Assessing the Impact of Data Quality on Pavement Management Systems

By

Ahmad Alhasan and Omar Smadi

Center for Transportation Research and Education/ Iowa State University

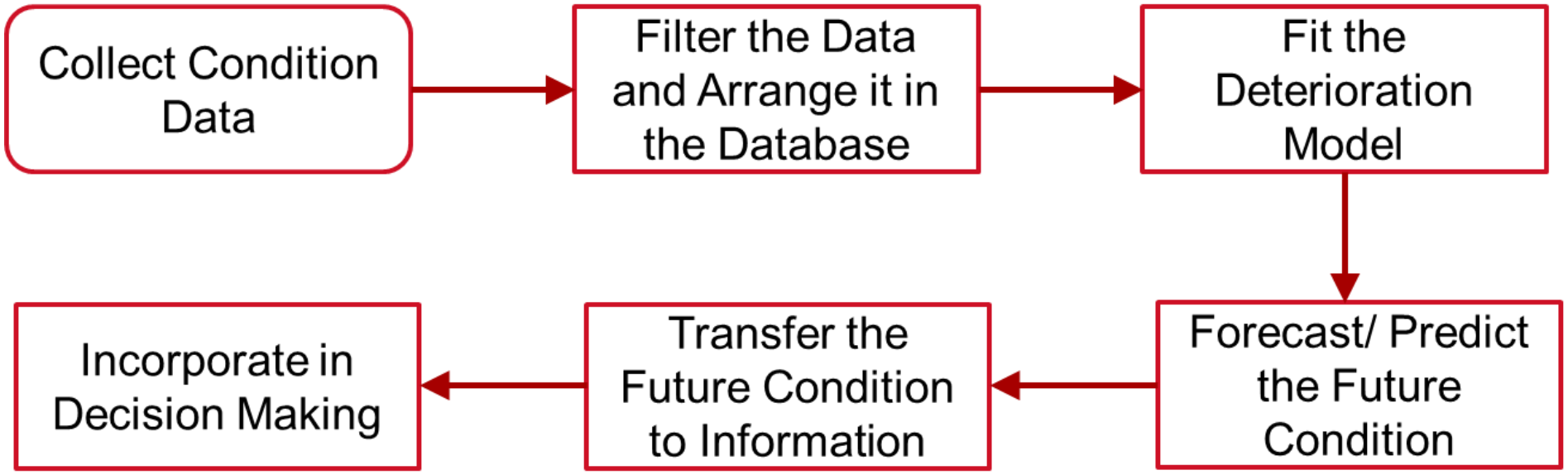
aalhasan@iastate.edu

RPUG Road Profile Users' Group

Observe, analyze, model, predict, and decide.

Leonardo Fibonacci 1170 - 1250

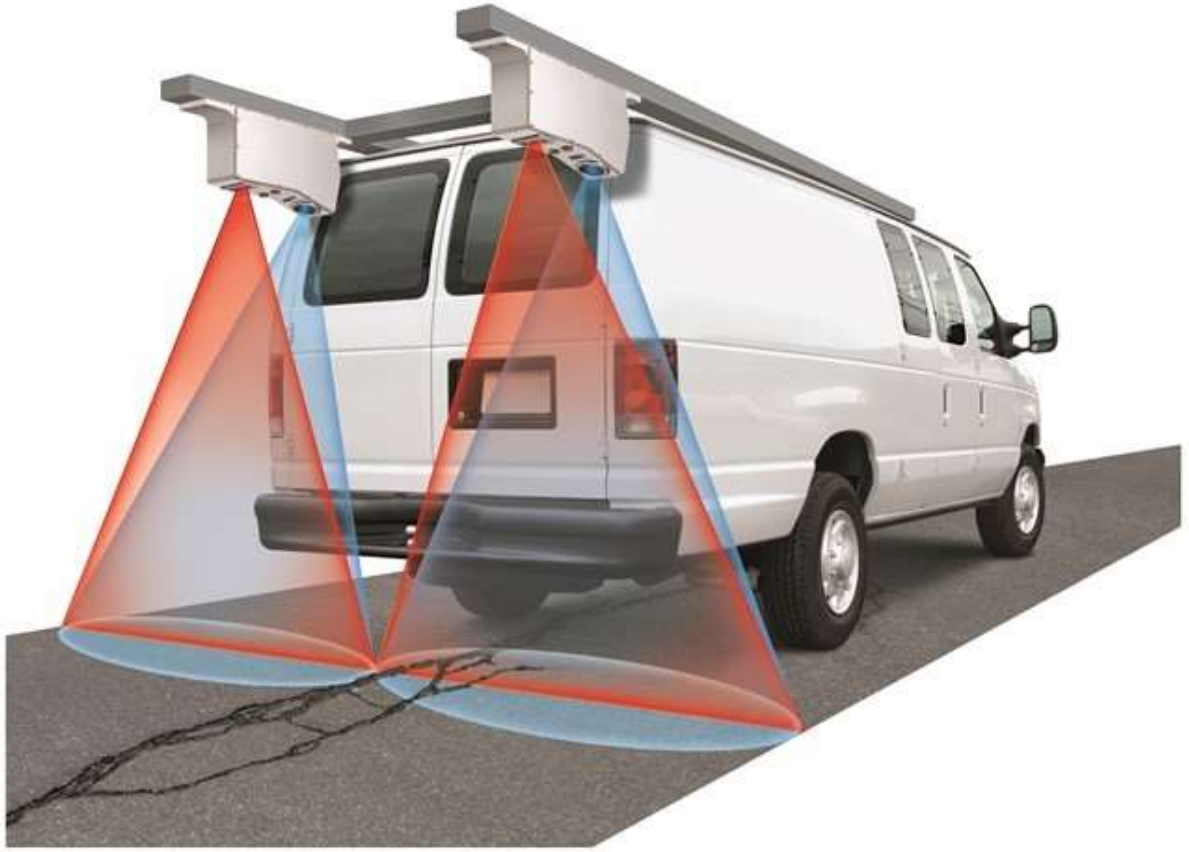
From data collection to decision making.



It all starts with monitoring and evaluation inventory.

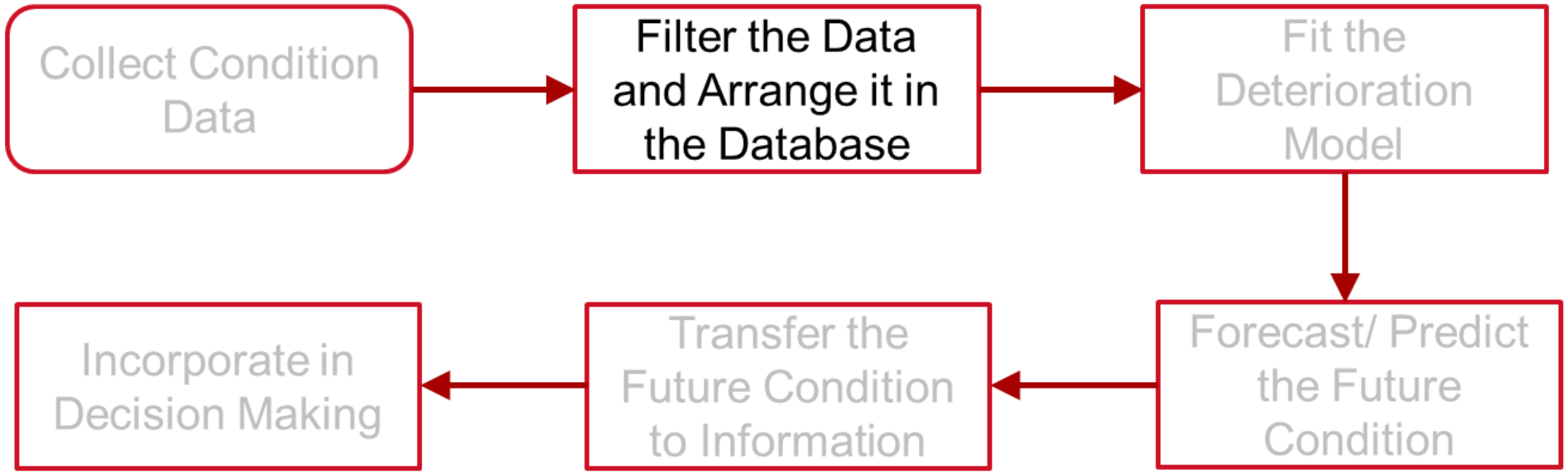
https://newscenter.nmsu.edu/articles/view/8486

It all starts with monitoring and evaluation inventory.



http://www.pavemetrics.com/applications/road-inspection/lcms2-en/#!

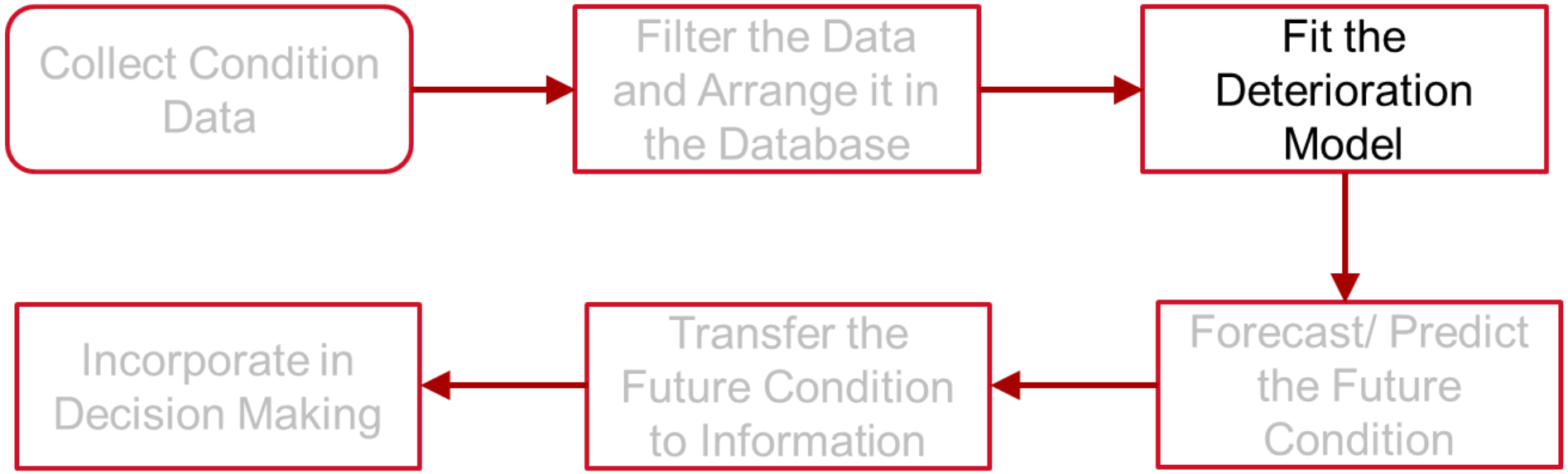
From data collection to decision making.



