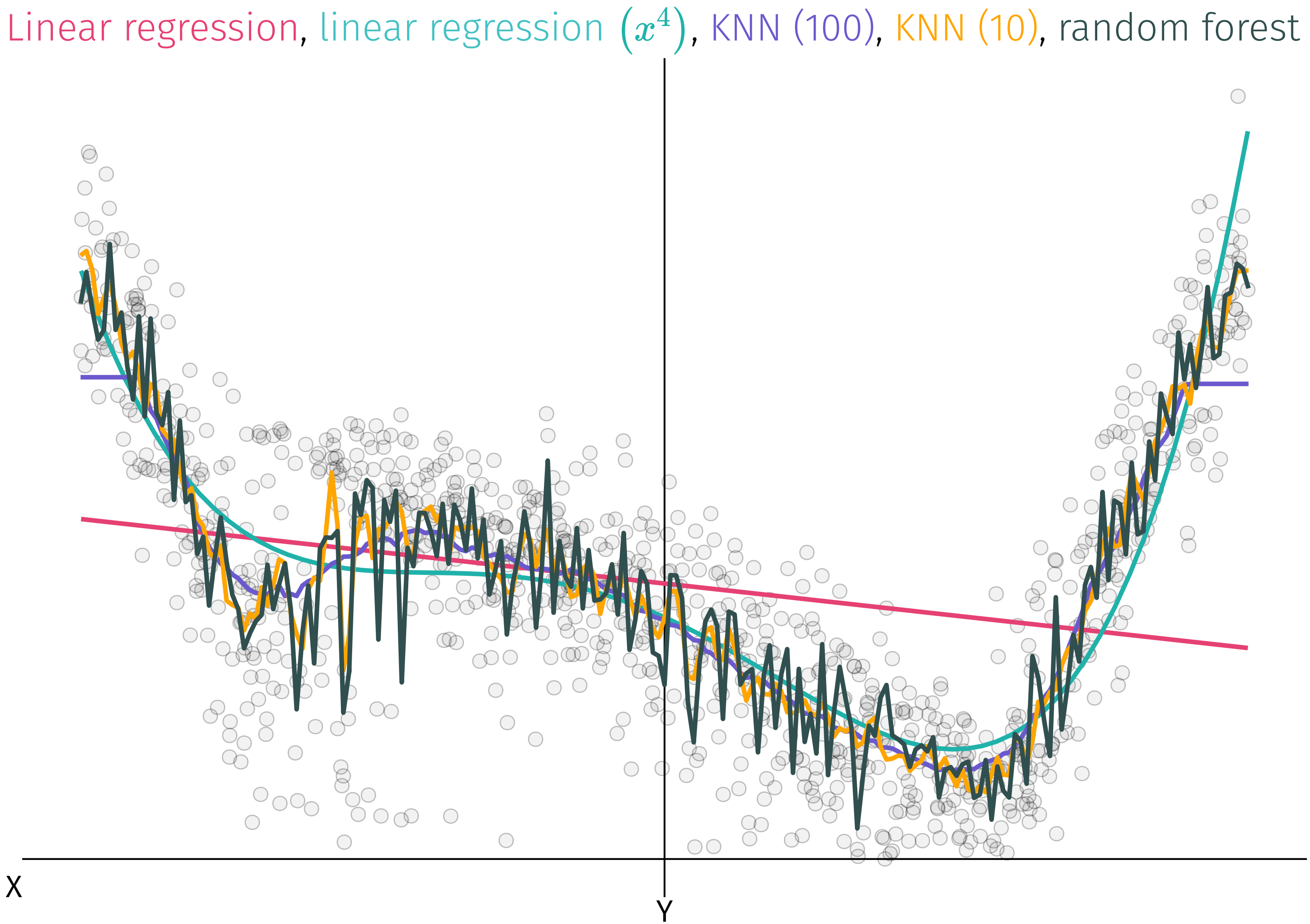
Linear regression, linear regression (x^4)




Linear regression, linear regression (x^4), KNN (100)
X
Y

Linear regression, linear regression (x^4), KNN (100), KNN (10)





Linear regression, linear regression (x^4), KNN (100), KNN (10), random forest
X
Y

Note That example only had one predictor...

What's the goal?

Tradeoffs

In prediction, we constantly face many tradeoffs, *e.g.*,

- **flexibility** and **parametric structure** (and interpretability)
- performance in **training** and **test** samples
- **variance** and **bias**

As your economic training should have predicted, in each setting, we need to **balance the additional benefits and costs** of adjusting these tradeoffs.

Many machine-learning (ML) techniques/algorithms are crafted to optimize with these tradeoffs, but the practitioner (you) still needs to be careful.

What's the goal?

There are many reasons to step outside the world of linear regression...

Multi-class classification problems

- Rather than {0,1}, we need to classify y_i into 1 of K classes
- *E.g.*, ER patients: {heart attack, drug overdose, stroke, nothing}

Text analysis and **image recognition**

- Comb though sentences (pixels) to glean insights from relationships
- *E.g.*, detect sentiments in tweets or roof-top solar in satellite imagery

Unsupervised learning

- You don't know groupings, but you think there are relevant groups
- *E.g.*, classify spatial data into groups

Stanford University (Stanford, CA) researchers have developed a deep-learning algorithm that can evaluate chest X-ray images for signs of disease at a level exceeding practicing radiologists.

Parking Lot Vehicle Detection Using Deep Learning

THE NEW YORKER

A REPORTER AT LARGE OCTOBER 14, 2019 ISSUE

The Next Word

Where will predictive text take us?

Text by John Seabrook

Gender Classifier	Darker Male	Darker Female	Lighter Male	Lighter Female	Largest Gap
Microsoft	94.0%	79.2%	100%	98.3%	20.8%
FACE++	99.3%	65.5%	99.2%	94.0%	33.8%
IBM	88.0%	65.3%	99.7%	92.9%	34.4%

Takeaways?

What are your main takeaways from these examples?

Mine

- Interactions and nonlinearities likely matter
- *Engineering* features/variables can be important
- Flexibility is huge—but we still want to avoid overfitting

Next time Start formal building blocks of prediction.

Sources

Sources (articles) of images

- Deep learning and radiology
- Parking lot detection
- *New Yorker* writing
- Gender Shades

Table of contents