

Evaluating Survival Prognosis in the Presence of Immortal Time Bias

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slides: goo.gl/khDyZV



Data and Motivation

- ▶ Data analysis: Survival times for patients recruited based on a first primary melanoma.
- ▶ Observational study: n_2 patients develop a second primary melanoma prior to death.
- ▶ **Question:** *How does a second primary melanoma change the survival prognosis?*

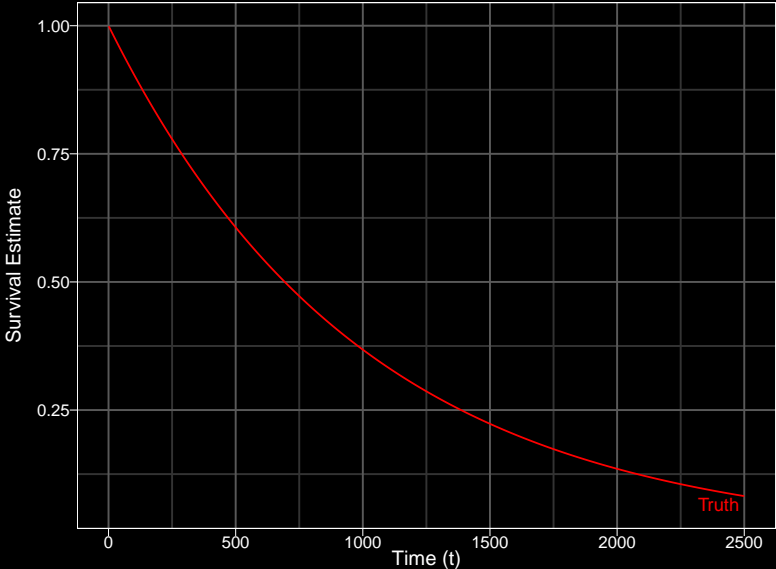
Data and Motivation

- ▶ *Problem:* Efficiently estimate survival prognosis for a data structure while avoiding immortal time bias.
- ▶ *Why?* Little attention in statistics, major problem in medicine.
- ▶ We employ and compare
 1. Cox proportional hazards with time-varying covariates,
 2. Several variations of the the Kaplan–Meier estimator.

Methodology — Cox Regression

- ▶ Cox model: proportional hazards assumption.
- ▶ $\lambda(t; \mathbf{Z} = \mathbf{z}) = \lambda_0(t) \exp(\beta^T \mathbf{z})$, $t \geq 0$.
- ▶ Efficiency by borrowing information across groups.
- ▶ *Time-varying covariate* for group transitions.

Results — Cox Proportional Hazards



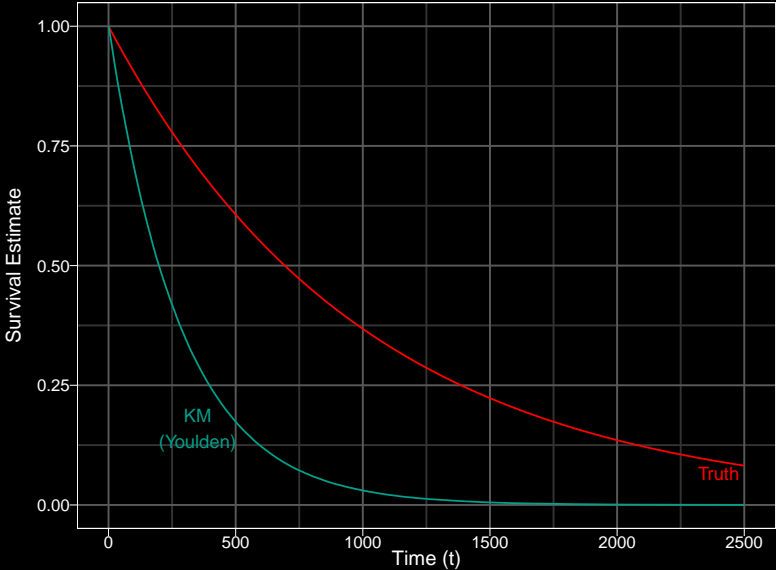
Methodology — Kaplan–Meier (Youlden)

- ▶ In practice, hard to justify Cox model assumptions.
- ▶ Nonparametric techniques are less confining.
- ▶ The Kaplan–Meier (KM) estimator is defined as

$$\widehat{S}(t) = \prod_{i:t(i) < t} \left(1 - \frac{d_i}{n_i} \right), \quad t \geq 0.$$

- ▶ *Proposal:* Fit KM for patients with only 1 melanoma.

Results — Kaplan–Meier (Youlden)



Methodology — Kaplan–Meier (Jewell)

- ▶ Striking difference between Kaplan–Meier and Cox.
- ▶ Why is Kaplan–Meier so sharply biased?
- ▶ Better way to estimate survival nonparametrically?
- ▶ Modify Kaplan–Meier to obtain accurate estimates?

Results — Kaplan–Meier (Jewell)