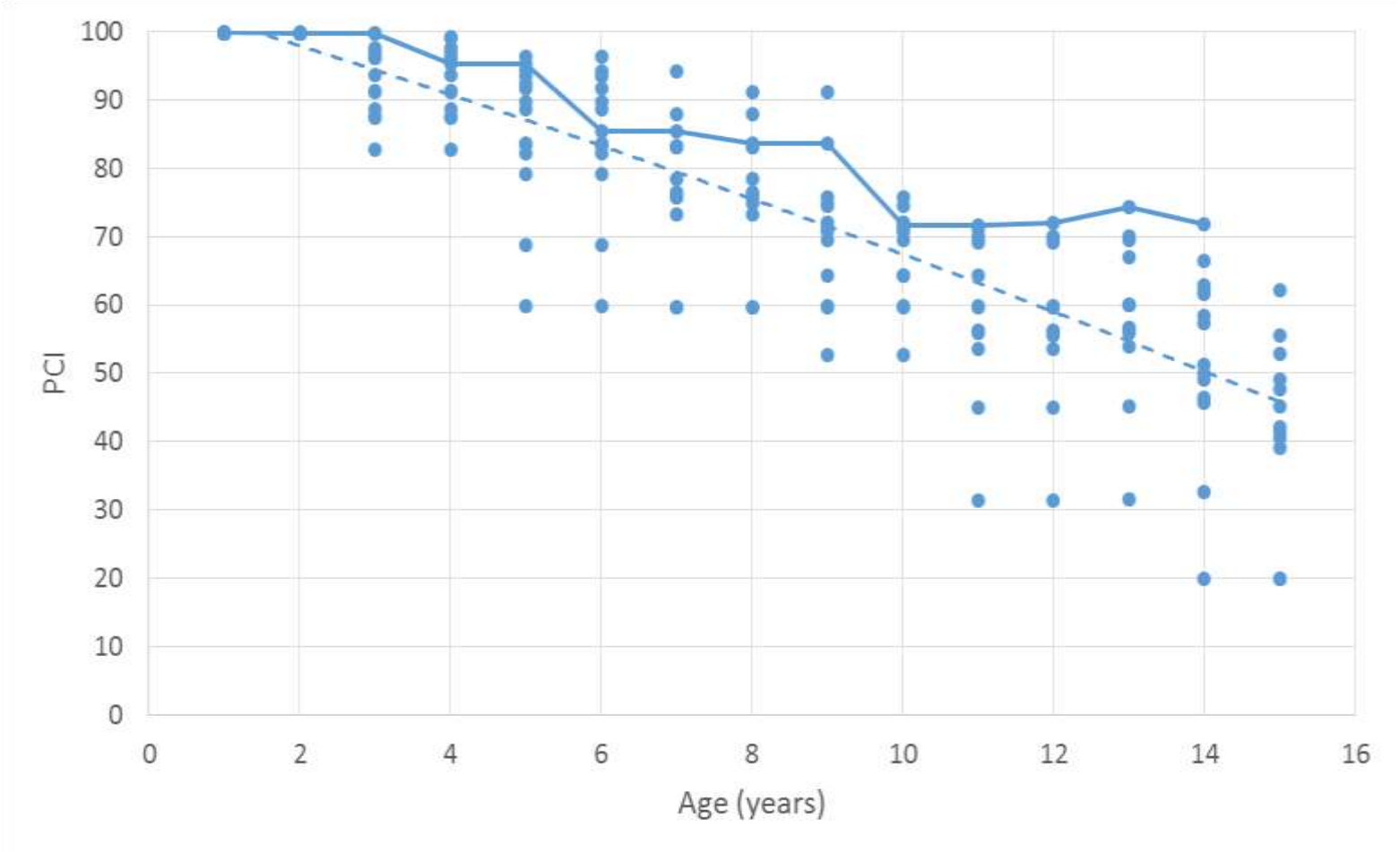
Data can be arranged in a GIS database.

http://data.iowadot.gov/datasets/48bfff7ffbfa4555bed8c374e44c9300_3?geometry=-102.09%2C40.522%2C-84.666%2C43.381

From data collection to decision making.



Performance starts beautiful and becomes ugly.



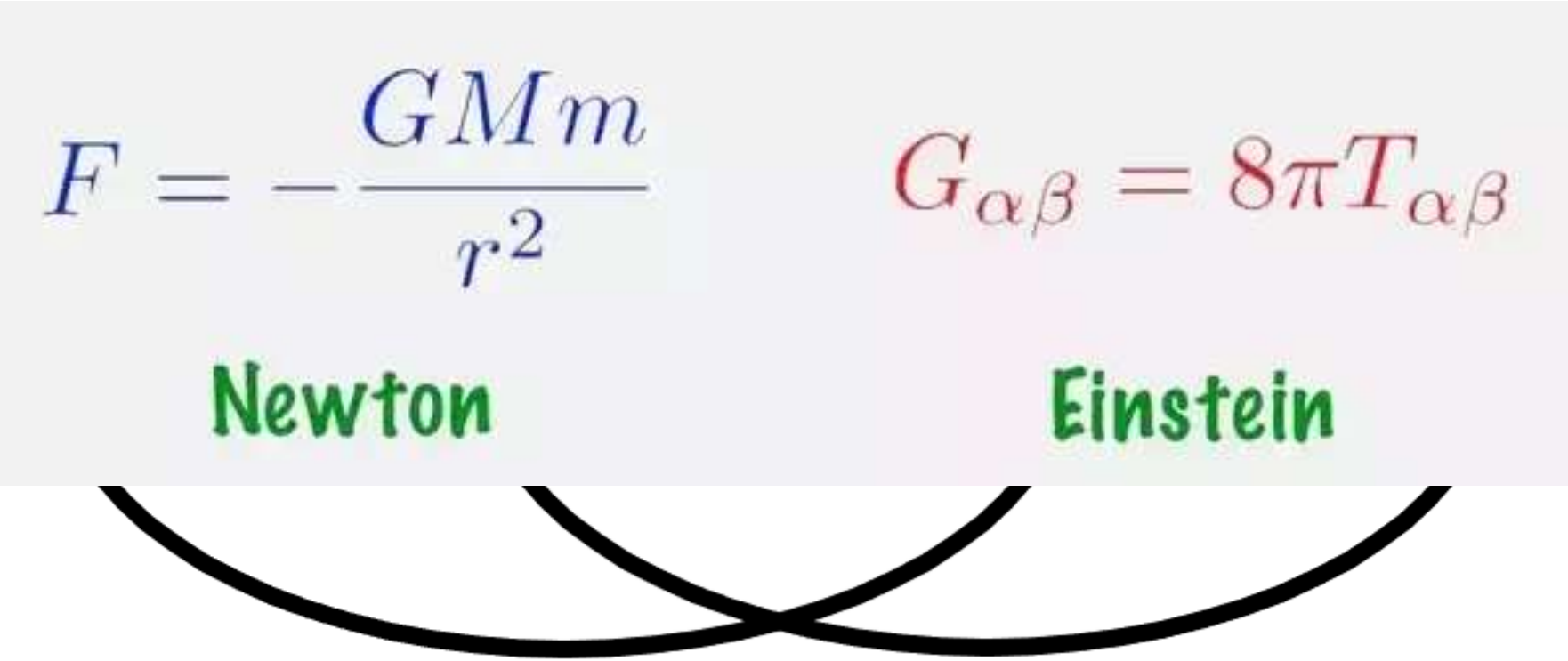
PE 2019

RPUG Road Profile Users' Group

Shopping for models.

https://www.workingmother.com/back-to-school-childrens-fashion-2016

A model can be a law or a theory.



https://en.wikipedia.org/wiki/Scientific_law

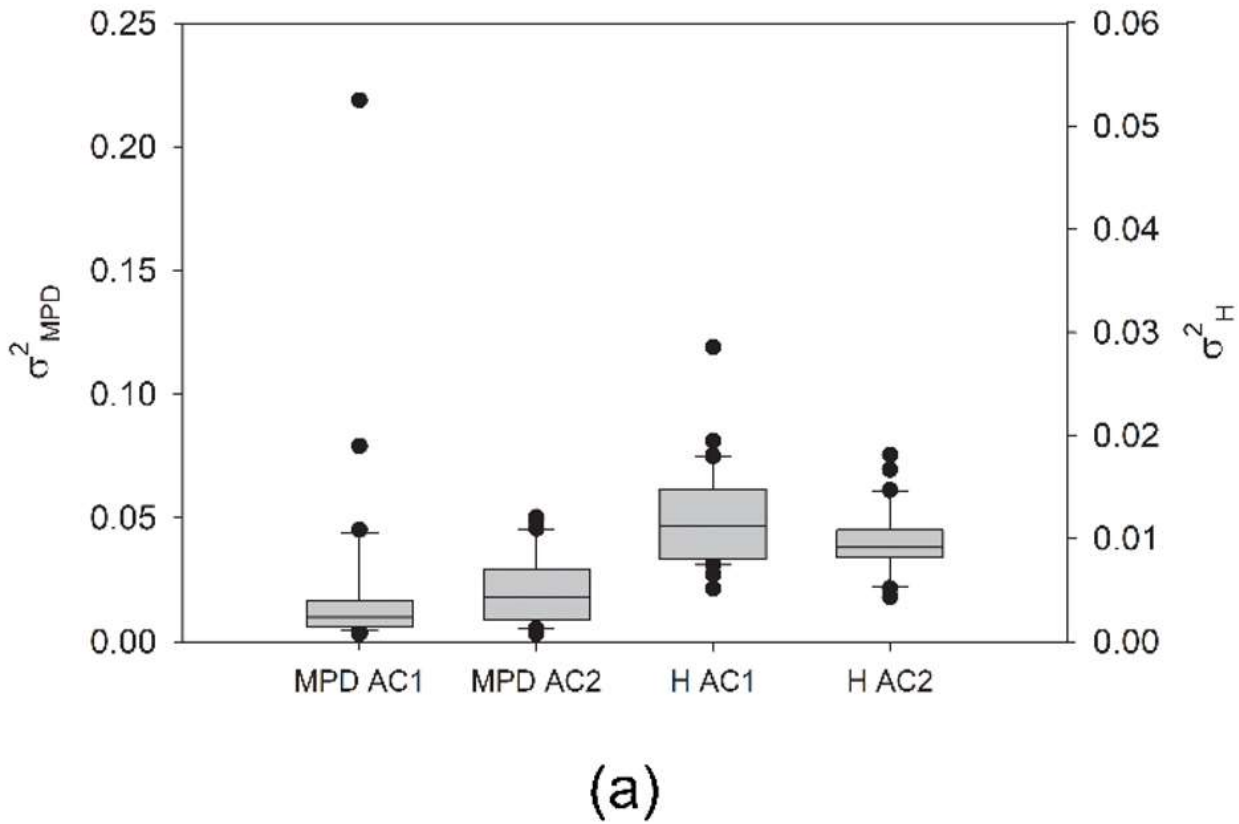
What is a model?

