Project 2: Savings Rate Calculator

Stat 133, Spring 2022

About

The purpose of this assignment is to create a **savings rate calculator using a shiny app.** You will have to create a shiny app, publish it on RStudio `shinyapps.io`, and record a 3-minute video showing how your app works and how to make sense of the displayed information.

We are assuming that you have gone through the learning materials covered in weeks 7, 8, 9 and 10.

Please carefully read this document in its entirety before writing any code.

1) Motivation

This section aims to provide context about the project and therefore is purely informative; no need to calculate or code anything for this part.

Suppose you are hired by a financial planner to help her design a shiny app that she will use when talking about personal finance with her clients. The overall goal of this app is to help her clients understand what impact their savings rate could have on their future plans.

Meet Astrid, one of the clients, who is 25 years old and has a personal goal of saving and investing part of her income in order to reach $1,000,000 somewhere in the future. She dreams of using that money for various purposes such as traveling, starting a business, donating to charity, and even to be able to take a sabbatical.

Astrid has an annual income of $65,000, and she is trying to figure out how much money she should be saving to reach her million-dollar goal: 5%, 10%, 15%, more? Also, given a certain savings rate, she would like to know how long it will take her to become a millionaire.

1.1) Some Theoretical Assumptions

Rate of Return. Let's suppose that Astrid invests in a set of financial assets (e.g. high-yield savings account, mutual funds, ETF's, etc) that on average give her an annual rate of return of 7%.

No inflation & No income growth. In theory, we should take into account inflation rate, as well as the rate at which Astrid expects to grow her income every year. However, to keep

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things simple, we'll ignore both inflation as well as income growth. This means that Astrid's income will remain constant forever.

Yes, these are theoretical assumptions that will hardly be met in real life. But we'll use them for sake of simplicity.

1.1) Future Value of Ordinary Annuity

If Astrid decides to save 5% of her annual income, she will be saving—and investing—$65,000 \times 0.05 = 3,250$ dollars every year. Assuming an annual return of 7%, how much money she could expect to have 5 years from now?

The answer to this question can be obtained by using the future value formula of an (ordinary) Annuity, given by:

$$\text{FV} = \text{C} \times \frac{(1+r)^t - 1}{r}$$

where:

- $\text{FV} =$ future value (of an ordinary annuity)
- $\text{C} =$ annual contribution
- $r =$ annual rate of return
- $t =$ number of years

So, going back to Astrid's data: if she contributes $\text{C} = \$3,250$ every year, at an annual rate of return $r = 0.07$, for $t = 5$ years, she could expect to have:

$$FV = 3,250 \times \frac{(1+0.07)^5 - 1}{0.07} = 18,689.90$$

1.2) Number of Years

This and the next sections describe examples that will guide you in coding your shiny app.

How long will it take Astrid to get to $1,000,000? To answer this question, from the above FV formula, we need to solve for t as follows:

$$t = \log\left(\frac{r \times \text{FV}}{\text{C}} + 1\right) \,/\, \log(1+r)$$

Using Astrid's data we get:

$$t = \log\left(\frac{0.07 \times 1,000,000}{3,250} + 1\right) \,/\, \log(1+0.07) \approx 46.04 \text{ years}$$

If Astrid can save only $3,250 every year, it's going to take her a very long time to accumulate $1,000,000. By then, she'll be 71 years old. There is nothing wrong with this as long as Astrid is willing to wait that many years to be able to spend her million dollars.

