

# STAT 243: Final Project

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December 17th, 2015

## 1 Function Design

We chose to use a functional style as opposed to an object-oriented style, and composed our main function `ars` from the auxiliary functions that are summarized in Table 1. Note that we employed a naming convention wherein all auxiliary functions begin with the prefix `faux`. In order to maximize efficiency, we distributed these auxiliary functions among our group. This necessitated an explicit mapping of the output of early functions to the input of later functions. Note also that objects that translate to the same ideas in the paper are named in a similar way to each other, and also to how those objects are named in the paper. For example, `inp_Dvec` is used consistently to represent  $D$ , and `inp_xvec` is used consistently to represent  $T_k$ .

A pseudocode summary of the overall function `ars` is included here:

```
ars <- function(n, g, D, k = 100) {  
  Check for log-concavity  
  Get initial points in  $T_k$   
  Get h, uk, lk, and sk  
  while (length of sample < n) {  
    Sample  $x^*$  from s  
    Generate  $w \sim \text{uniform}(0,1)$   
    Determine which interval  $x^*$  falls into  
    if (w passes squeezing test) {  
      Include  $x^*$  in sample  
    } else if (w passes rejection test) {  
      Include  $x^*$  in sample  
      if (there are no numerical issues with the derivative) {  
        Include  $x^*$  in  $T_k$   
        Recalculate z, u, l, and s  
      }  
    }  
  }  
  return(sample)  
}
```

## 2 Testing

We used `testthat` throughout our work on this project. We tested our functions as we created them, and in some cases we modeled test-driven development by writing the tests before the function. Writing tests for each others' functions was our main method of code review, although we did engage in further code review as well as pair programming.

The tests for our auxiliary functions mainly took these three forms:

1. Valid input. For example, testing that
  - (a)  $g$  is a function;
  - (b)  $D$  is a numeric vector of length 2; and
  - (c)  $T_k$  is a numeric vector.
2. Valid output. For example, testing that
  - (a) `faux_CheckLogConcavity` produces a logical vector of length 1;
  - (b) `faux_hx` produces a function; and

Table 1: Summary of the auxiliary functions.

Function Name	Summary
<code>faux.CheckLogConcavity</code>	Takes $g$ and $D$ and returns TRUE if $g$ is log-concave. We chose to do one global check at the beginning as opposed to multiple checks throughout
<code>faux.hx</code>	Takes $g$ and returns $h$ .
<code>faux.findmode</code>	Takes $g$ and $D$ and returns the mode of $g$ . Obtaining initial points in $T_k$ on either side of the mode was how we ensured $h'(x) > 0$ and $h'(x_k) < 0$ .
<code>faux.InitChoose</code>	Takes $g$ , $D$ , and an initial $k$ and returns $T_k$ .
<code>faux.hPrimex</code>	Takes $g$ and $T_k$ and returns $h'(T_k)$ .
<code>faux.Lkx</code>	Takes $g$ and $T_k$ and returns $l_k$ .
<code>faux.Zj</code>	Takes $g$ , $T_k$ , and $D$ and returns the $z_j$ .
<code>faux.uInterval</code>	Takes the $z_j$ and returns the intervals between the $z_j$ .
<code>faux.Ukx</code>	Takes $g$ and $T_k$ and returns $u_k$ .
<code>faux.Skx</code>	Takes $u_k$ and the intervals between the $z_j$ and returns $s_k$ .
<code>faux.SampleSkx</code>	Takes $u_k$ and the intervals between the $z_j$ and returns a sample from $s_k$ .

(c) `faux.Ukx` produces a list of functions.

3. Correct output. For example, testing that

(a) `faux.CheckLogConcavity` detects that  $g(x) = \phi(x)$  is log-concave;

(b) `faux.hPrimex` returns  $h'(x) = -2$  for  $g(x) = 2e^{-2x}$ ; and

(c) `faux.findmode` returns 0 for  $g(x) = \phi(x)$ .

In addition to the tests for each auxiliary function, we also wrote tests for the overall `ars` function, checking its output against theory. This modular testing structure allowed us to easily create an overall testing function `test-main.R` which combined all tests into one. After all was said and done, we tested the package in the BCE.

### 3 Documentation

We used `roxygen2` to facilitate the creation of documentation; essentially it allows us to create all the documentation with a single command. We maintained the documentation throughout the coding process, ensuring that function descriptions, inputs, outputs, and examples were up-to-date. We followed the R Style Guide for coding and linting practices, and heavily commented our code to ensure clarity and to facilitate code review.

### 4 Collaboration

We used Git in order to collaborate on the code itself. We also created a private Slack group for collaboration and real-time communication. Slack employs a markdown-based text formatting interface which allows easy formatting of code and text. Lastly, we used a Google doc for group documentation, including meeting minutes, technical notes on the `ars` function, and to-do lists.

We all contributed to the writing of functions, tests, and documentation, with major contributions breaking down as follows:

1. Jonathan wrote `faux.CheckLogConcavity` and assisted with `faux.hx`, `faux.Lkx`, `faux.Ukx`, and `faux.SampleSkx`.
2. Chenzhi
3. Courtney
4. Shamindra