- Mathematically we can define (model) any condition data observation for any asset as a function $f(\mathbf{X}, t)$ with error term ϵ_i:

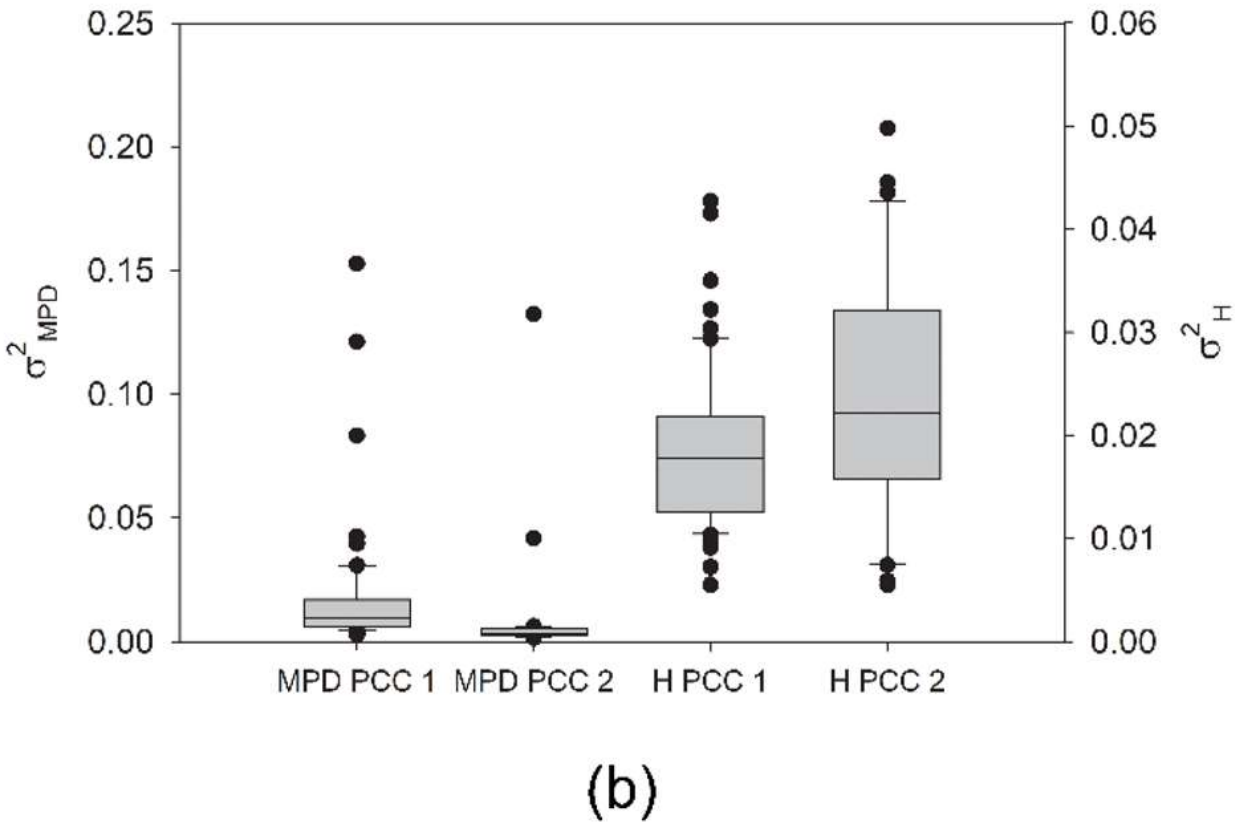
$$y_i = f(\mathbf{X}, t) + \epsilon_i$$

- Where y_i is the condition record described as a function of multiple independent variables contained in $\mathbf{X}$ at a given time *t*.
- Many approaches can be used to find the function describing the change in condition over time.

Variability or Uncertainty?!



(a)

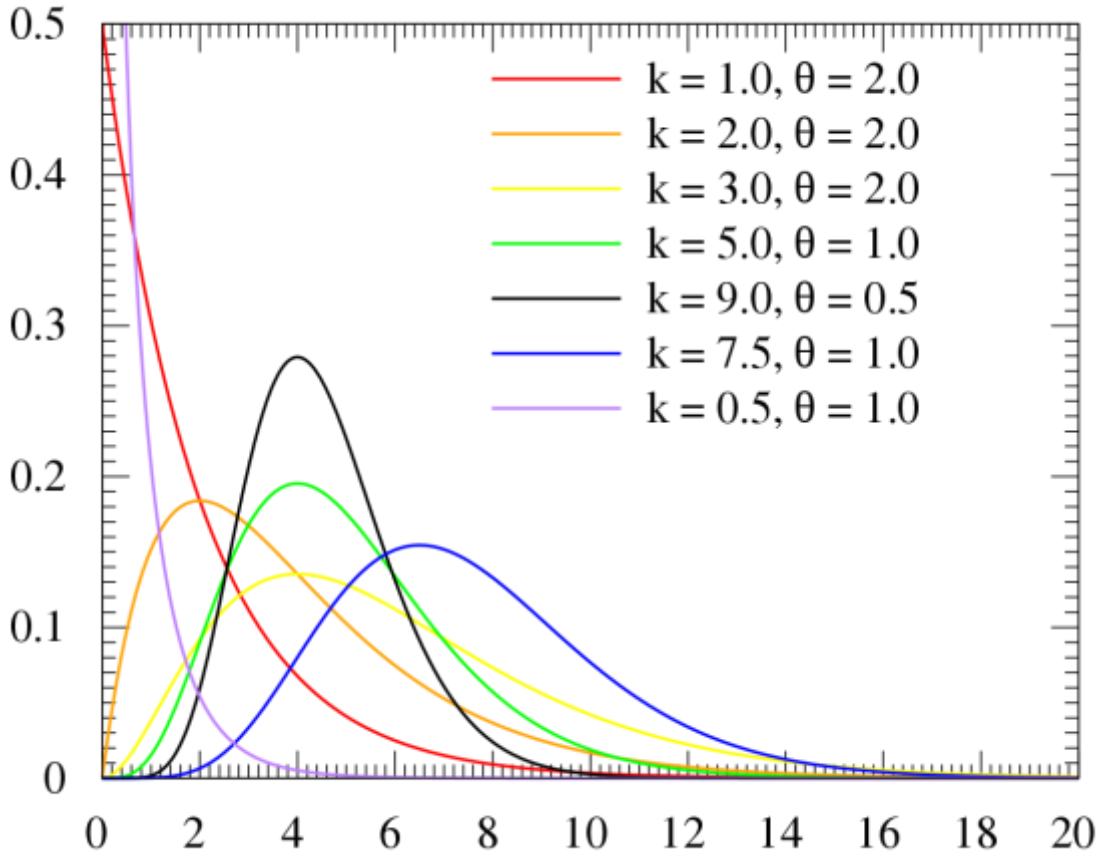


(b)

PE 2019

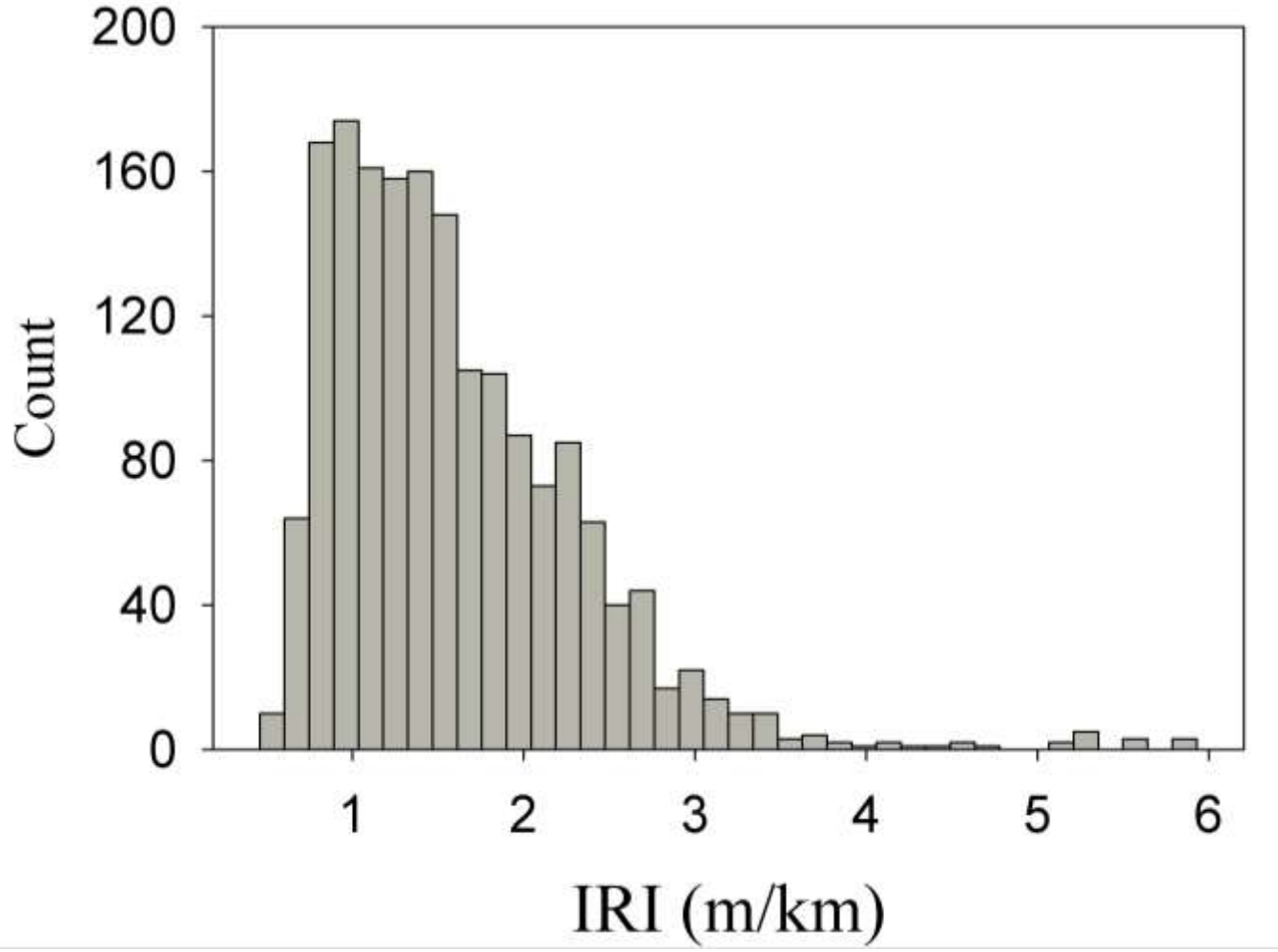
RPUG Road Profile Users' Group

Variability or Uncertainty?!

