Advertising Simulator

Günter J. Hitsch

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```r
library(data.table)
library(ggplot2)
```

Model

Demand function:

$$\log(Q_t) = \alpha + \gamma g_t$$

Goodwill:

$$g_t = \log(a_t) + \delta \log(a_{t-1}) + \cdots + \delta^L \log(a_{t-L})$$

Sales response simulation function

- `T`: prediction horizon
- `adv_base_level`: Constant base level of advertising
- `adv_insert`: Vector of advertising levels that are added to the base level (values can be negative)
- `insert_t`: Period when first element in `adv_insert` is added to the base level of advertising (between 1 and `T`)
- `param`: List of model parameters

```r
advertisingResponse <- function(T, adv_base_level, adv_insert, insert_t, param) {
   if (insert_t > T) stop("Insert time outside simulation period")

   geom_weights = cumprod(c(1.0, rep(param$delta, param$L)))
   geom_weights = sort(geom_weights)

   # Pad with zero values before and after insertin period
   adv_insert = c(rep(0, insert_t-1), adv_insert, rep(0, T))

   log_Q = rep(NA, times = T)
   adv   = rep(adv_base_level, param$L)
   for (t in 1:T) {
      adv = c(adv, adv_base_level + adv_insert[t])
      g   = sum(geom_weights*tail(log(adv), param$L+1))
      log_Q[t] = param$alpha + param$gamma*g
   }

   L = length(adv)
   DT = data.table(time  = 1:T,
                   adv   = adv[(L-T+1):L],
                   log_Q = log_Q)

   return(DT)
}
```

Parameter settings

```
parameters = list(alpha = 1.0,
                   gamma = 1.0,
                   delta = 0.8,
                   L     = 10   )
```

Simulation

```
T             = 20
adv_base_level = 1
insert_t       = 4
adv_insert     = c(4, 4, 2)

DT = advertisingResponse(T, adv_base_level, adv_insert, insert_t, parameters)
```

Graph the response

```
ggplot(DT, aes(x = time, y = adv)) +
    geom_vline(xintercept = c(insert_t, min(insert_t+length(adv_insert), T)),
               color = "lightblue1", size = 2, alpha = 0.8) +
    geom_step(color = "gray75", size = 0.5) +
    geom_point(shape = 21, color = "gray30", fill = "hotpink", size = 1.75, stroke = 0.5) +
    scale_x_continuous(minor_breaks = 1:T) +
    theme_bw()
```
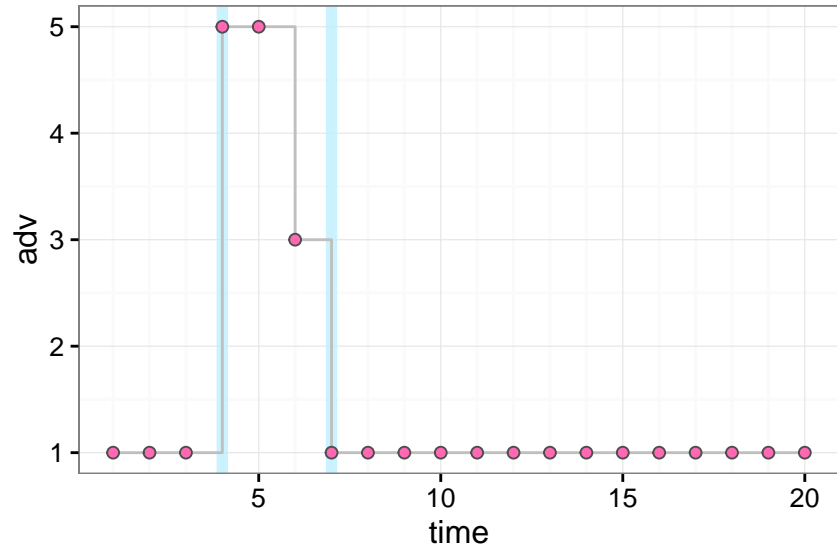


```
# ggsave("Simulated-Adv.pdf", width = 6, height = 2)
```

```
ggplot(DT, aes(x = time, y = log_Q)) +
    geom_vline(xintercept = c(insert_t, min(insert_t+length(adv_insert)+parameters$L, T)),
               color = "lightblue1", size = 2, alpha = 0.8) +
    geom_step(color = "gray75", size = 0.5) +
    geom_point(shape = 21, color = "gray30", fill = "midnightblue", size = 1.75, stroke = 0.5) +
    scale_x_continuous(minor_breaks = 1:T) +
    theme_bw()
```
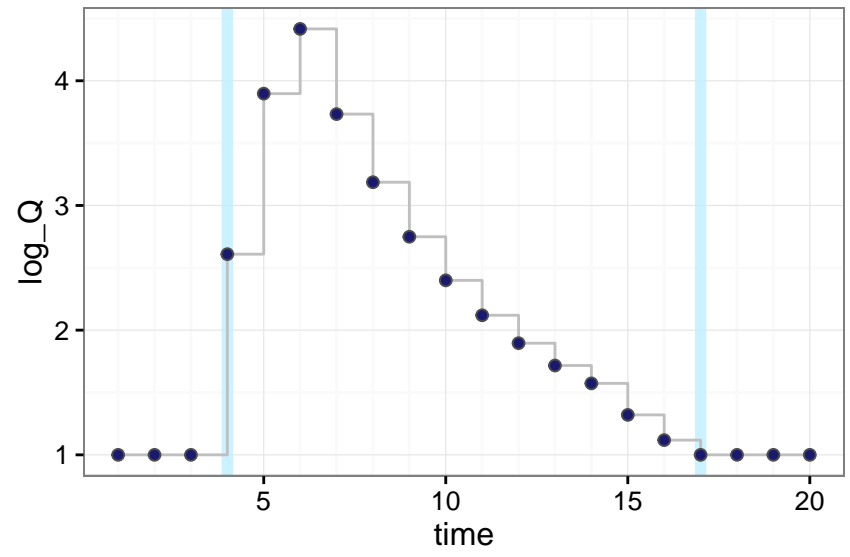
```
# ggsave("Simulated-Sales.pdf", width = 6, height = 2)
```