# Question

## April 2021

I'm writing a dissertation about bootstrap methods and the main book I'm using is "Efron, B., & Tibshirani, R.J. (1994). An Introduction to the Bootstrap(1st ed.). Chapman and Hall/CRC".
Now I need to deal with the bootstrap-t confidence intervals but I got many doubts about it. I'm not a native speaker but I'll try to be as clear as possible.

We're in a situation where $(x_1, ..., x_n)$ is a fixed data set from an unknown distribution $F$, $\theta$ is a parameter, not necessary the mean, and $\hat{\theta} = s(X_1, ..., X_n)$ is an estimator. We denote with $\mathbf{x_1}^*, ..., \mathbf{x_B}^*$ B bootstrap samples and respectively with $\hat{\theta}^*(1), ..., \hat{\theta}^*(B)$ the bootstrap replications. Following pages 160-161 of Efron's book, it uses the following estimator to find bootstrap-t intervals: $Z_b^* = \frac{\hat{\theta}^*(b) - \hat{\theta}}{\hat{se}^*(b)}$, where $\hat{se}^*(b)$ is the standard error of $\hat{\theta}^*(b)$. Now I got some questions to ask:

1. Why he took exactly $Z_b^*$ and not, for example, just $\hat{\theta}^*(b) - \hat{\theta}$? In fact, we can't say that $Z_b^*$ is normal or Student, we can't even say that it is close to a Student because we don't know the distribution $F$ and we don't know what is $\theta$. So we could find $\alpha$th percentiles that Efron finds in the same way with $\hat{\theta}^*(b) - \hat{\theta}$.

2. Why the intervals we found are for $\theta$, when in $Z_b^*$ the parameter $\theta$ does't appear?

3. Why in $Z_b^*$ we use $\hat{se}^*$ instead of $\hat{se}$?

4. the term $\hat{\theta}$ in $Z_b^*$ is for $s(X_1, ..., X_n)$, so a random variable, or for $s(x_1, ..., x_n)$, so a fixed value?

5. Which are the analogies with the t-Student?