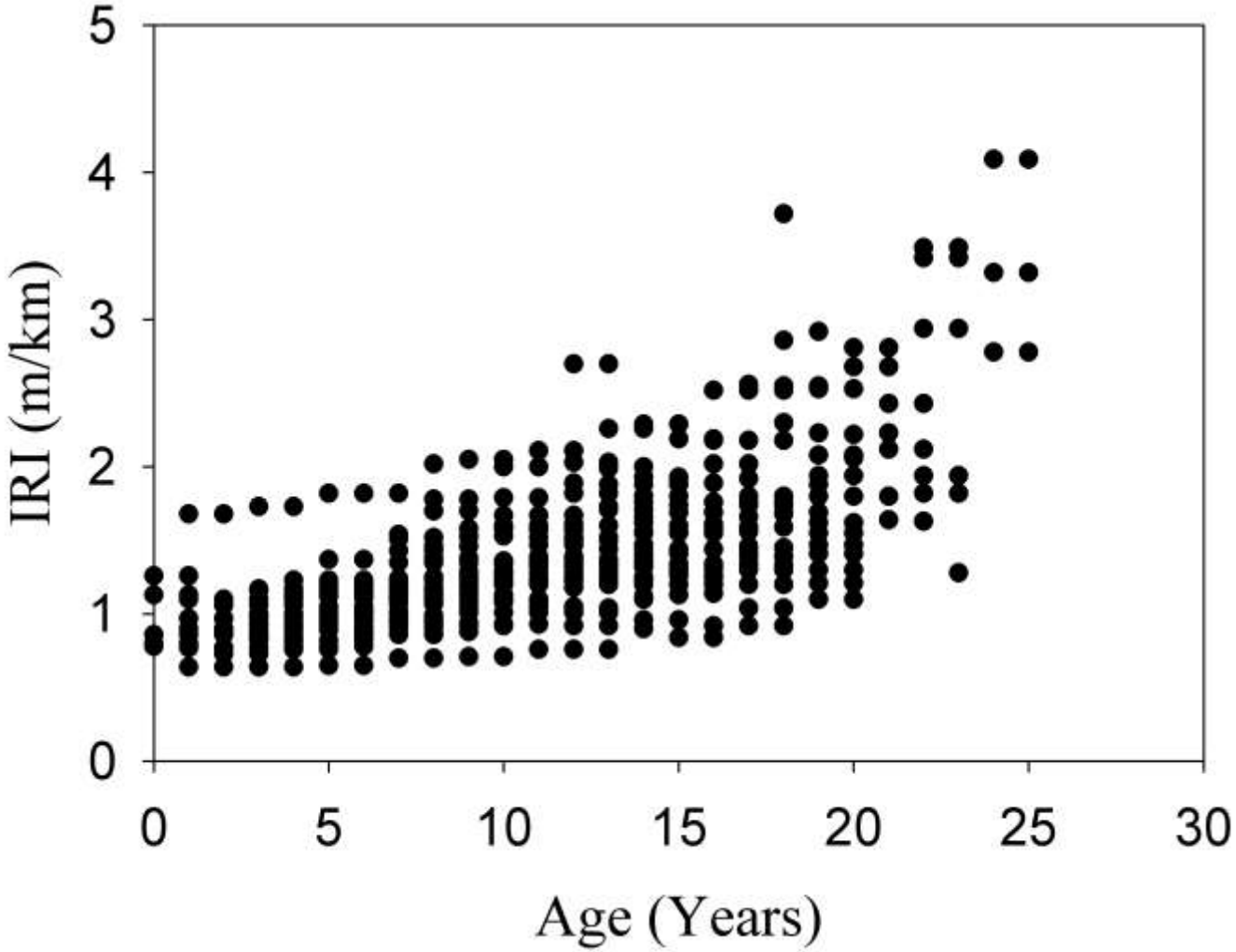


https://en.wikipedia.org/wiki/Gamma_distribution

Check the assumptions.



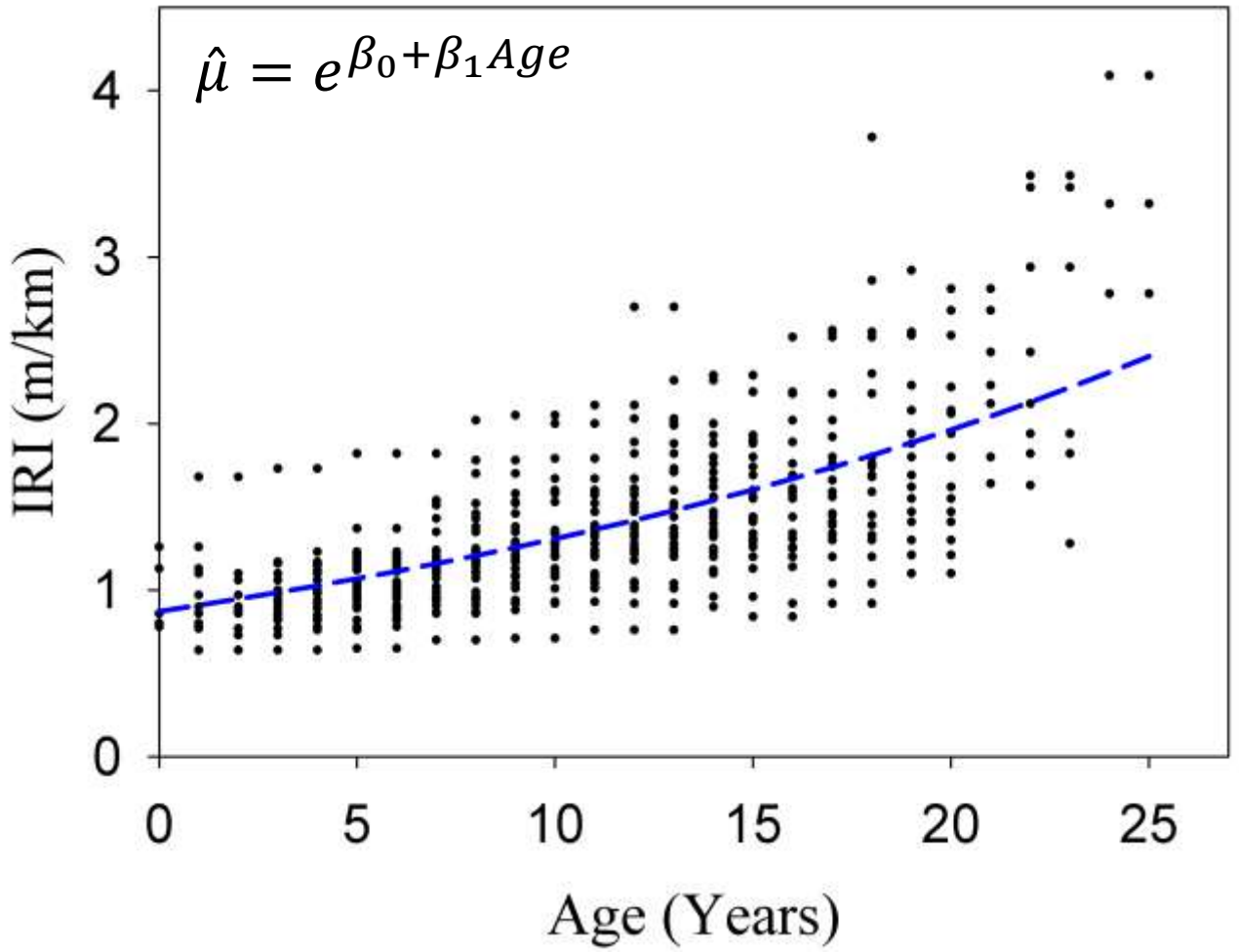
Check the assumptions.



PE 2019

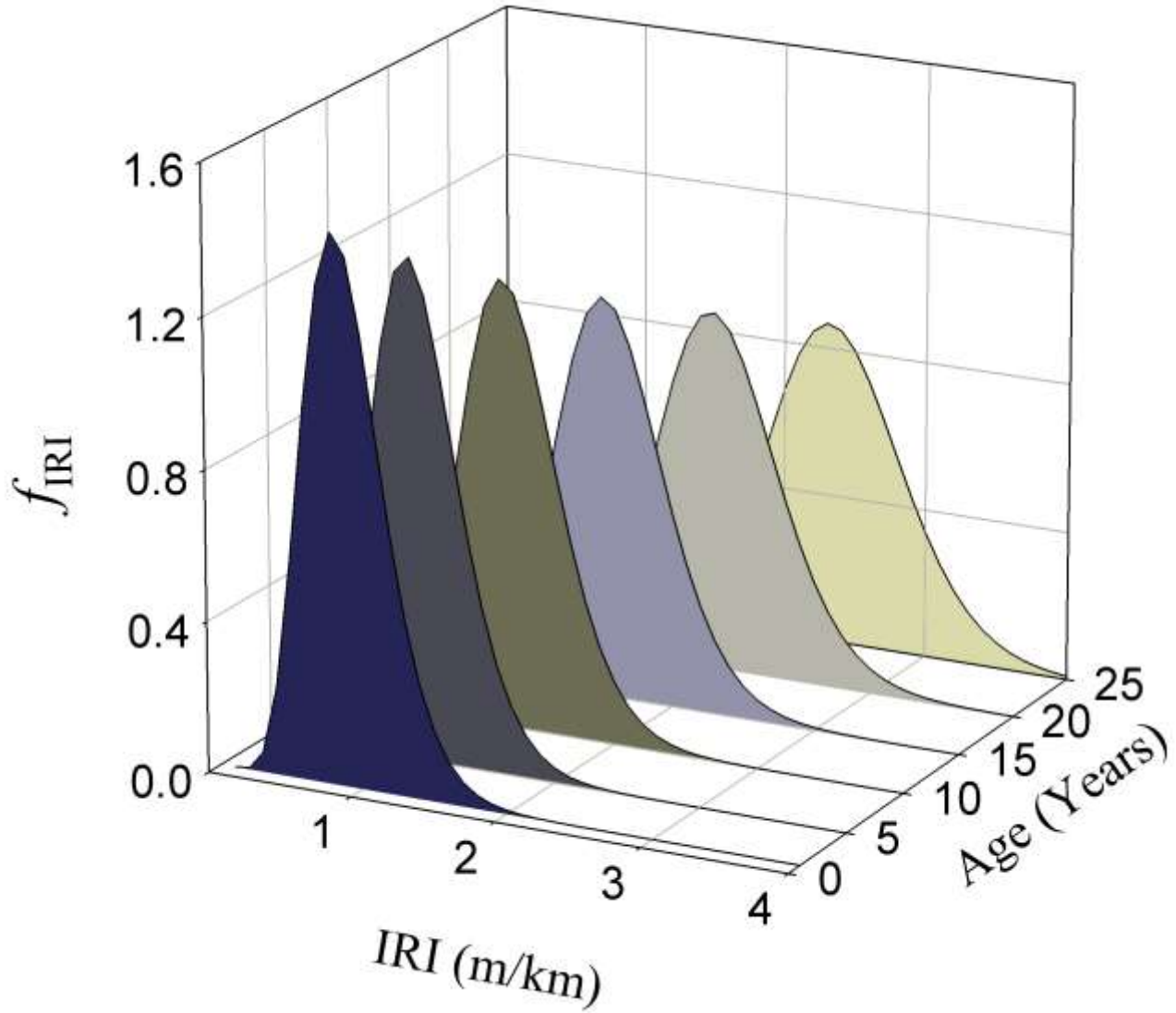
RPUG Road Profile Users' Group

Choose proper regression model.



Look deeper.

