

Intuition Inverse Probability of Treatment Weighting (IPTW)

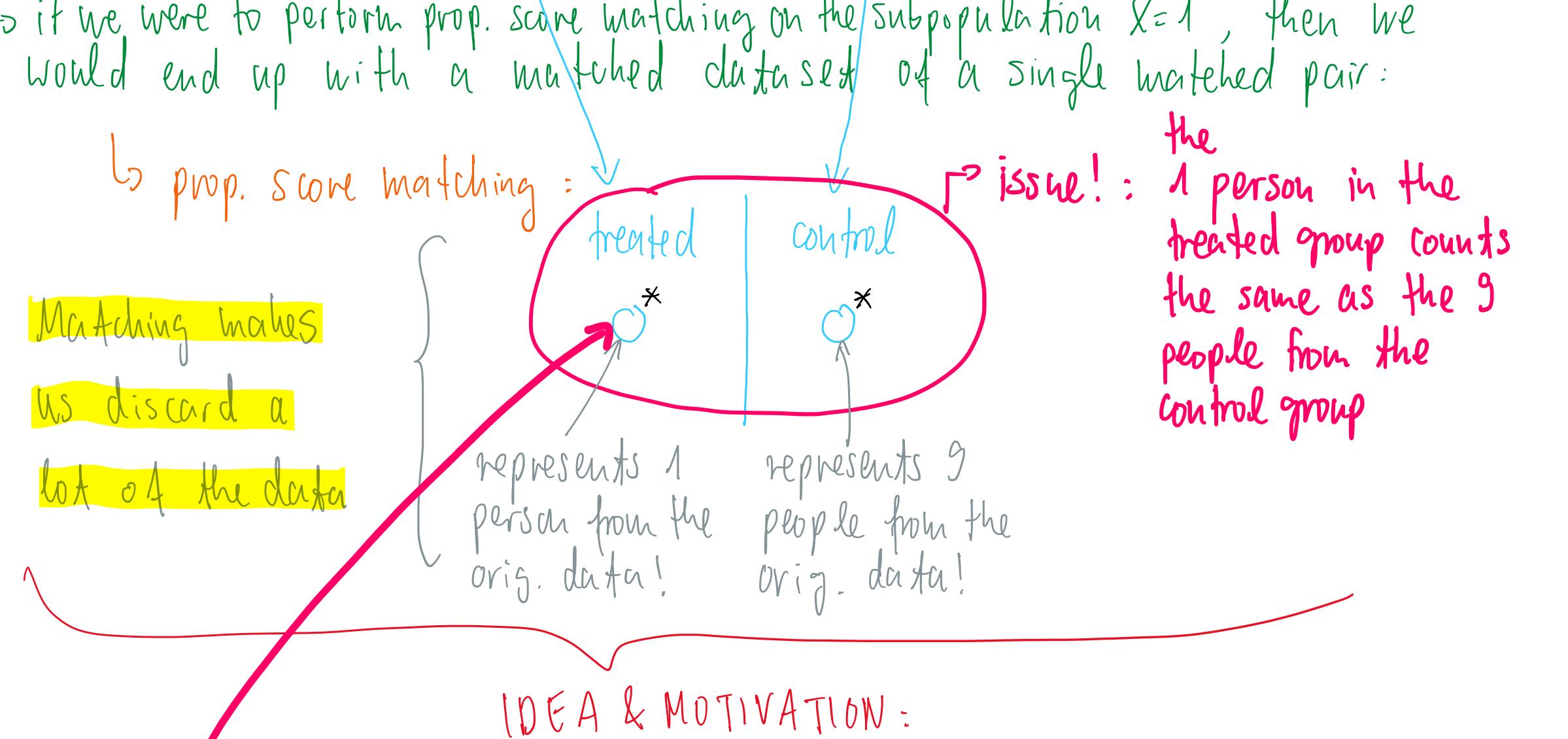
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- goal: relate IPTW to Matching

Example: suppose single confounder X (binary)

- $P(A=1|X=1) = 0.1$
- $P(A=1|X=0) = 0.8$

↓



⇒ if we were to perform prop. score matching on the subpopulation $X=1$, then we would end up with a matched dataset of a single matched pair:

↳ prop. score matching :

issue!: the 1 person in the treated group counts the same as the 9 people from the control group

Matching makes us discard a lot of the data!

