

Why Propensity Scores Should Not Be Used For Matching

Gary King¹

Richard Nielsen²

Institute for Quantitative Social Science
Harvard University

MIT

(Society for Political Methodology talk, University of Rochester, 7/24/2015)

¹GaryKing.org

²www.mit.edu/~rnielsen

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 - The mathematical theorems about propensity scores

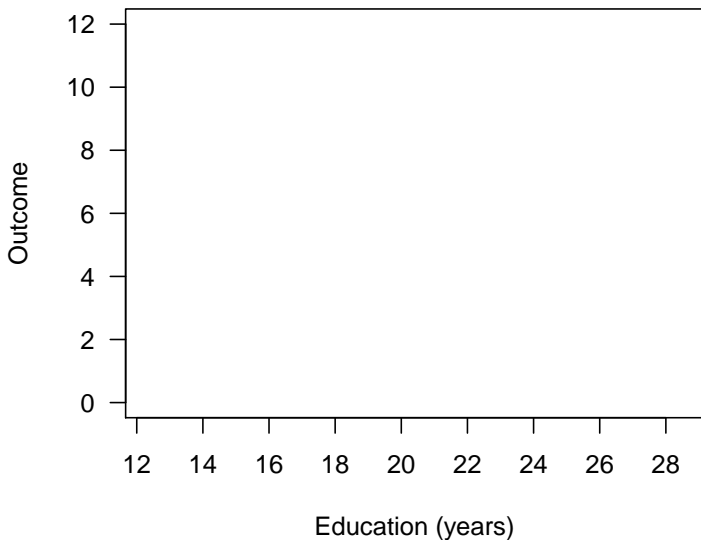
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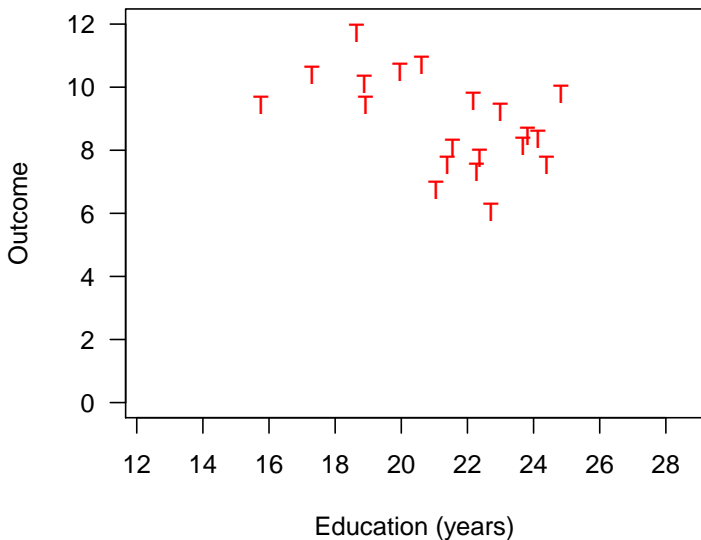
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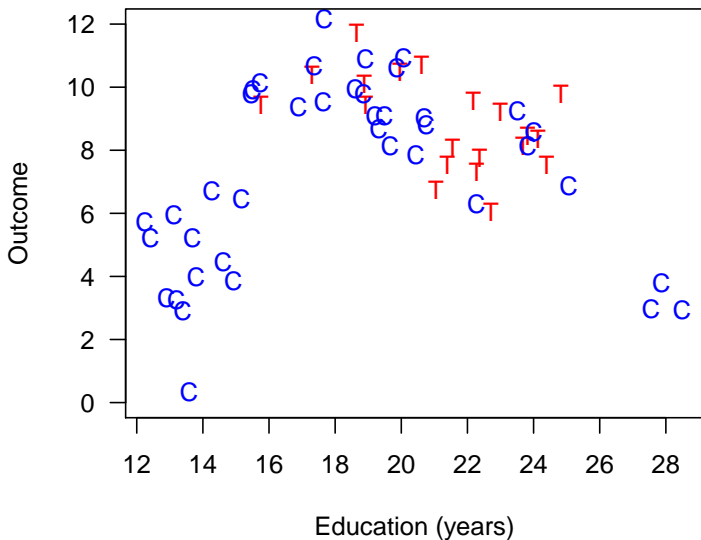
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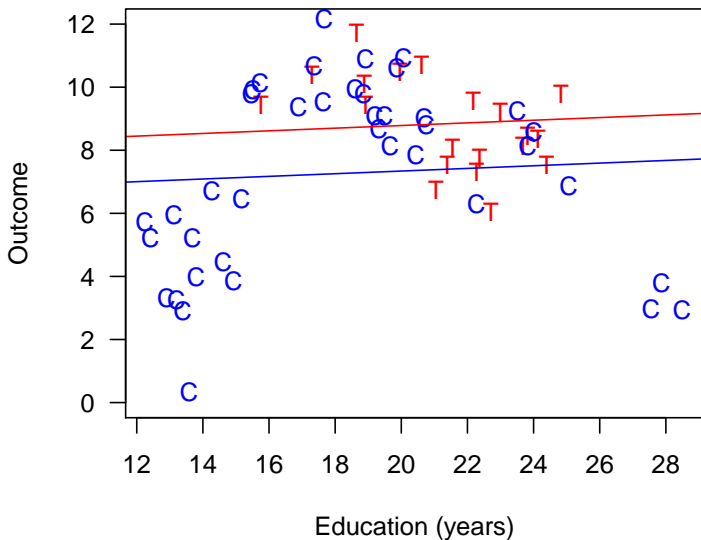
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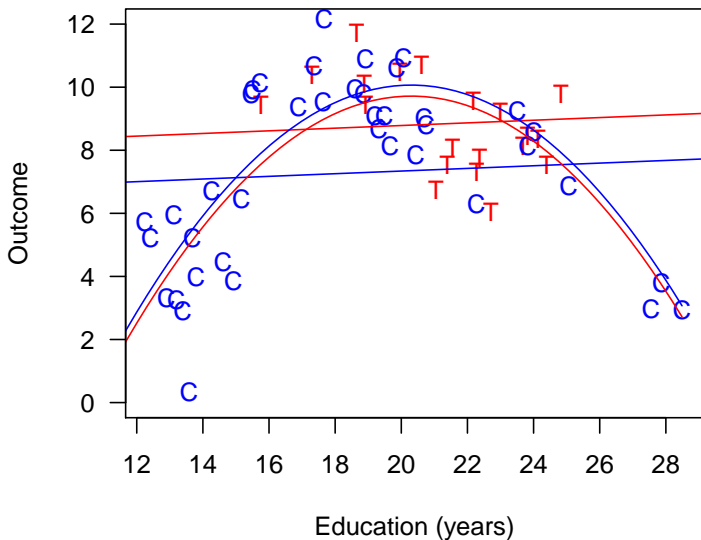
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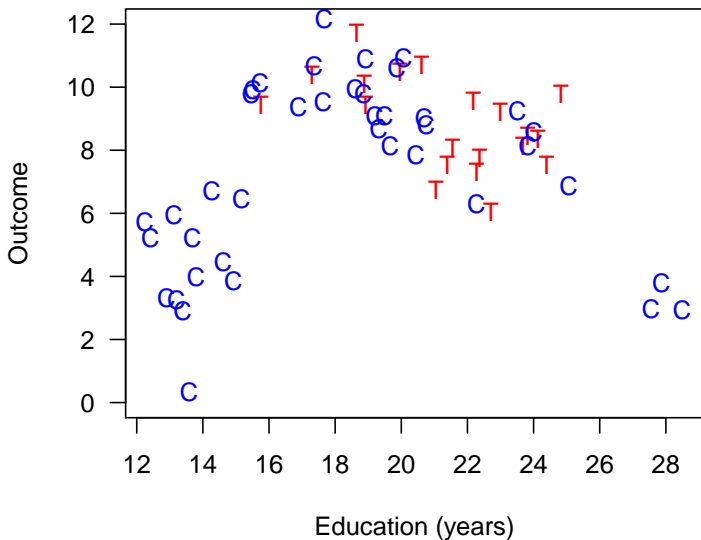
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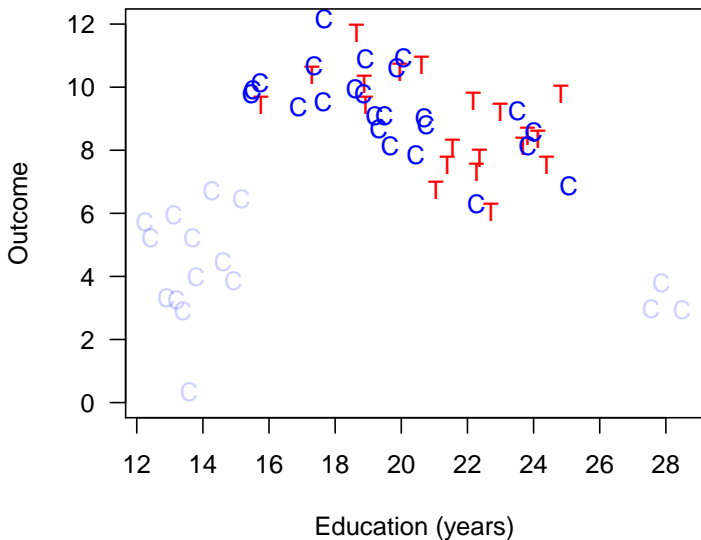
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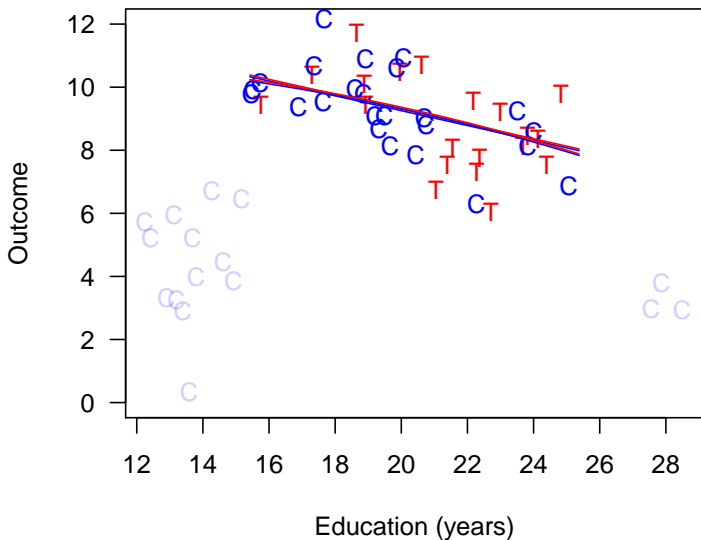
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- “Teaching psychology is mostly a waste of time” (Kahneman 2011)