- $f_{IRI} = \frac{IRI^{(\hat{\mu}/T)-1} e^{-IRI/\varphi}}{\Gamma[\hat{\mu}/\varphi]\varphi^{\hat{\mu}/\varphi}}$
- $E[IRI] = \hat{\mu}$
- $Var(IRI) = \hat{\mu}\varphi$

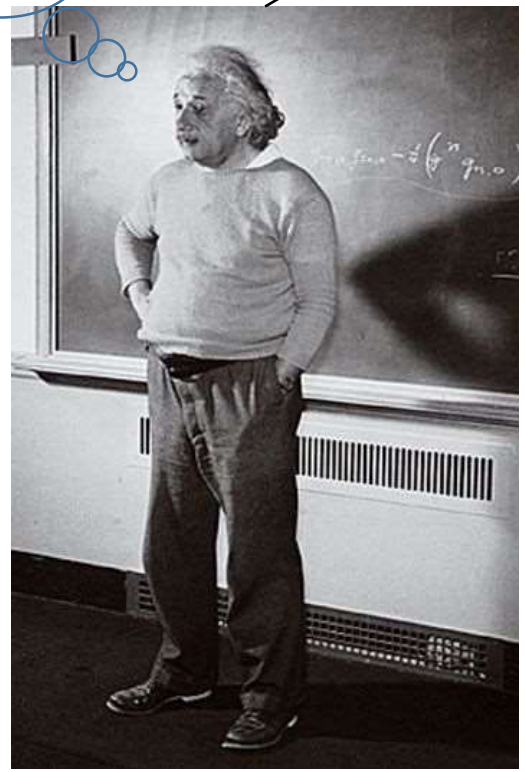


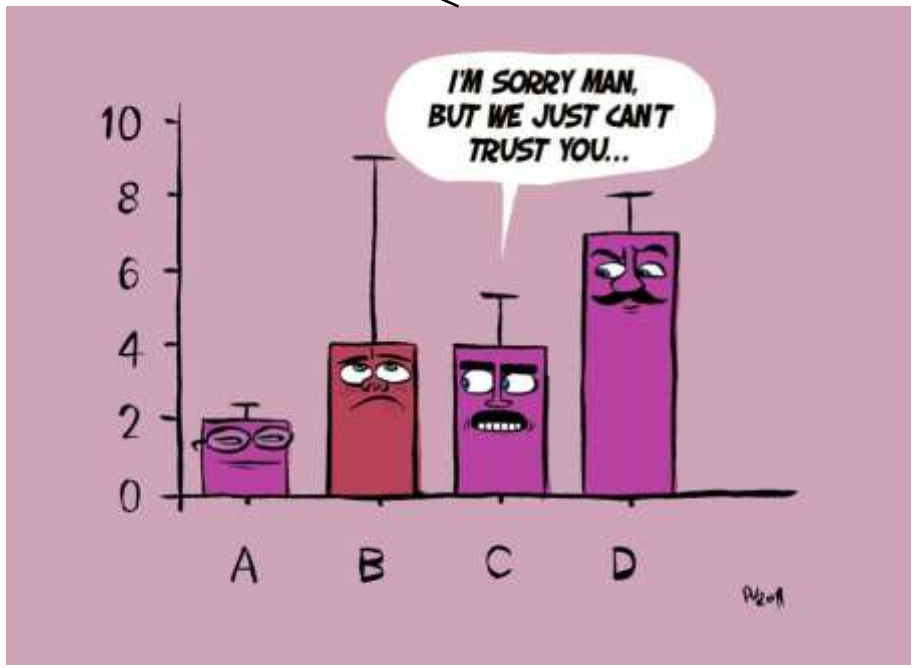
RPUG Road Profile Users' Group

Variability and Uncertainty Decomposition.

Is my model good?!