IDEA & MOTIVATION:

→ rather than match, we could use ALL DATA, but "down-weight" some and "up-weight" other subjects

this single treated subject should have 9 times more weight than any of the control subjects

Weighting:

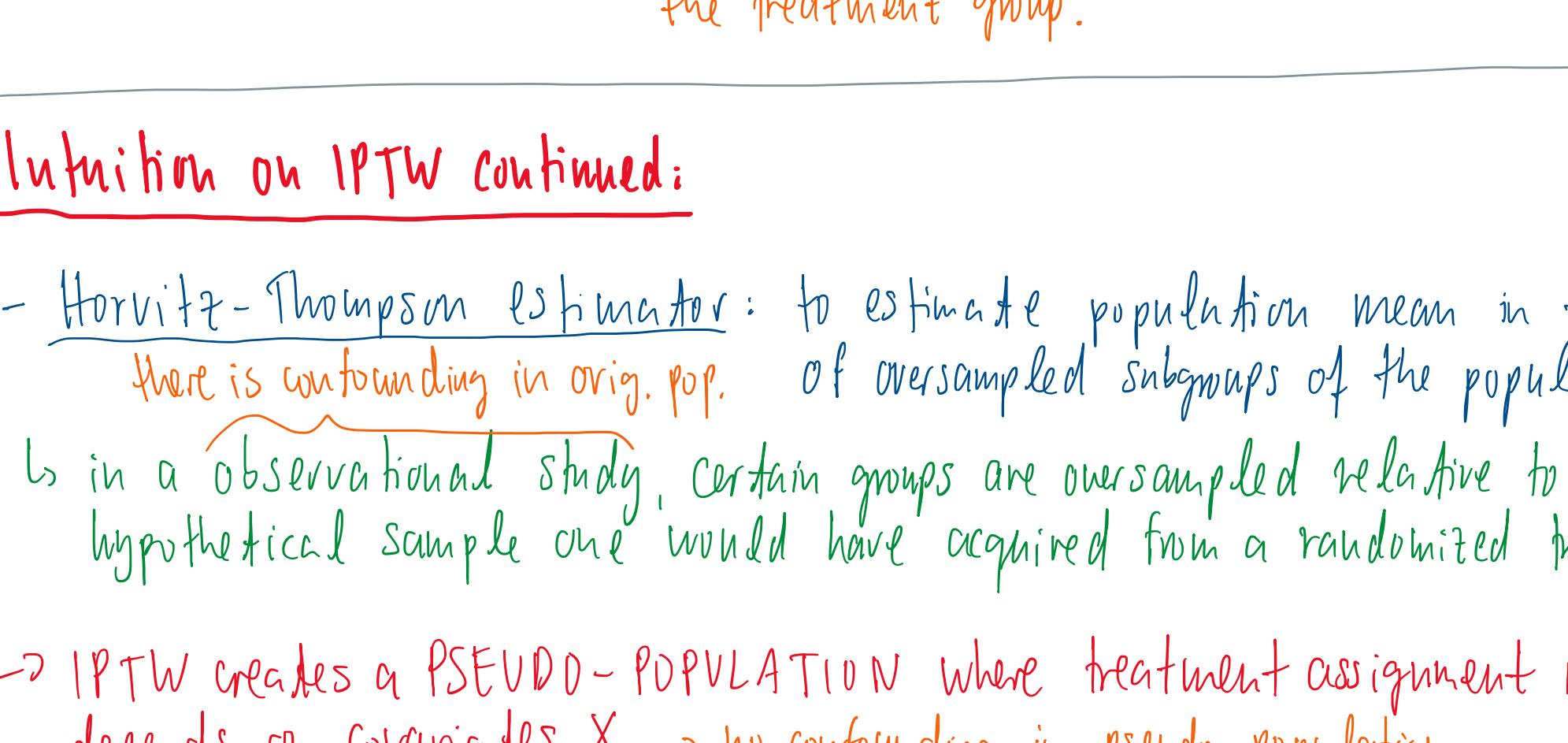
$$\underbrace{\frac{1}{0.1} = 10}_{\text{weight of treated subject}}, \quad \underbrace{\frac{1}{0.9} = \frac{10}{9} = 1.11}_{\text{weight of control subjects}}$$

prop. score!

- for treated subjects: weight by the inverse of the probability of treatment: $P(A=1|X)$
- for control subjects: weight by the inverse of the probability of no treatment: $P(A=0|X)$