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A central project of statistics: Automating away human discretion

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 - **Pruning nonmatches makes control vars matter less:** reduces imbalance, model dependence, researcher discretion, & bias

Matching: Finding Hidden Randomized Experiments

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Types of Experiments



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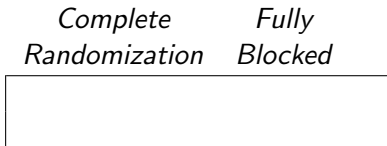
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- **Other matching methods dominate PSM** (wait, it gets worse)

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2. Estimation Difference in means or a model

Method 1: Mahalanobis Distance Matching

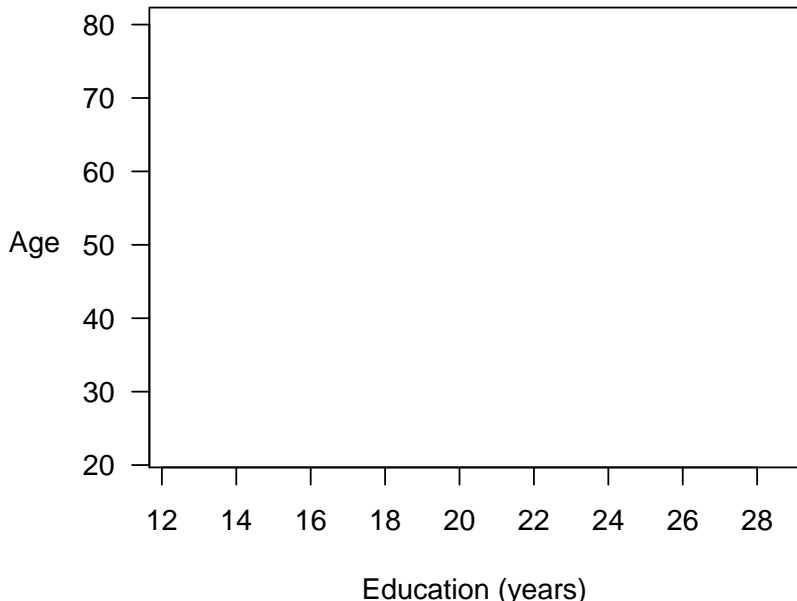
(Approximates Fully Blocked Experiment)

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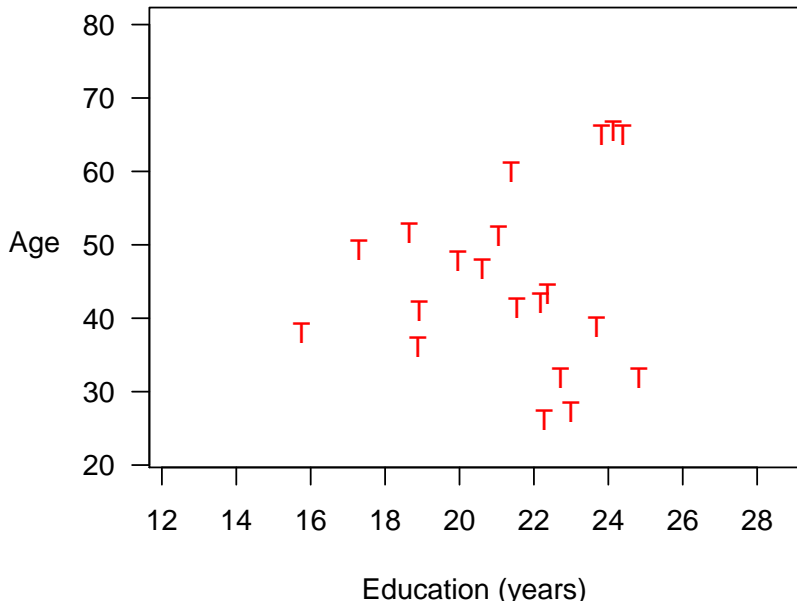
- $\text{Distance}(X_c, X_t) = \sqrt{(X_c - X_t)'S^{-1}(X_c - X_t)}$
- (Mahalanobis is for methodologists; in applications, use Euclidean!)
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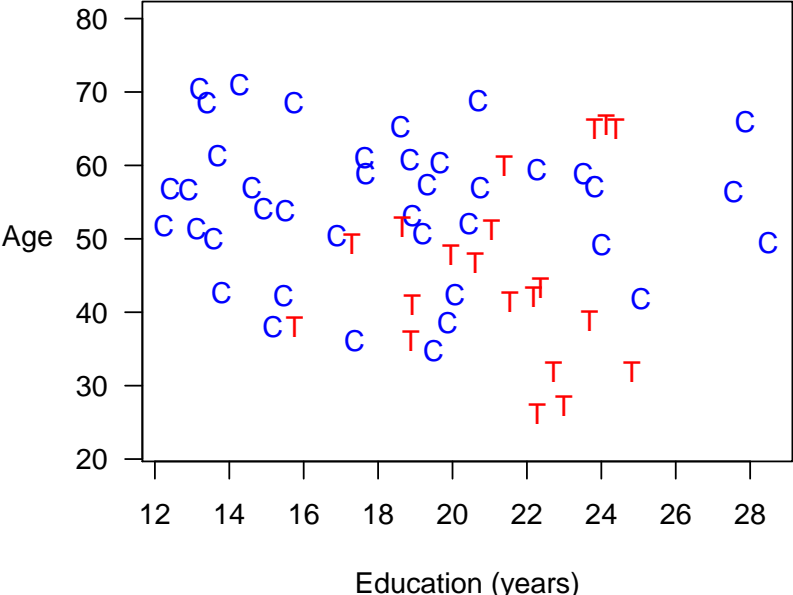
Mahalanobis Distance Matching



