

Propensity Score

The **propensity score** is the probability that a unit (e.g., a person, patient, or subject) would receive a particular **treatment or exposure**, **given a set of observed covariates**.

Formal Definition

The **propensity score** is the conditional probability of assignment to a treatment, given a vector of observed covariates:

$$e(x) = P(T = 1 \mid X = x)$$

where:

- T is the treatment indicator (1 = treated, 0 = untreated),
- X is the vector of observed covariates.

Purpose

Propensity scores are used in **observational studies** to reduce **selection bias** when comparing outcomes between treated and untreated groups.

In randomized trials, treatment is assigned randomly. In contrast, observational studies often have confounding differences between groups. Propensity scores help **balance** these covariates, making groups more comparable.

Common Applications

- **Matching:** Pairing treated and untreated subjects with similar scores.
- **Stratification:** Dividing subjects into strata (e.g., quintiles) based on scores.
- **Weighting:** Applying inverse probability weights to create a pseudo-population.
- **Covariate adjustment:** Using the score as a covariate in a regression model.

Example

In a study comparing surgery vs. medical therapy for a disease, patients may receive surgery based on age, comorbidities, or severity. A propensity score estimates the **probability of surgery** given these factors. Researchers can then compare outcomes as if the groups had been randomized.

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