ESS 575: Discrete Logistic Lab

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Objective

See the course website for a full lab description. Important R concepts and methods utilized include:

1. writing functions
2. creating data structures
3. looping
4. plotting

Question 1

$$x_{t+1} = \lambda x_t(1 - x_t) \tag{1}$$

Where:

- λ is the per capita rate of population growth
- x_t is the population size at time t.

Write an R function for equation 1. Use your function to simulate how population size changes over time in response to variation in the parameter λ. Set up a model experiment with an outer for loop controlling the value of λ to range from .25 to 4.0 in steps of .25. Create an inner loop varying time from 2 to 30 in steps of 1. Assume that the initial condition (i.e., the value of x at time = 1) for the population size is .01. Create a plot of x as a function of time for each value of λ. You should display your plots with 4 x 4 panels, one panel for each of your simulations. Give each plot a title showing the value of λ. (Hint, convert the numeric value of λ to a character value using z = as.character(lambda) and use main = z as an option in the plot statement). What can you conclude about the effect of λ on the dynamics? Use your panel plot to illustrate the points in your discussion.For an engaging time waster, figure out how to put a symbolic λ in the title of your plots. So, you will need to combine a symbolic λ with a numeric value that changes with each plots title. See ?plotmath for hints.

```
# set data range
dta <- data.frame(
  dbh = seq(2, 230, 2)
)
# define coefficients
  a <- 72.82
```

```r
  b <- 0.0156
  c <- 0.8634
# define function
weibull_fn <- function(x) {
  # return
  return(a * ( 1 - exp( -b * (x^c) ) ) )
}

# plot
my_plot <- ggplot(dta, aes(x = dbh)) +
  geom_function(
    fun = weibull_fn
    , size = 2
    , alpha = 0.8
  ) +
  annotate(
    'text'
    , x = 35
    , y = 50
    , label = "HT == a %*% bgroup('[',1 - italic(e)^(-b %*% DBH^c),']') "
    , parse = TRUE
    , size = 4
  ) +
  labs(
    title = "Weibull Tree Height-Diameter Growth Function"
    , subtitle = expression(paste(
        "example based on coefficients for Ponderosa Pine ("
        , italic("Pinus ponderosa")
        , ")"
      ))
    , caption = paste0(
        "where: a = "
        , as.character(a)
        , "; b = "
        , as.character(b)
        , "; c = "
        , as.character(c)
      )
  ) +
  annotate(
    "text"
    , x = max(dta$dbh) * .9
    , y = 2
    , label = "created by: George Woolsey"
    , size = 3
  ) +
  xlab("Tree DBH (cm)") +
  ylab("Tree Height (m)") +
  theme_bw() +
  theme(
    legend.position="none"
  )
```

```r
# Export PDF
pdf("../plot_assignment1_GWoolsey.pdf", paper = "USr", height = 8.5, width = 11)
print(my_plot)
dev.off()
```

Literature Cited

Yang, R. C., Kozak, A., & Smith, J. H. G. (1978). The potential of Weibull-type functions as flexible growth curves. *Canadian Journal of Forest Research*, **8(4)**, 424-431.

Zhang, L. (1997). Cross-validation of non-linear growth functions for modelling tree height–diameter relationships. *Annals of Botany*, **79(3)**, 251-257.