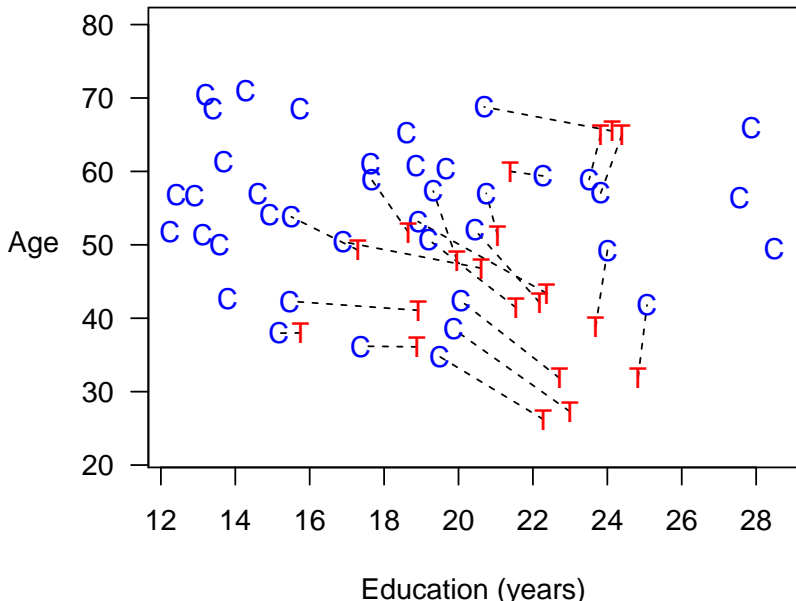
Mahalanobis Distance Matching



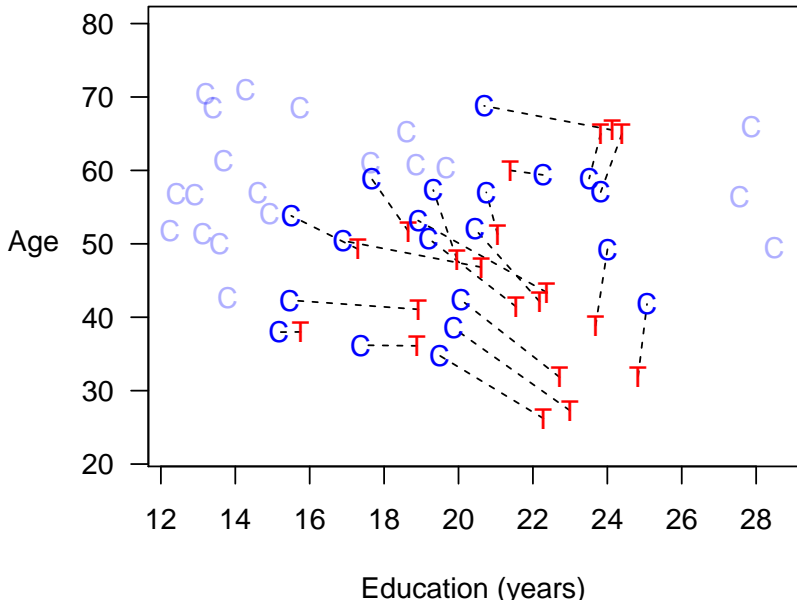
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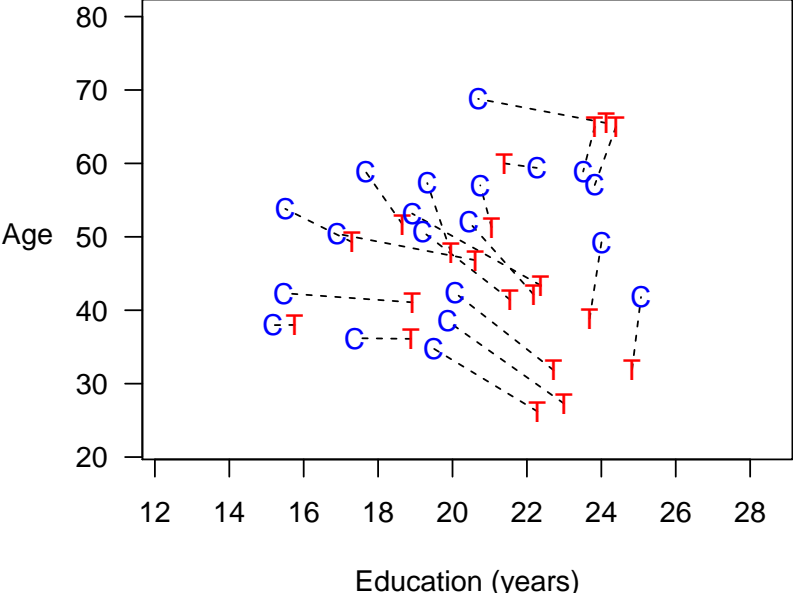
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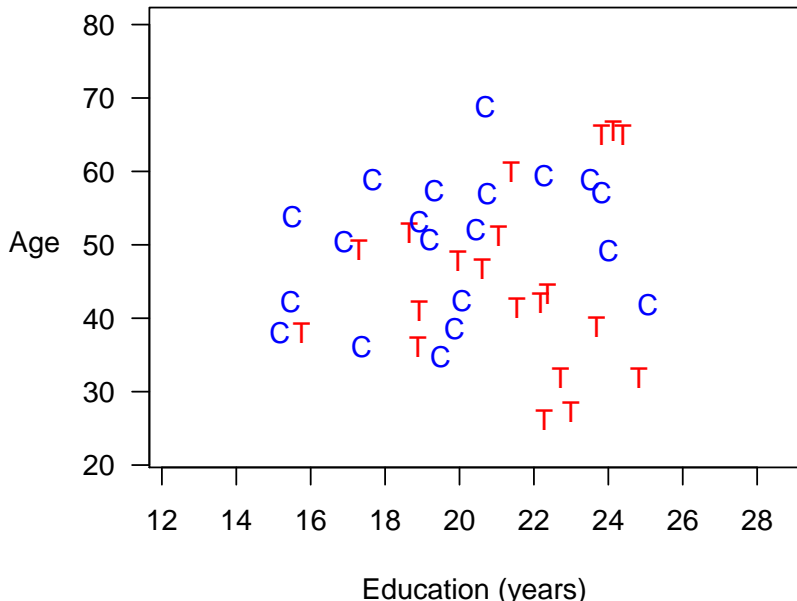
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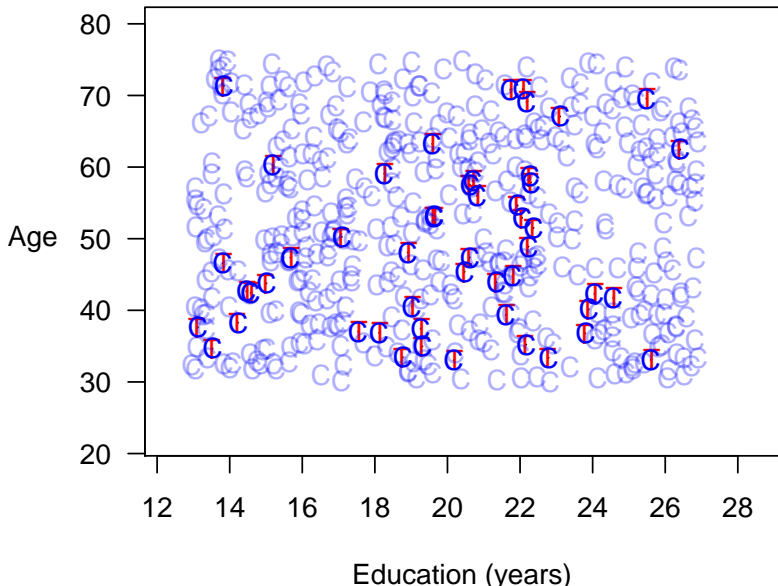


