Engineering Maths EMAT 30007, Bootstrapping

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1 Bootstrap confidence intervals:

MATLAB function ci = bootci(nboot,bootfun,...) works out bootstrap confidence interval. The default value of alpha is 0.05 (95% confidence interval). The first argument `nboot` is the number of bootstrap replications used in the computation. The second argument `bootfun` is the parameter you estimate. The third argument is input data. The last argument defines the type of the bootstrap confidence interval. There are three major ones described in the lecture:

(1) basic percentile bootstrap CI - `'percentile'`
(2) bootstrap-t or studentized CI - `'student'`
(3) CI with bootstrapped standard error - `'normal'`

Notice that the default bootstrap method is the `'accelerated percentile method'`.

(a) The random sample of 10 elements in the code below represents the auditory nerve fiber responses rates in cats. We want to estimate the population mean response rate.

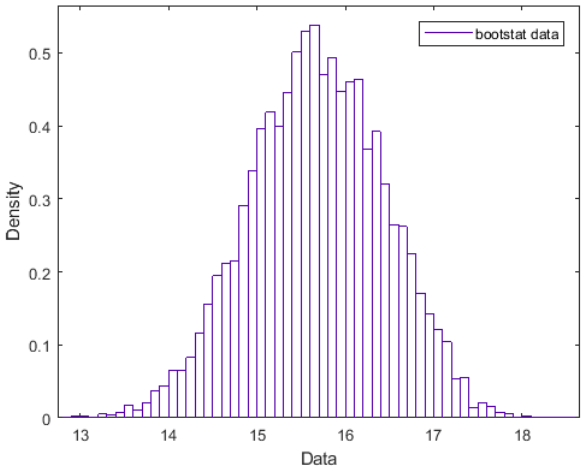
```
>> x=[15.1 14.6 12.0 19.2 16.1 15.5 11.3 18.7 17.1 17.2] % input vector
>> parameter=@(y)mean(y) % we estimate mean for each bootstrap sample
>> ci=bootci(3000,{parameter, x}, 'alpha', 0.05,'type', 'percentile')

OR

>> [ci,bootstat] =bootci(3000,{parameter, x}, 'alpha', 0.05,'type', 'percentile')
% returns the bootstrapped statistic computed for each of the bootstrap sample
```

Work out:

- Run the function `bootci` several times. Do you get a different confidence interval each time? Explain.
- Plot the bootstrap distribution on the graph. Does the distribution look normal? What is the bootstrap standard error?



- Using `bootstat` output (i.e. bootstrap distribution), work out bootstrap percentile CI 'by hand'. You can use MATLAB function `prctile`.
- Apply another bootstrap method - bootstrap-t CI- by using `bootci` function. Does it give similar results?
- Applying CI with bootstrapped standard error method.

(b) Compare the performance of three bootstrap methods for any skewed distribution. You can perform the following steps:

- Apply Monte Carlo simulations for generating random samples (for example, generate samples from the exponential distribution `R = exprnd(mu)`).

- Apply three bootstrap methods by taking one random sample from the distribution as an input.
- Compare the results of three bootstrap methods with the population parameter.
- Does the number of replications affect the result?