Web-based Supplementary Materials for "Identifying Predictive Markers for Personalized Treatment Selection"

by

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This supplementary material contains the proof of convergence of the proposed test statistics.

Convergence of the Proposed Test Statistic

We can write the statistic in terms of stochastic process:

$$\widehat{Q}_{\psi} = n^{-1}\widehat{\boldsymbol{\Delta}}^{\mathsf{T}}\mathbb{K}_n\widehat{\boldsymbol{\Delta}} = \int\int k(\mathbf{x},\mathbf{x}')d\widehat{\Theta}(\mathbf{x})d\widehat{\Theta}(\mathbf{x}') \tag{1}$$

where

$$\widehat{\Theta}(\mathbf{x}) = n^{-\frac{1}{2}}\sum_{i=1}^{n}\frac{(Y_i-\bar{Y}_1)I(T_i=1)}{\hat{\pi}_1}I(\mathbf{x}_i \leqslant \mathbf{x}) - n^{-\frac{1}{2}}\sum_{i=1}^{n}\frac{(Y_i-\bar{Y}_0)I(T_i=0)}{\hat{\pi}_0}I(\mathbf{x}_i \leqslant \mathbf{x}). \tag{2}$$

To derive the influence function of $\widehat{\Theta}(\mathbf{x})$, we write the first part of $\widehat{\Theta}(\mathbf{x})$ in the following way:

$$\begin{aligned}
&n^{-\frac{1}{2}}\sum_{i=1}^{n}\frac{(Y_i-\bar{Y}_1)I(T_i=1)}{\hat{\pi}_1}I(\mathbf{X}_i \leqslant \mathbf{x})\\
=&n^{-\frac{1}{2}}\sum_{i=1}^{n}\frac{(Y_i-\mu_1)I(T_i=1)}{\pi_1}\left[I(\mathbf{X}_i \leqslant \mathbf{x}) - n^{-1}\sum_{i=1}^{n}I(T_i=1)I(\mathbf{X}_i \leqslant \mathbf{x})\right] + o_P(1)\\
=&n^{-\frac{1}{2}}\sum_{i=1}^{n}\frac{(Y_i-\mu_1)I(T_i=1)}{\pi_1}\left[I(\mathbf{X}_i \leqslant \mathbf{x}) - \mathcal{F}(\mathbf{x})\right] + o_P(1)
\end{aligned}$$

where $\mathcal{F}(\mathbf{x}) = P(\mathbf{X}_i \leqslant \mathbf{x})$. Since by a uniform law of large numbers (ULLN) (Pollard, 1990), $n^{-1}\sum_{i=1}^{n}\frac{I(T_i=1)I(\mathbf{X}_i \leqslant \mathbf{x})}{\pi_1}$ converges in probability to its limit, $\mathcal{F}(\mathbf{x})$, uniformly in $\mathbf{x}$. Therefore,

$$\widehat{\Theta}(\mathbf{x}) = n^{-\frac{1}{2}}\sum_{i=1}^{n}\theta_i(\mathbf{x}) + o_P(1), \tag{3}$$

where

$$\theta_i = \left[\frac{(Y_i-\mu_1)I(T_i=1)}{\pi_1} - \frac{(Y_i-\mu_0)I(T_i=1)}{\pi_0}\right]\left[I(\mathbf{X}_i \leqslant \mathbf{x}) - \mathcal{F}(\mathbf{x})\right] \tag{4}$$

It is not hard to show that $E\{\theta_i(\mathbf{x})\} = 0$. In addition, it follows from a functional central limit theorem (Pollard, 1990) that $\widehat{\Theta}(\mathbf{x})$ converges jointly to a zero mean Gaussian process $G(\mathbf{x})$. By

Lemma A.3 of Bilias et al. (1997) and the strong representation theorem, we have

$$(1) \to \int\int k(\mathbf{x}, \mathbf{x}')dG(\mathbf{x})dG(\mathbf{x}')$$

References

Bilias, Y., Gu, M., Ying, Z., et al. (1997). Towards a general asymptotic theory for cox model with staggered entry. *The Annals of Statistics* **25,** 662–682.

Pollard, D. (1990). *Empirical processes: theory and applications.* NSF-CBMS Reginal Conference Series in Probability and Statistics 2. Institute of Mathematical Statistics and American Statistical Association.