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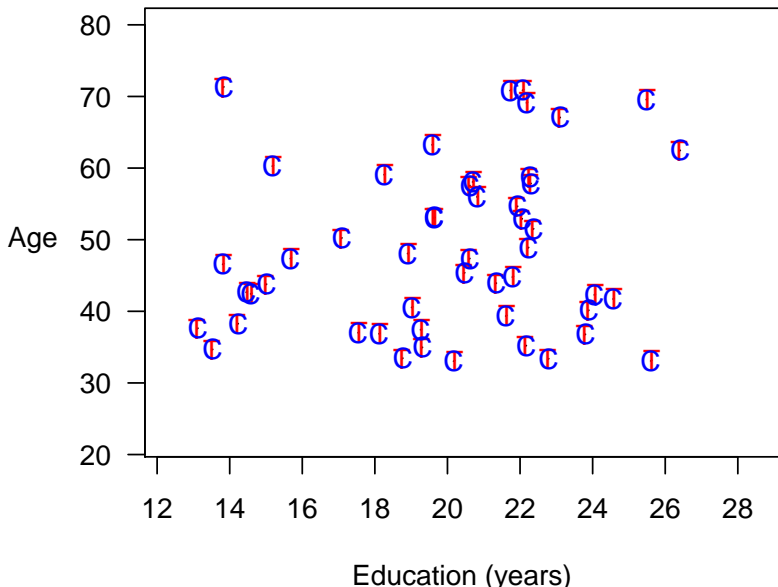


Best Case: Mahalanobis Distance Matching

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Method 2: Coarsened Exact Matching

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(Approximates Fully Blocked Experiment)

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1. **Preprocess** (Matching)
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1. **Preprocess** (Matching)
 - Temporarily coarsen X as much as you're willing

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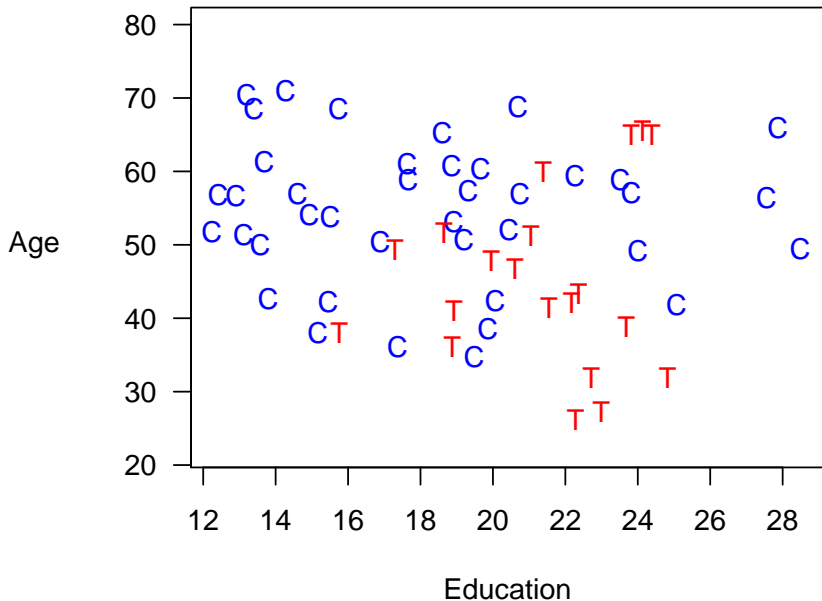
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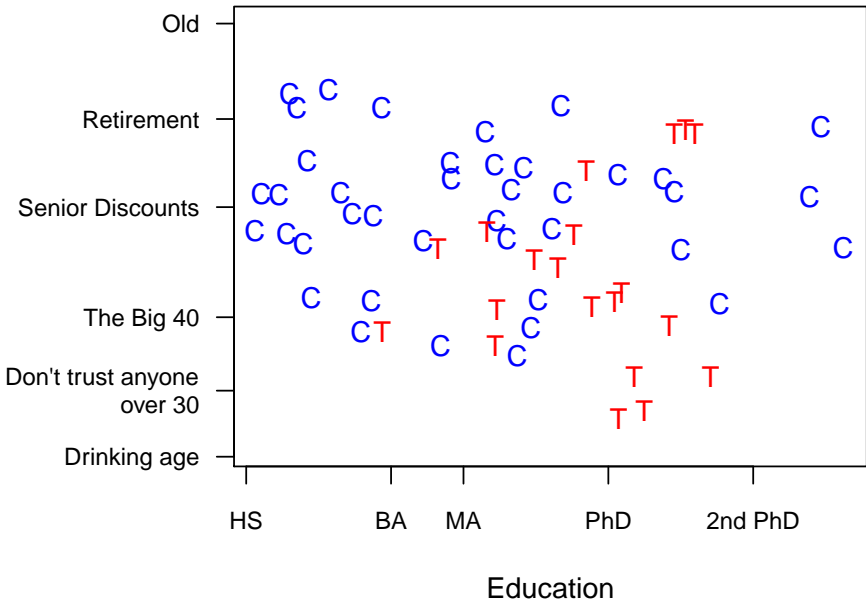
- Weight controls in each stratum to equal treateds