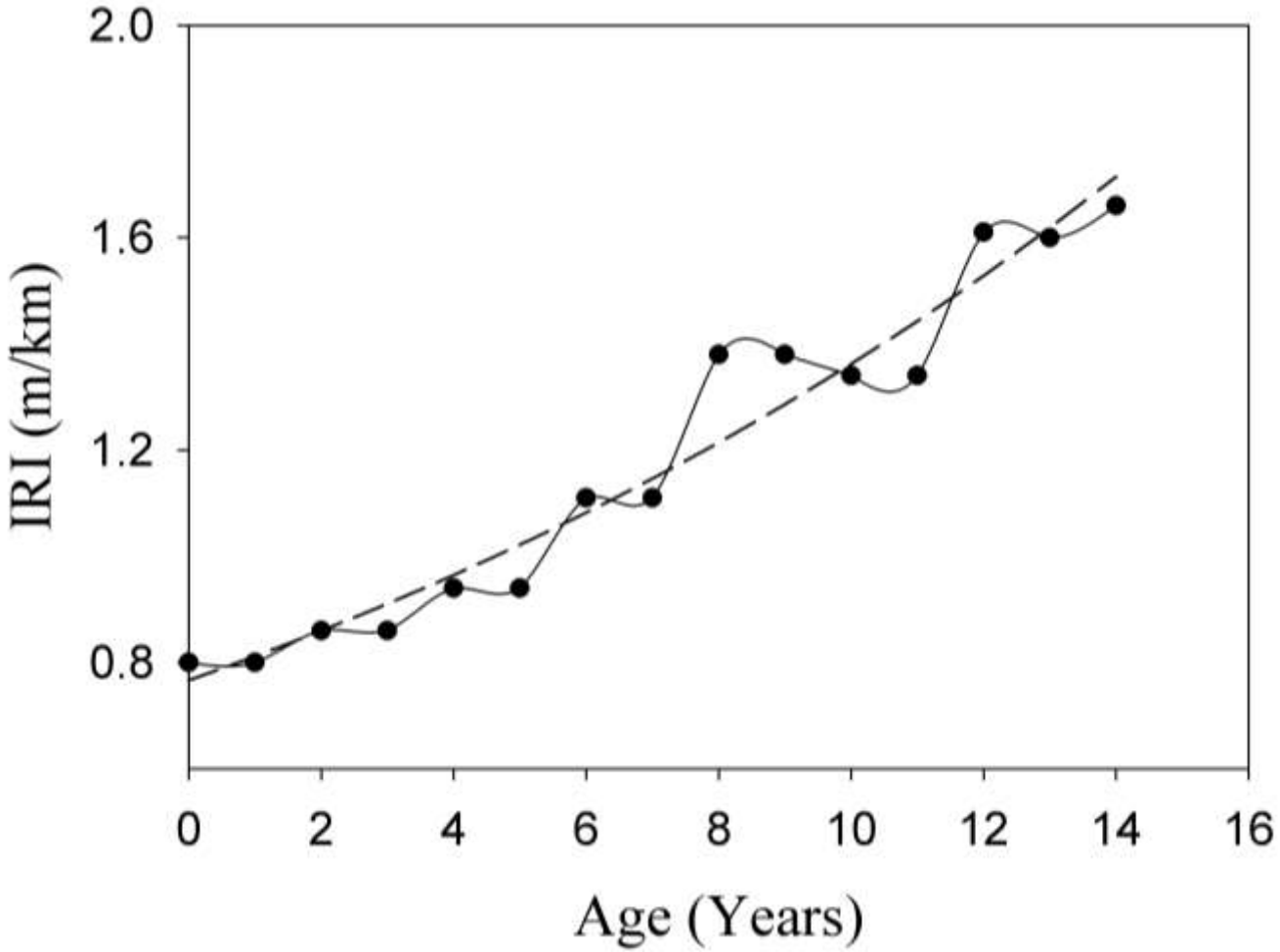
$$y_i = f(\mathbf{X}, t) + \epsilon_i$$



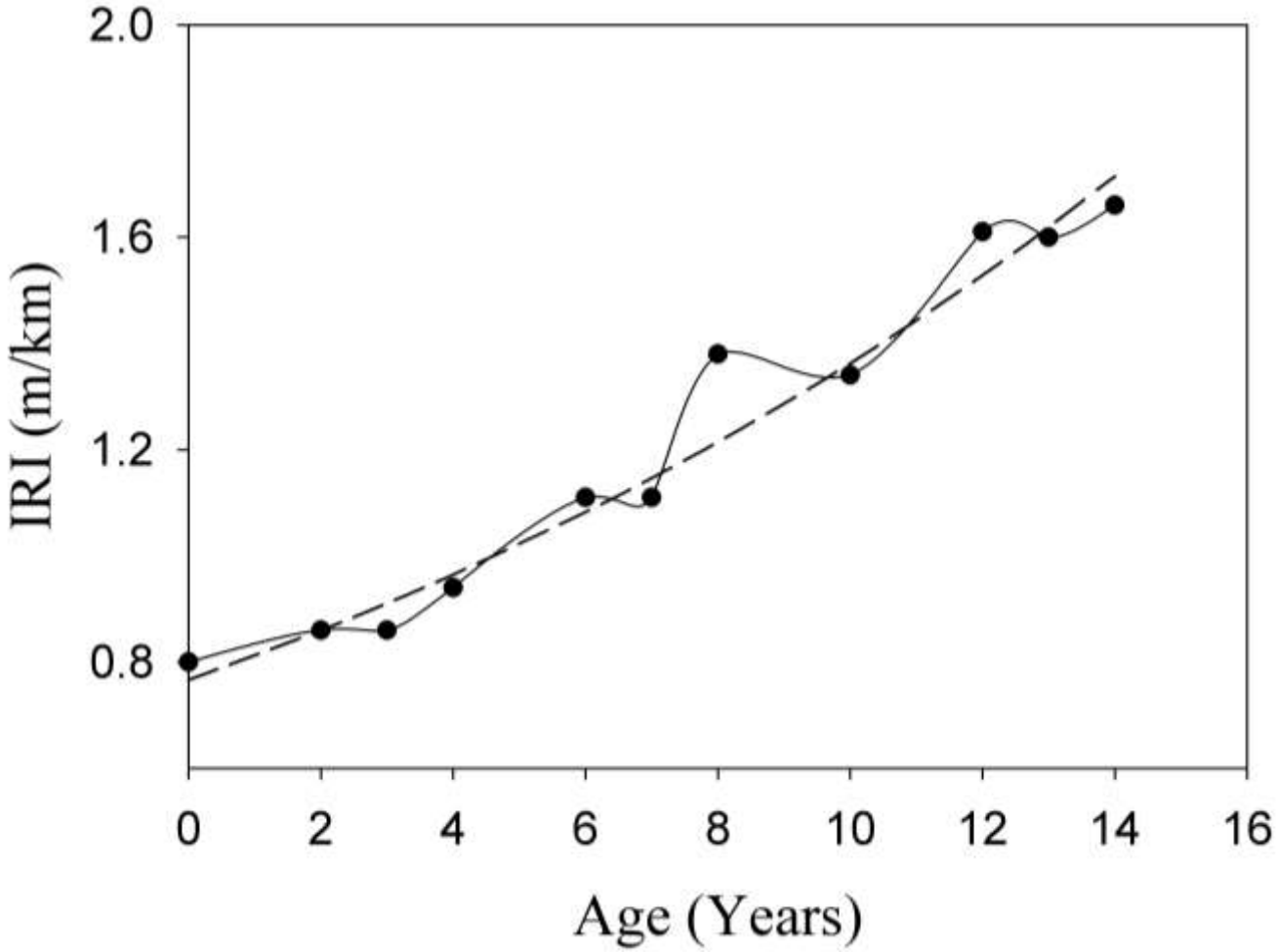


http://berkeleysciencereview.com/importance-uncertainty/

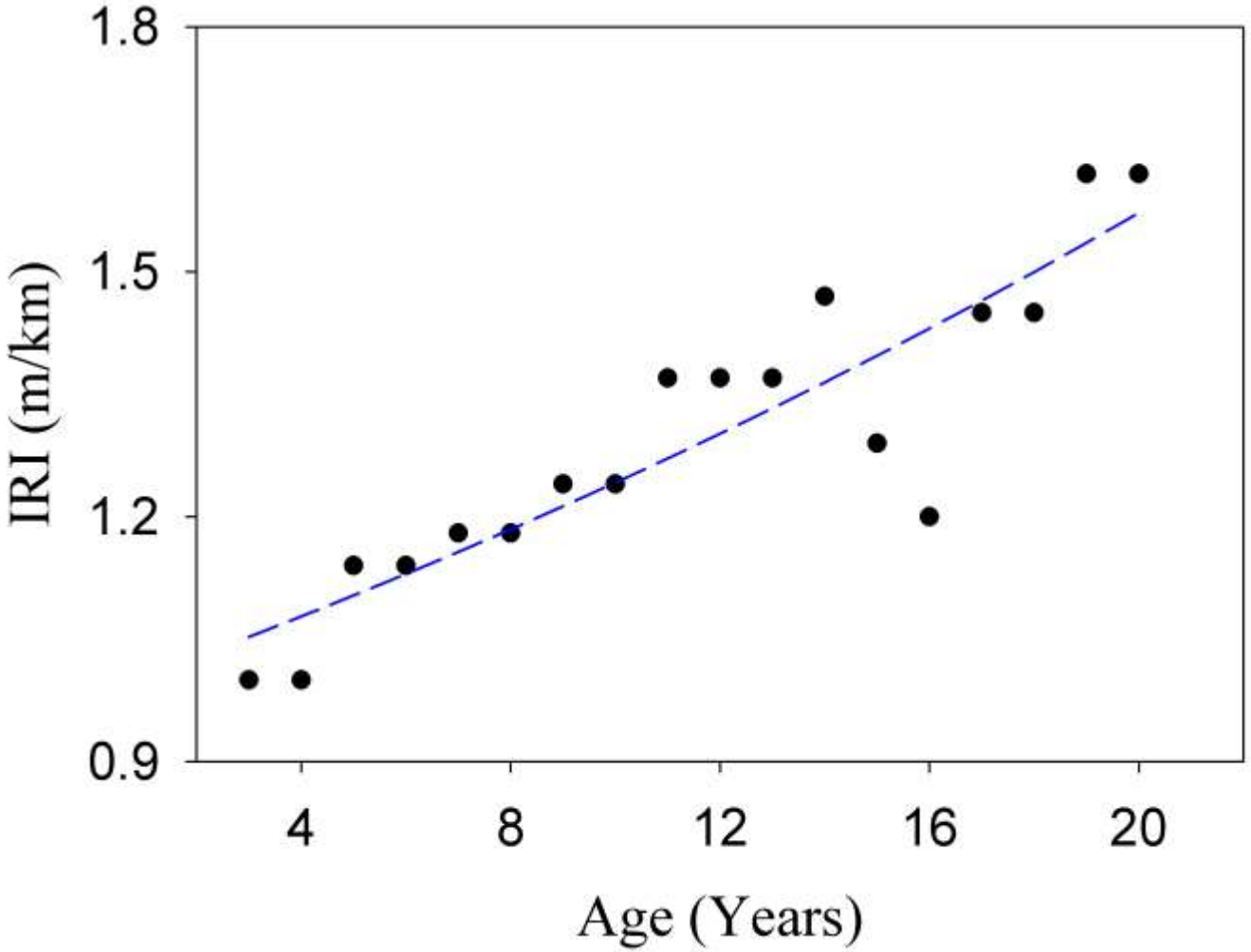
Filtering can make data noisy.



Filtering can make data noisy.



Would cleaner data help?



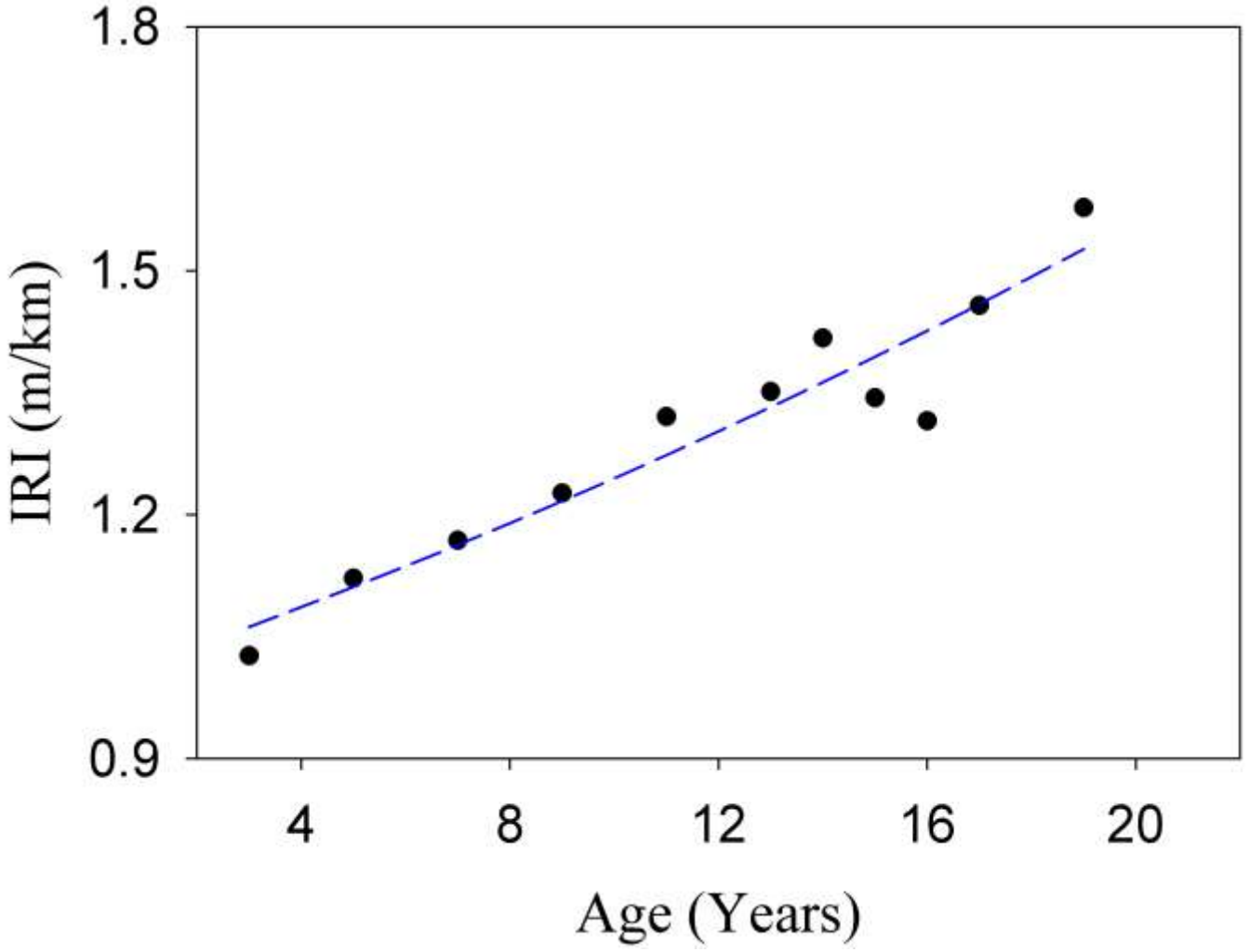
PE 2019

RPUG Road Profile Users' Group

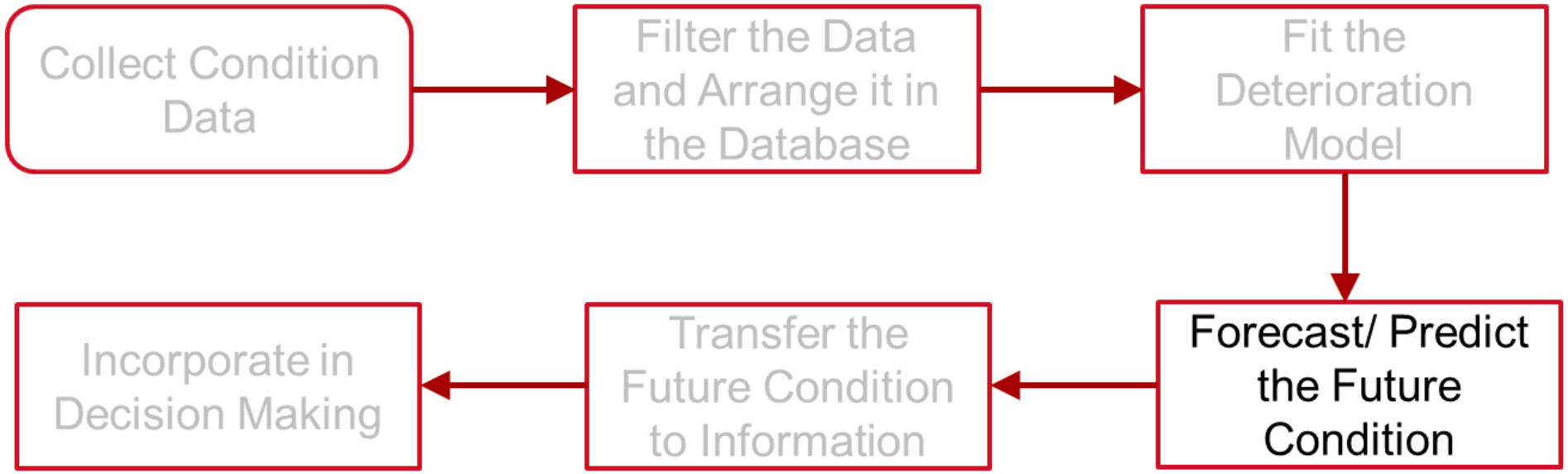
Would cleaner data help?

- Repeated measurements were removed and the errors were reduced by half.

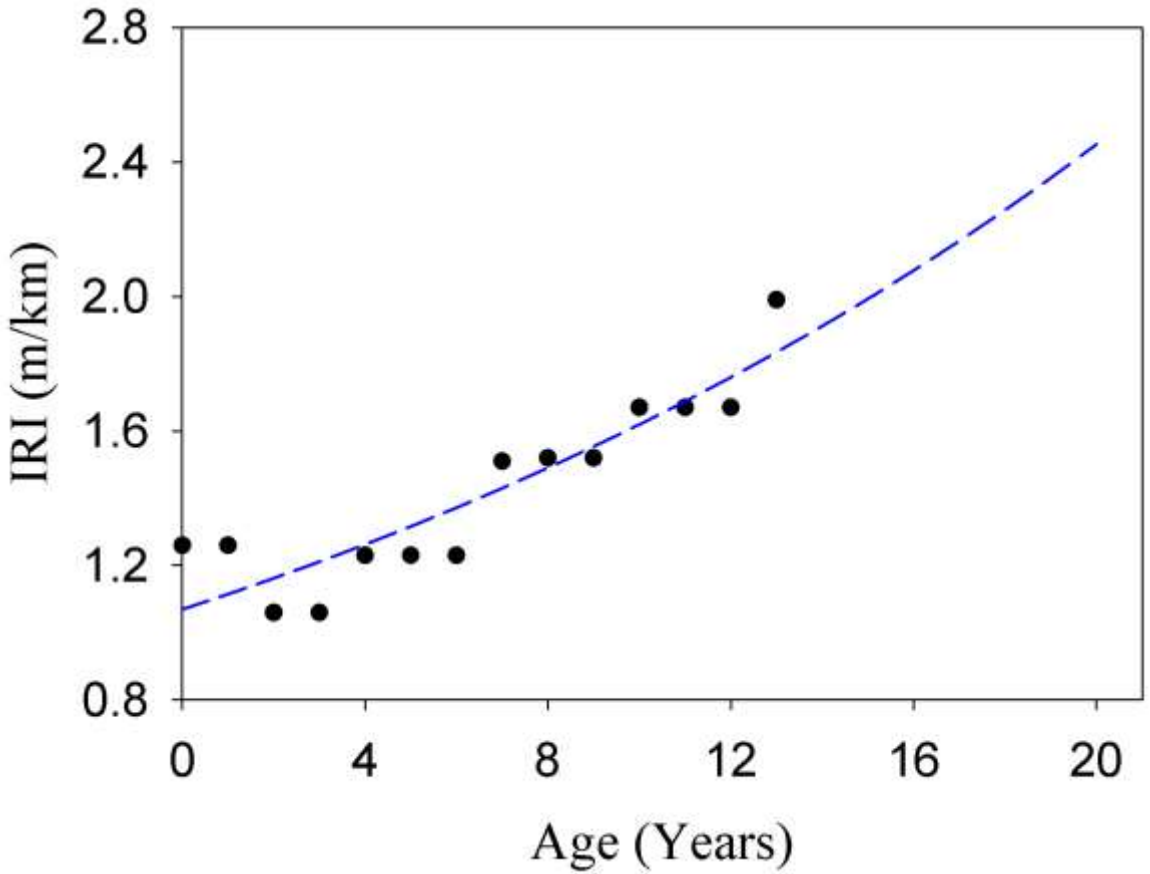
- $\sigma^{*2} = (0.5^2)\sigma^2$



From data collection to decision making.