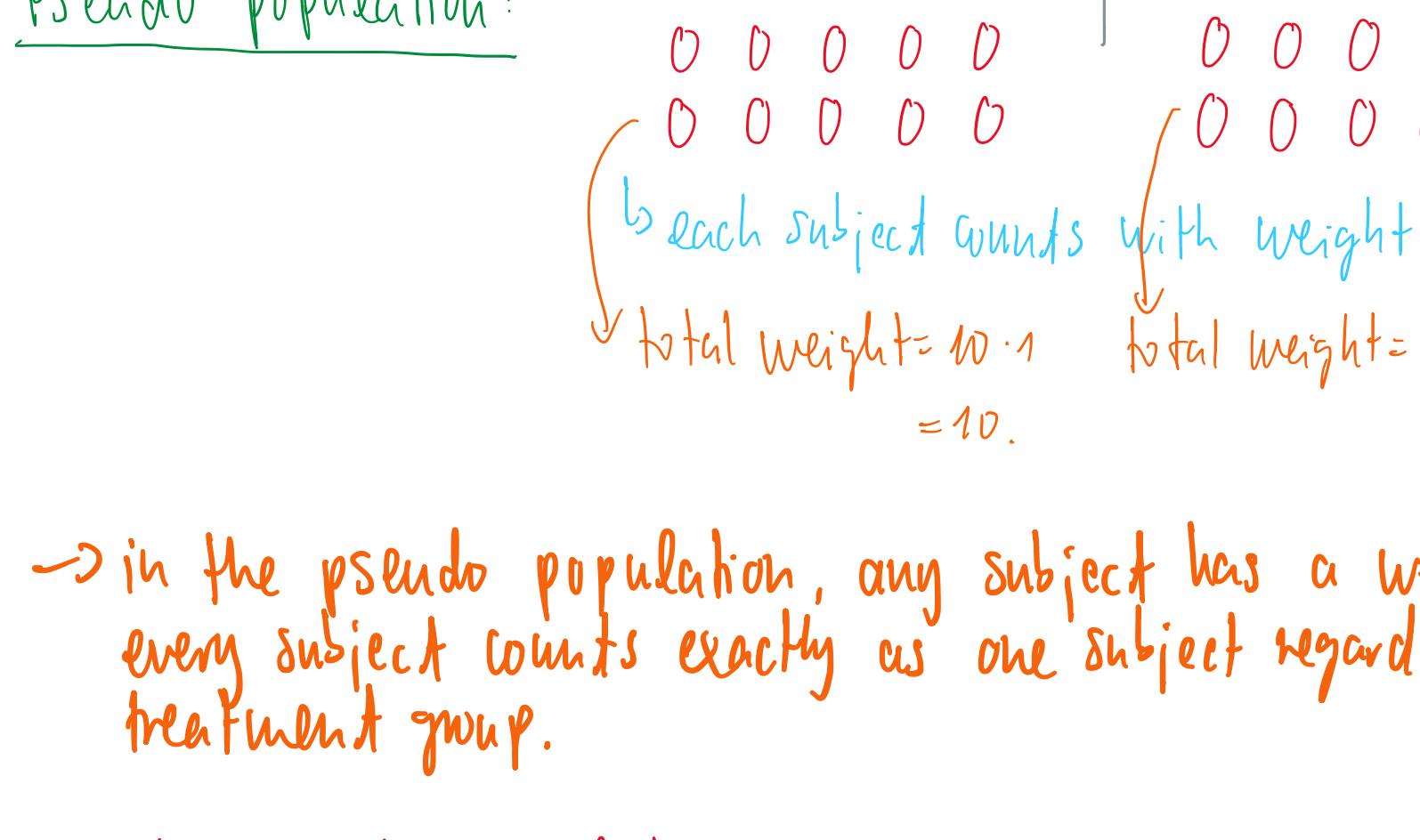
⇒ in other words: always weight by the inverse of the prob. of treatment each subject has actually received.

Example of using IPTW:



→ with IPTW, we end up counting the collection of treated subjects the same as the collection of the control subjects.

Now repeat for subpopulation w/ $X=0$:



Intuition on IPTW continued:

- Horvitz-Thompson estimator: to estimate population mean in the presence of confounding in orig. pop. of oversampled subgroups of the population.

↳ in a observational study, certain groups are oversampled relative to the hypothetical sample one would have acquired from a randomized trial.

→ IPTW creates a PSEUDO-POPULATION where treatment assignment no longer depends on covariates X → no confounding in pseudo-population.

Example: suppose $P(A=1|X)=0.9$

Treated ($A=1$) | Control ($A=0$)

Original population:

apply weight $\frac{1}{P(A=1|X)} = \frac{1}{0.9} = \frac{10}{9}$

$$\text{total weight} = 9 \cdot \frac{10}{9} = 10.$$

$$\text{apply weight} \Rightarrow \frac{1}{P(A=0|X)} = 10$$

$$\text{total weight} = 1 \cdot 10 = 10.$$

Pseudo population:

$$\text{apply weight} \Rightarrow \frac{1}{P(A=1|X)} = \frac{10}{9}$$

$$= \frac{1}{0.8} = \frac{10}{8} = 1.25$$

$$= 1.25$$

$$\text{apply weight} \Rightarrow \frac{1}{P(A=0|X)} = 10$$

$$= \frac{1}{0.2} = \frac{10}{2} = 5$$

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$$\text{total weight} = 10 \cdot 1 = 10$$

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