Coarsened Exact Matching

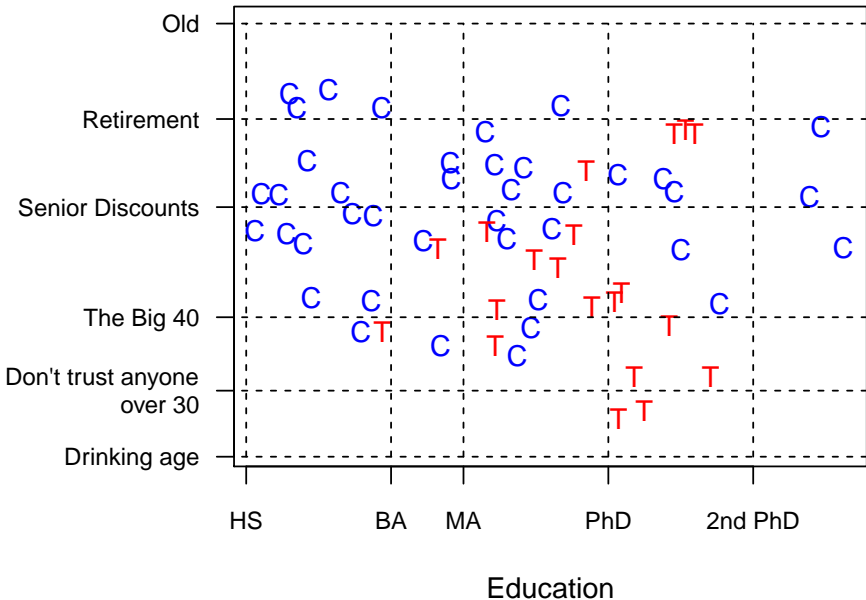
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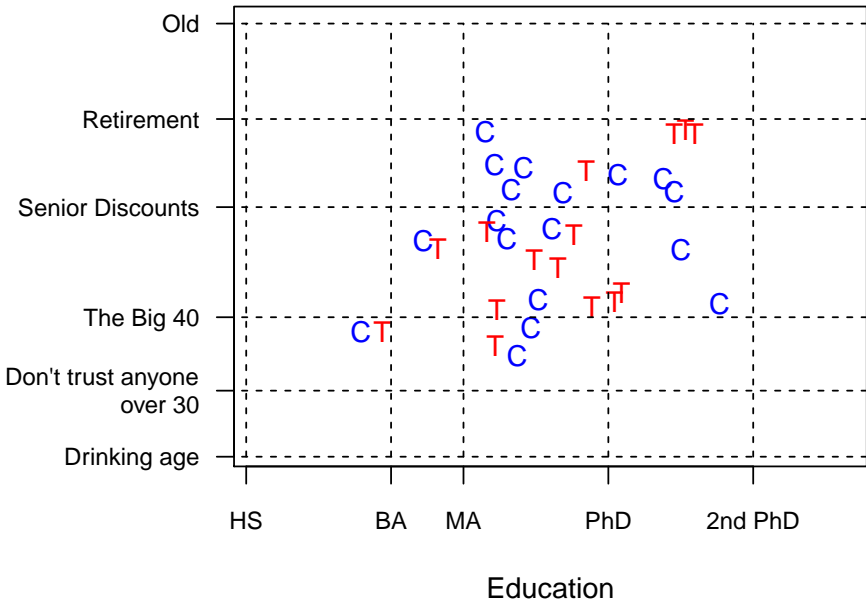
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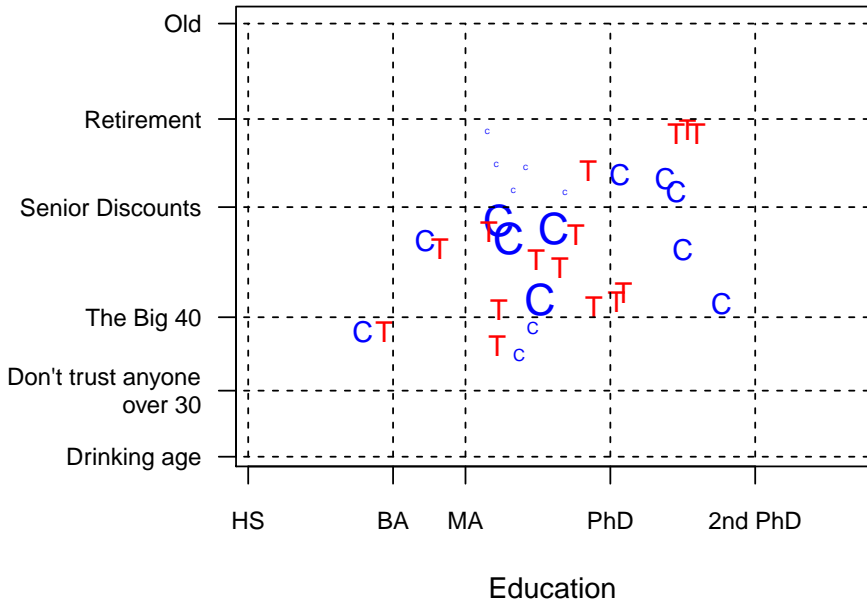
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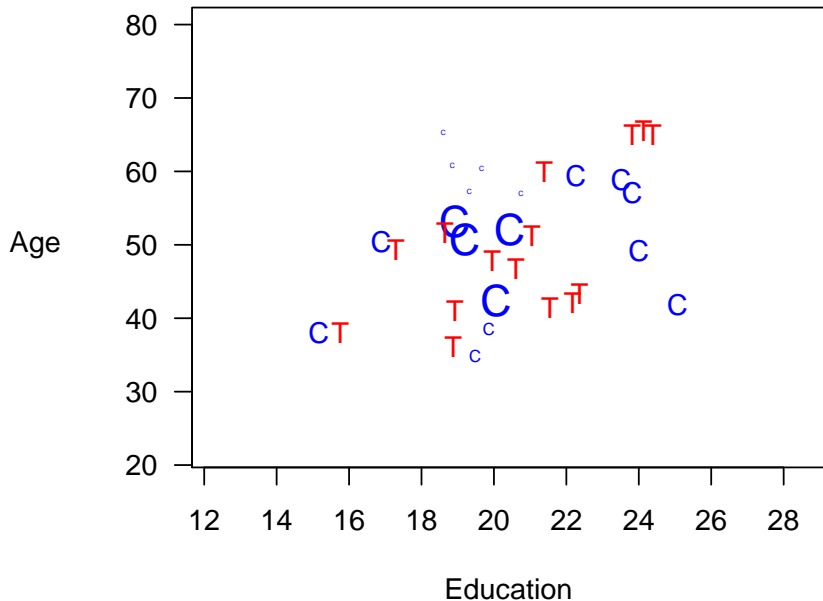
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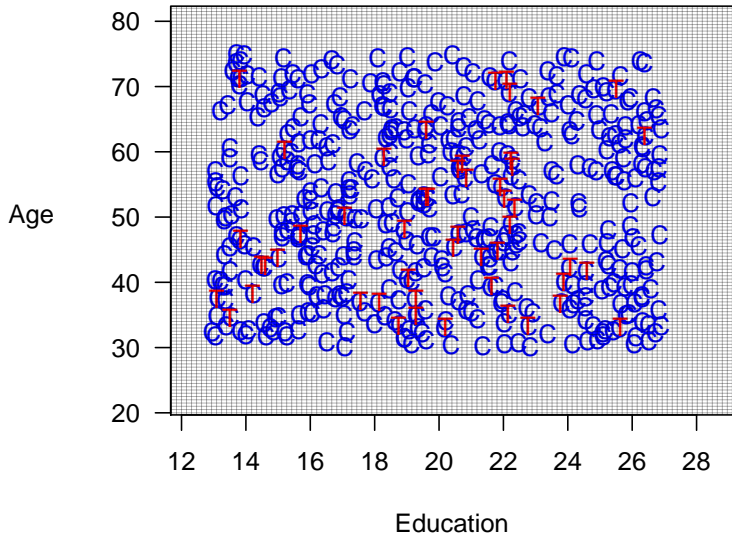


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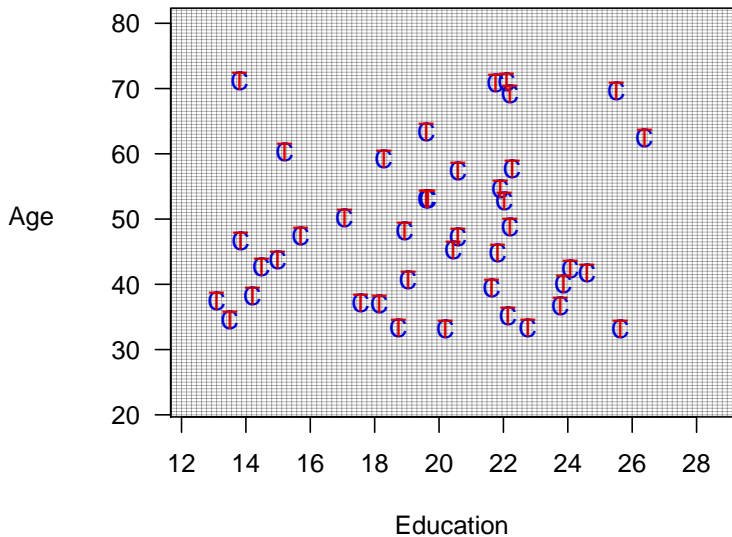


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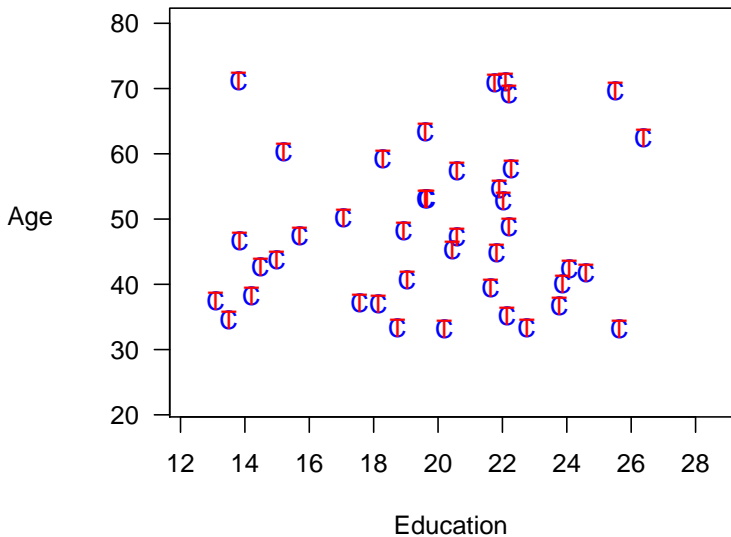
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Method 3: Propensity Score Matching