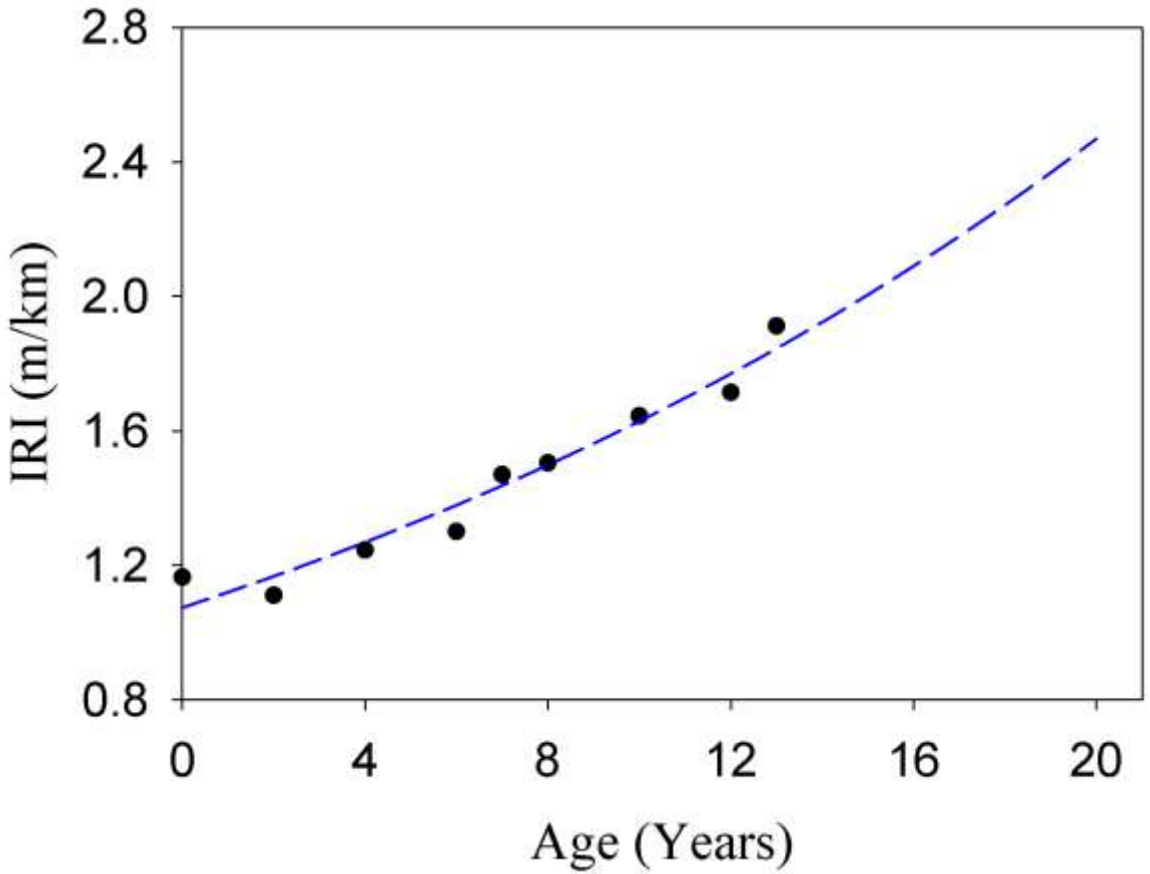
If you know your past you might know your future!



PE 2019

RPUG Road Profile Users' Group

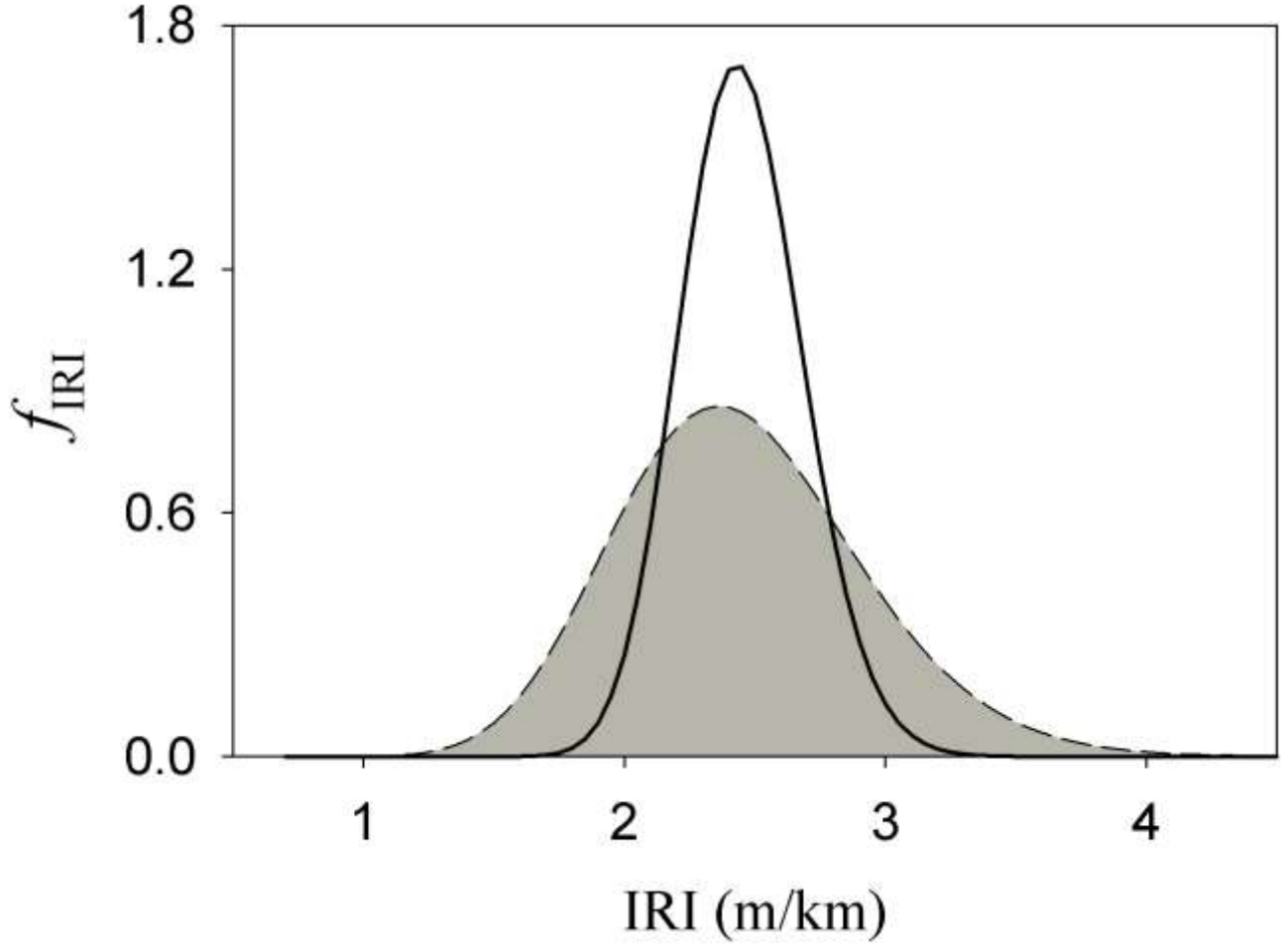
If you know your past you might know your future!



PE 2019

RPUG Road Profile Users' Group

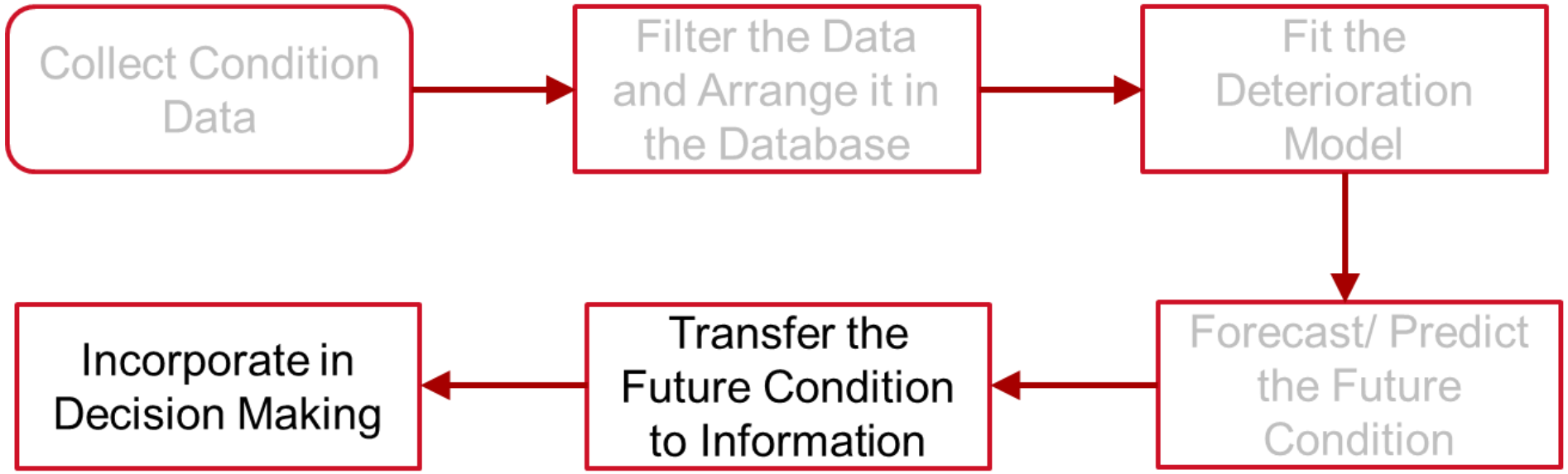
Better data can reduce the uncertainty.