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(Approximates Completely Randomized Experiment)

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$$\pi_i \equiv \Pr(T_i = 1|X) = \frac{1}{1+e^{-X_i\beta}}$$

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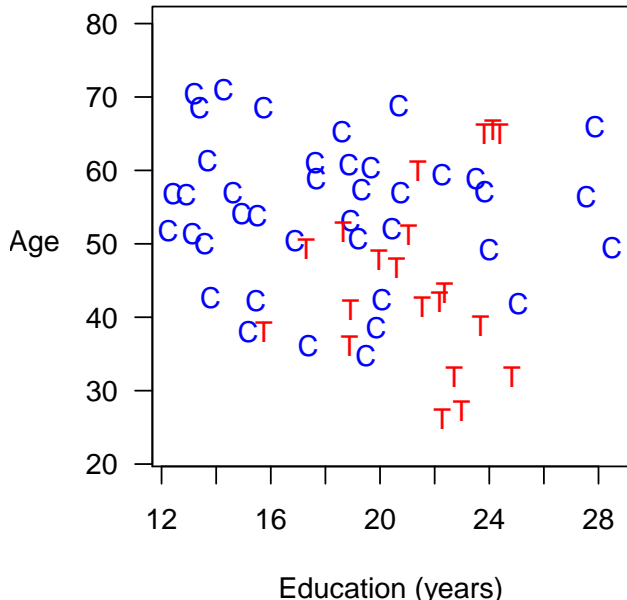
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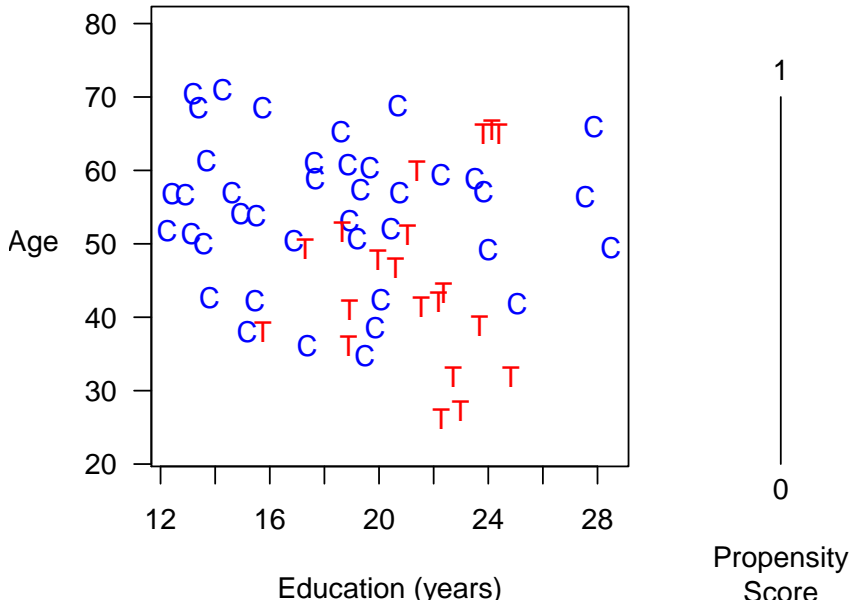
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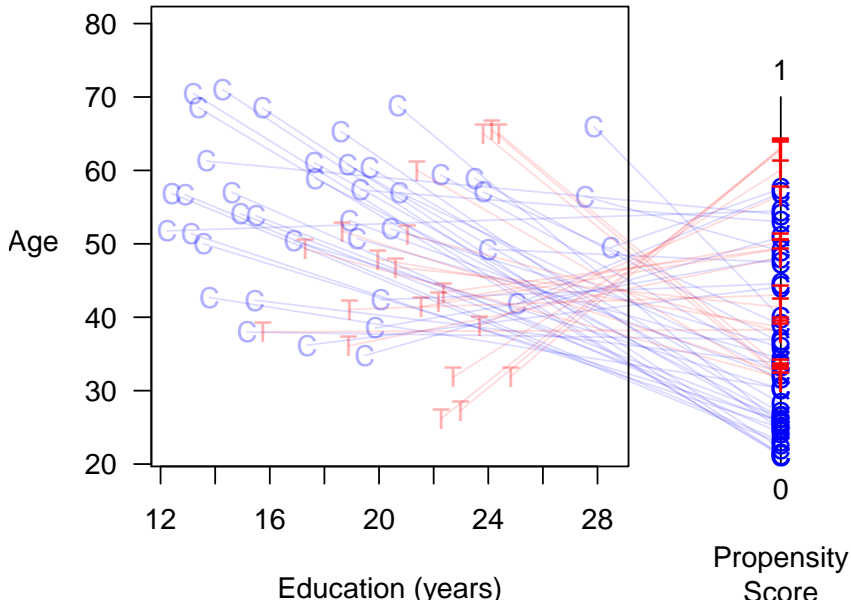
Propensity Score Matching



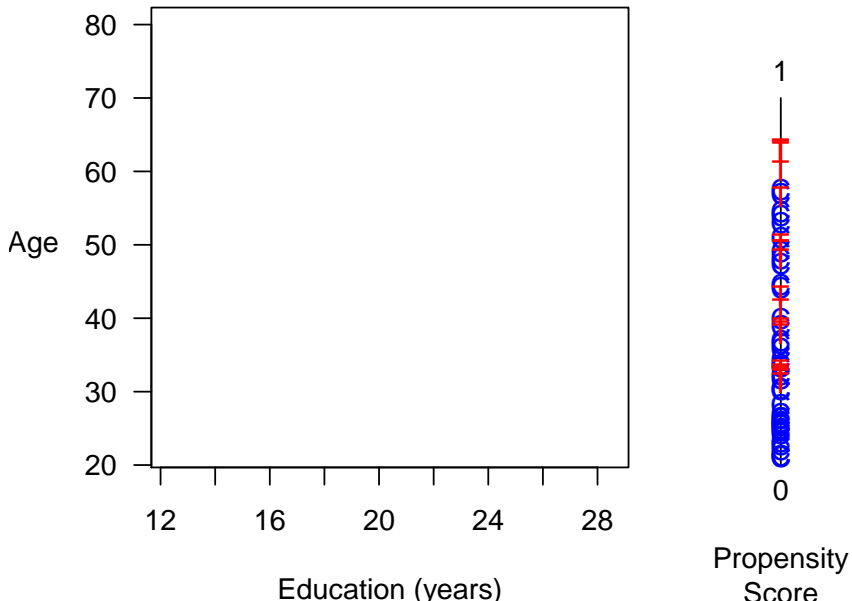
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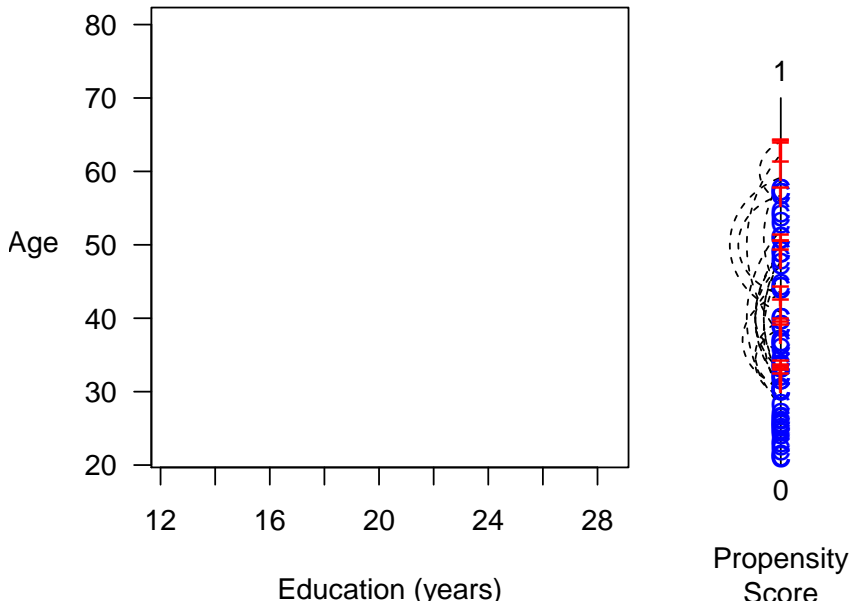
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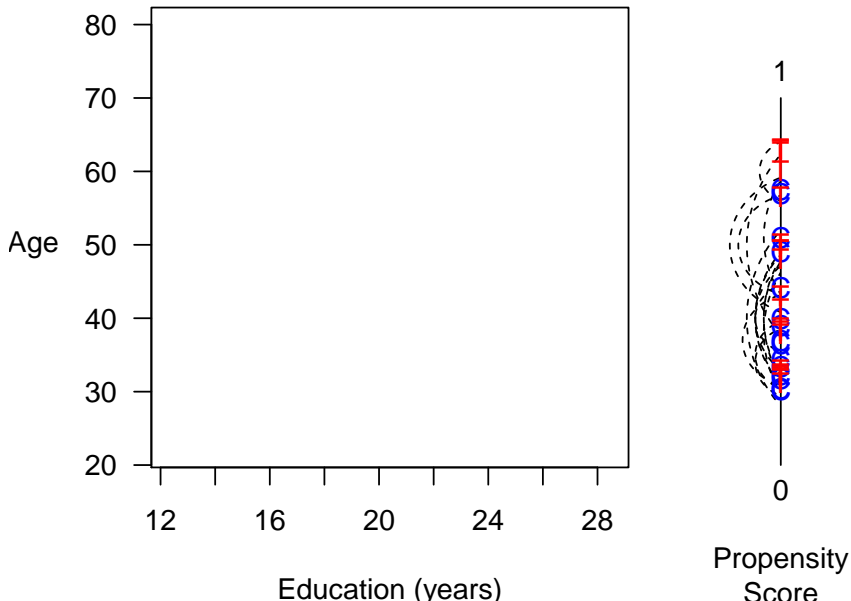
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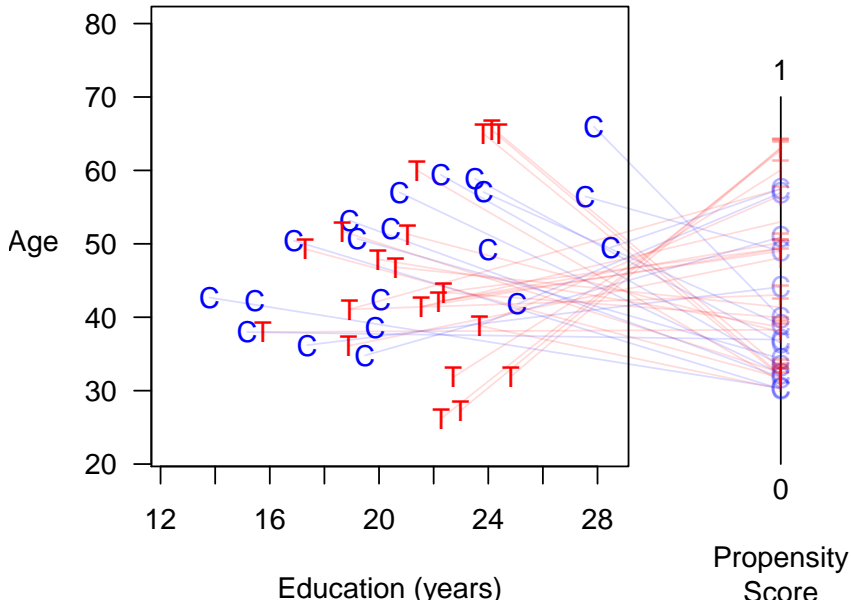
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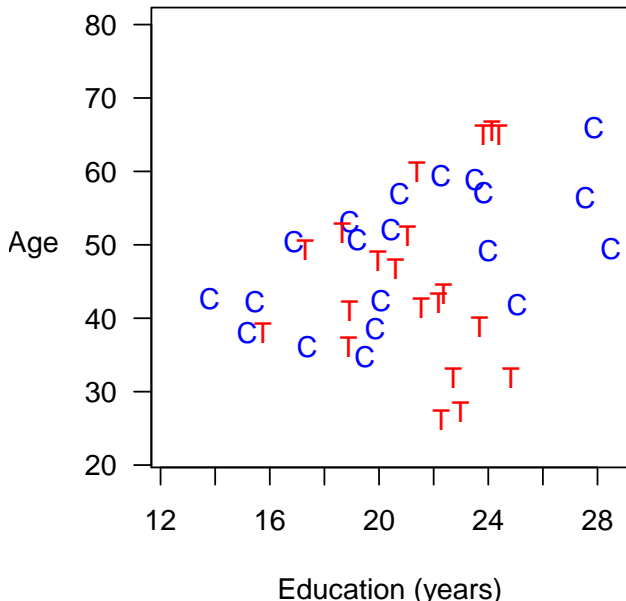
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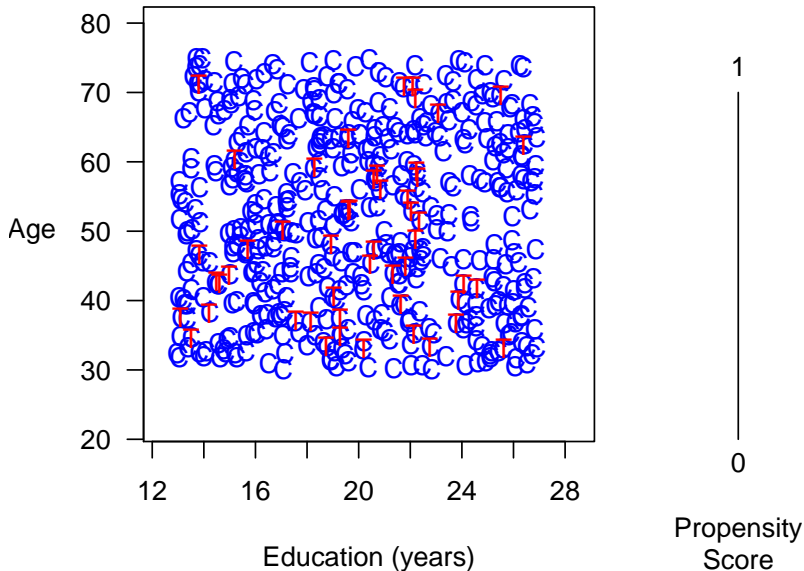


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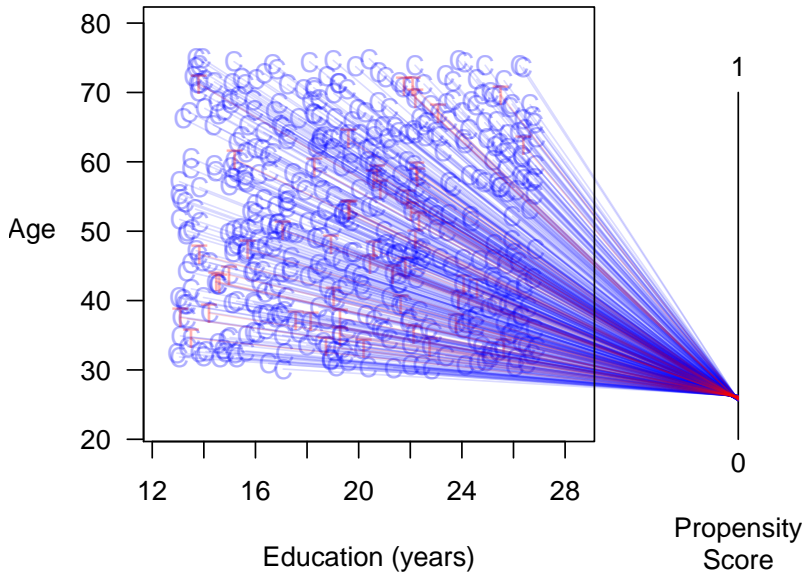