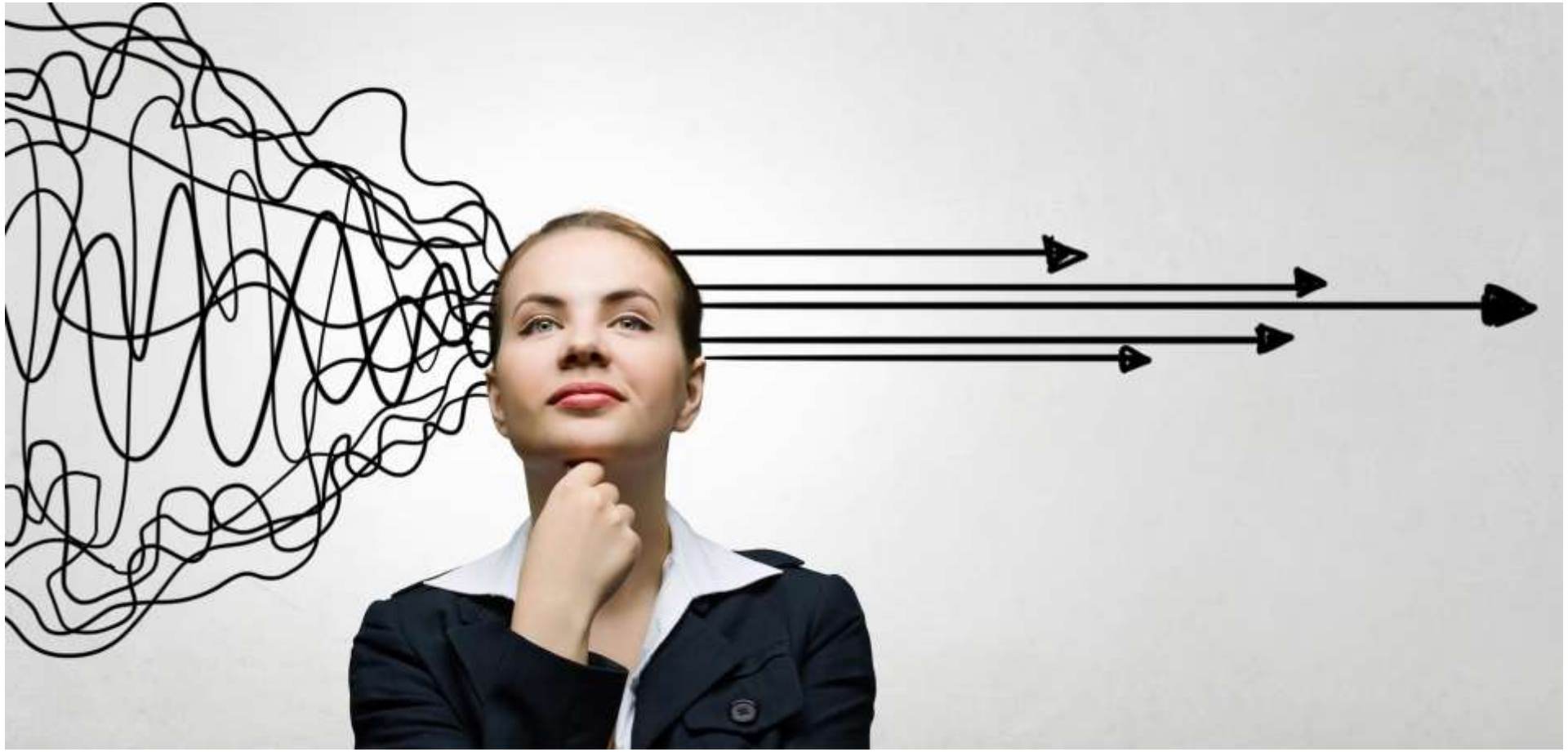
PE 2019

RPUG Road Profile Users' Group

From data collection to decision making.



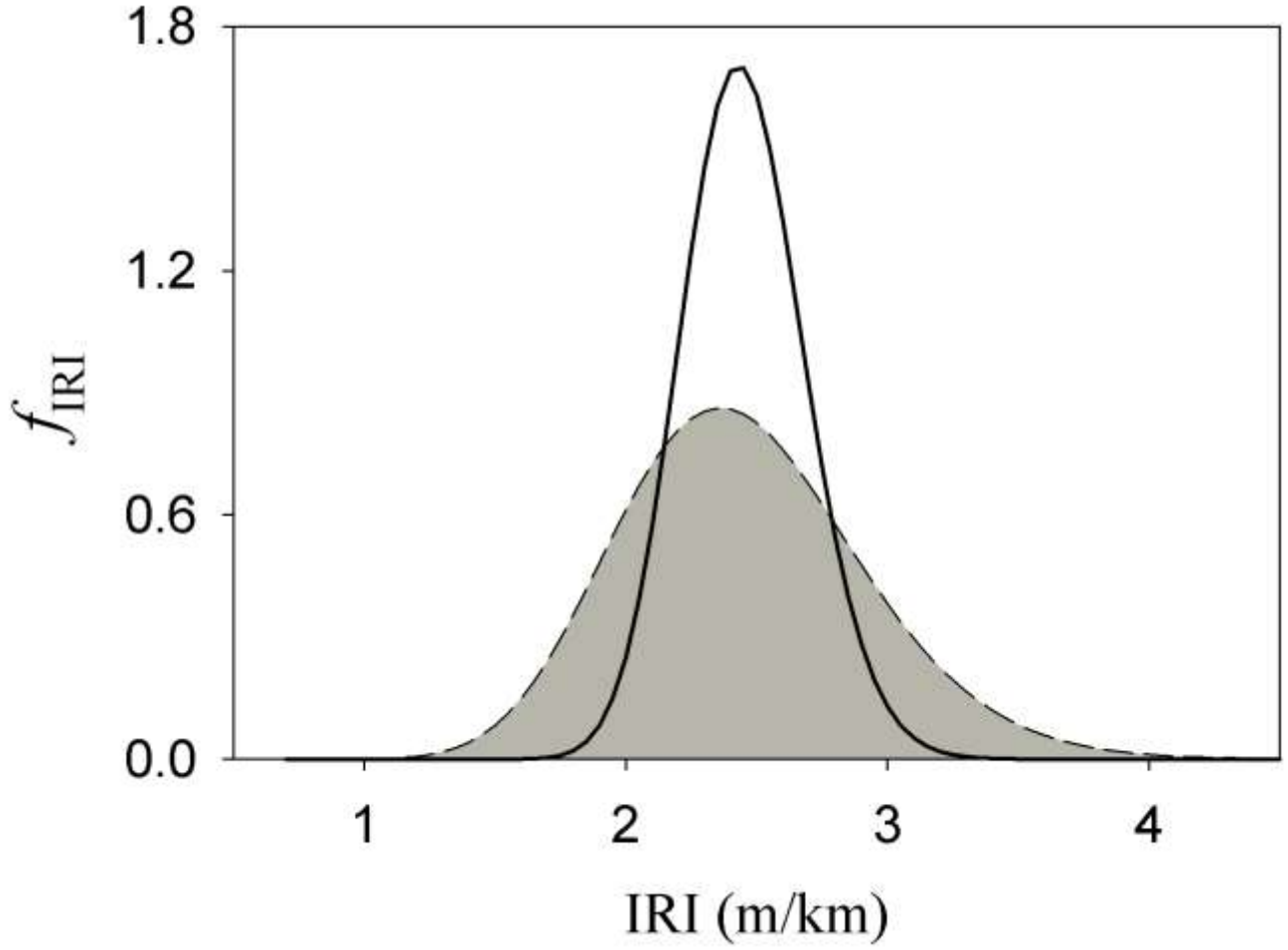
Data is great but harder to report and use in decision making.



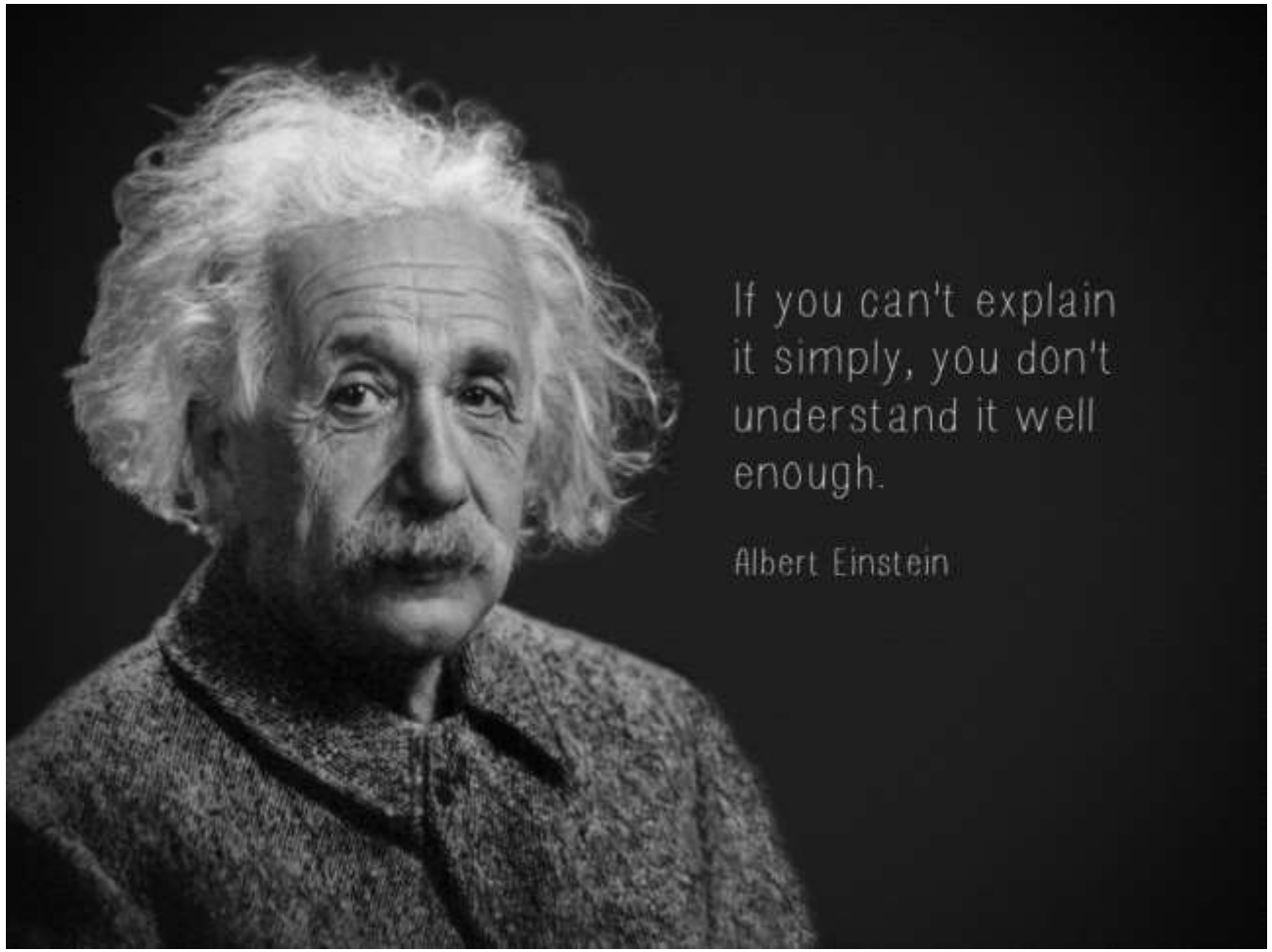
https://www.tilburguniversity.edu/education/professional-learning/sensible-business-decisions-under-uncertainty

Better data can reduce the uncertainty.

- Both models expect Fair condition.
- $P_1(C \neq Fair) = 0.3$
- $P_1(C \neq Fair) = 0.15$



If you are uncertain ask questions



https://projectscreenwriter.com/2017/01/25/loglines-and-a-lot-of-head-scratching/