Best Case: Propensity Score Matching

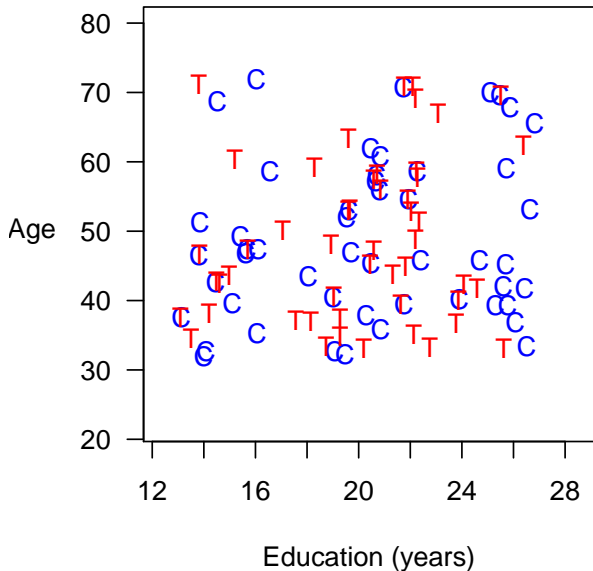
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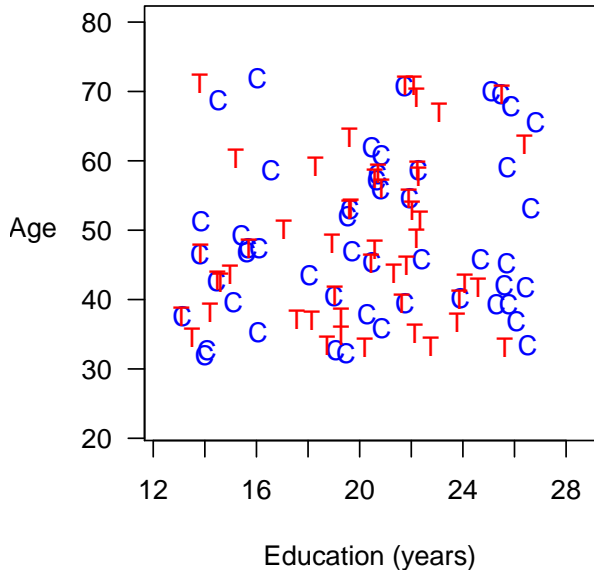
Best Case: Propensity Score Matching



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Best Case: Propensity Score Matching is Suboptimal



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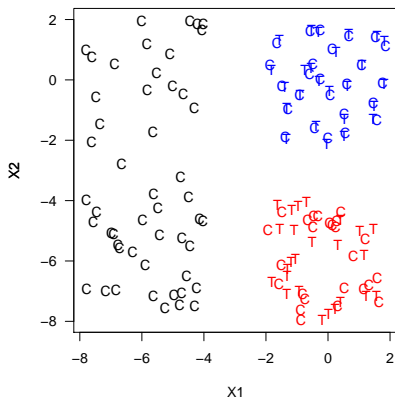
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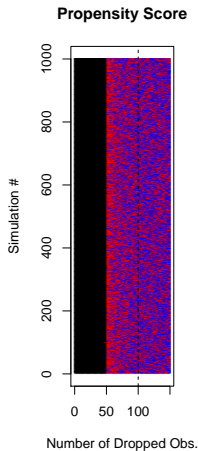
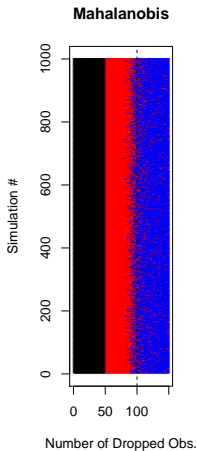
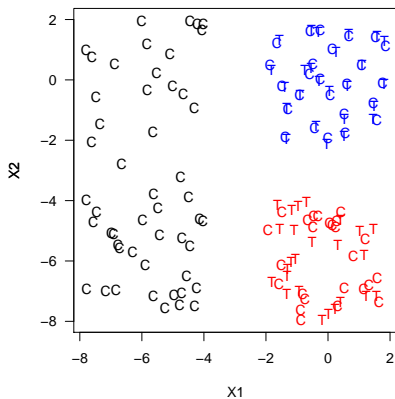
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PSM is Blind Where Other Methods Can See

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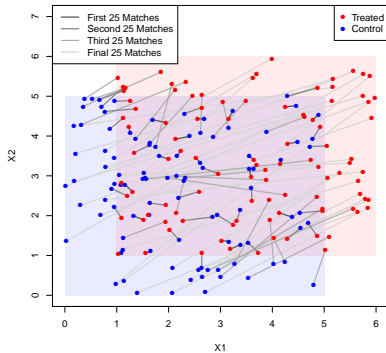


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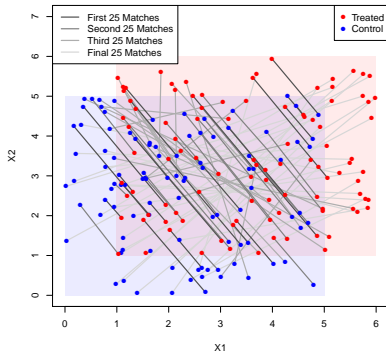


What Does PSM Match?

MDM Matches



PSM Matches

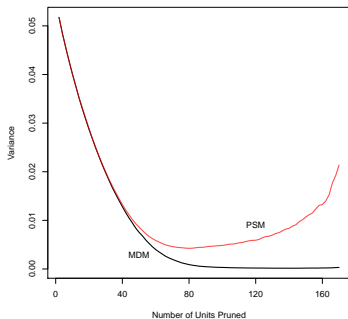


Controls: $X_1, X_2 \sim \text{Uniform}(0,5)$

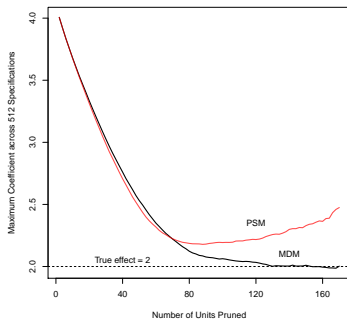
Treateds: $X_1, X_2 \sim \text{Uniform}(1,6)$

PSM Increases Model Dependence & Bias

Model Dependence



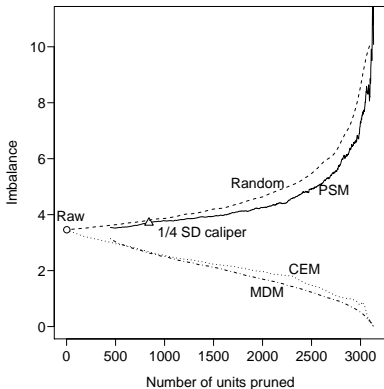
Bias



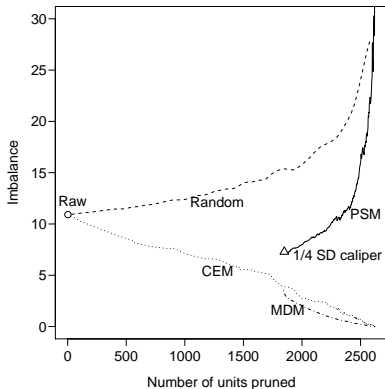
$$Y_i = 2T_i + X_{1i} + X_{2i} + \epsilon_i$$
$$\epsilon_i \sim N(0, 1)$$

The Propensity Score Paradox in Real Data

Finkel et al. (JOP, 2012)



Nielsen et al. (AJPS, 2011)



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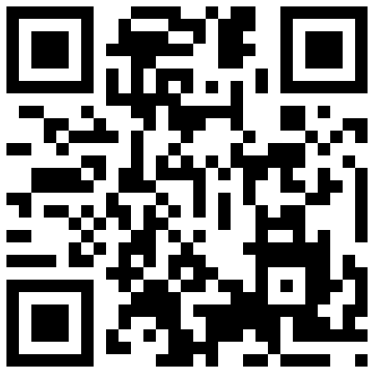
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For more information, papers, & software



GaryKing.org
www.mit.edu/~rnielsen