1.3) Various Savings Rates

What if Astrid saves 10%, or 15%, or 20%? How many years will she need? The answer is given in the following table, together with a barchart to visualize the relationship between savings-rate and number of years to become a millionaire

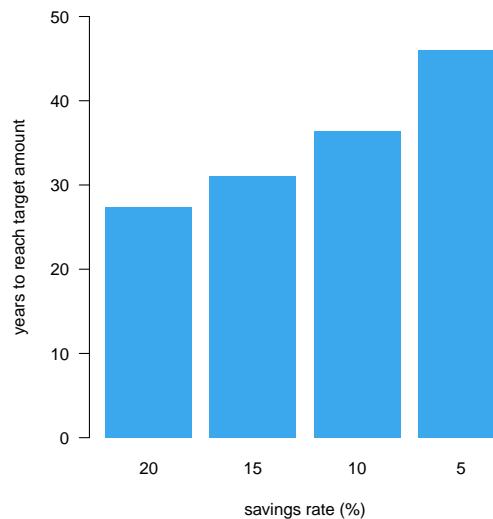| Savings Rate	Annual Contribution	Number of Years	Age at Target
5%	$3,250	46.04	71.0
10%	$6,500	36.44	61.4
15%	$9,750	31.06	56.1
20%	$13,000	27.40	52.4

Figure 1: Number of years to reach 1,000,000 depending on savings rate (assuming an income of 65000, and return of 0.07)

> **Goal 1) Visualizing the relationship between savings-rates and number of years to reach a target amount.**
>
> One of the data visualizations in your shiny app should be a bar-chart (similar to the one displayed above) that shows the number of years to reach a target amount for savings rates of 5%, 10%, 15%, ..., 90%, 95% and 100%.

1.4) Total Contribution and Total Growth

In addition to knowing the number of years it will take to reach a target amount (e.g. $1,000,000), it's worth inspecting how much of that target amount comes from Astrid's annual contributions, and how much comes from the growth of her investments.

For example, with a savings rate of 5%, and an annual return of 7%, Astrid needs about 46 years to become a millionaire. This means that Astrid will have a:

- total contribution of: $3,250 \times 46.06 = \$149,695$

- total growth (from investments) of: $\$1,000,000 - \$149,695 = \$850,305$

As you can tell, $149,500/1,000,000 = 14.96\%$ will come from Astrid's contributions, and the rest 85.05% will come from the growth of her investments.

In contrast, with a savings rate of 20%, and an annual return of 7%, Astrid needs 27.40 years to become a millionaire. This means that Astrid will have a:

- total contribution of: $13,000 \times 27.40 = \$356,200$

- total growth (from investments) of: $\$1,000,000 - \$356,200 = \$643,800$

In this case, 35.62% comes from Astrid's contributions, and 64.38% comes from the growth of her investments.

The following table displays the various outputs that can be calculated for savings rates of 5%, 10%, 15% and 20%

Savings Rate	Annual Contrib	Total Contribution	Total Growth	Percent Contrib	Percent Growth	Number of Years	Age at Target
5%	$3,250	$149,640.5	$850,359.5	14.96%	85.04%	46.04	71.0
10%	$6,500	$236,860.7	$763,139.3	23.69%	76.31%	36.44	61.4
15%	$9,750	$302,856.9	$697,143.1	30.29%	69.71%	31.06	56.1
20%	$13,000	$356,208.5	$643,791.5	35.62%	64.38%	27.40	52.4

> **Goal 2) Visualizing the "total contributions" and the "total growth" for various savings rates.**
>
> Your shiny app should also include a second data visualization that allows you to compare the "total contributed amount" and the "total growth amount" for various savings rates. You can use the total amounts, and/or the proportions (i.e. percentages) that they represent out of the target amount.

> **Goal 3) Table of Numeric Outputs.**
>
> In addition to the two data visualizations, your shiny app should also include a table like the above one. Optionally, you can include more numeric summaries to help you with the interpretation/understanding of the effect that various savings rates have on reaching a specific target amount.

2) Shiny App

Your mission is to create a shiny app that helps a user understand the effect that their savings rate, given a certain rate of return, will have on the time needed to reach a target amount. Specifically, the app should consider the following sequence of savings-rates: 5%, 10%, 15%, ..., 95%, 100%. That is, from 5% to 100% in steps of 5% increments.

Your app should have a layout like the following diagram (see specifications below). You can find a template R script file `app-template.R` in the folder containing this pdf of instructions (bCourses).
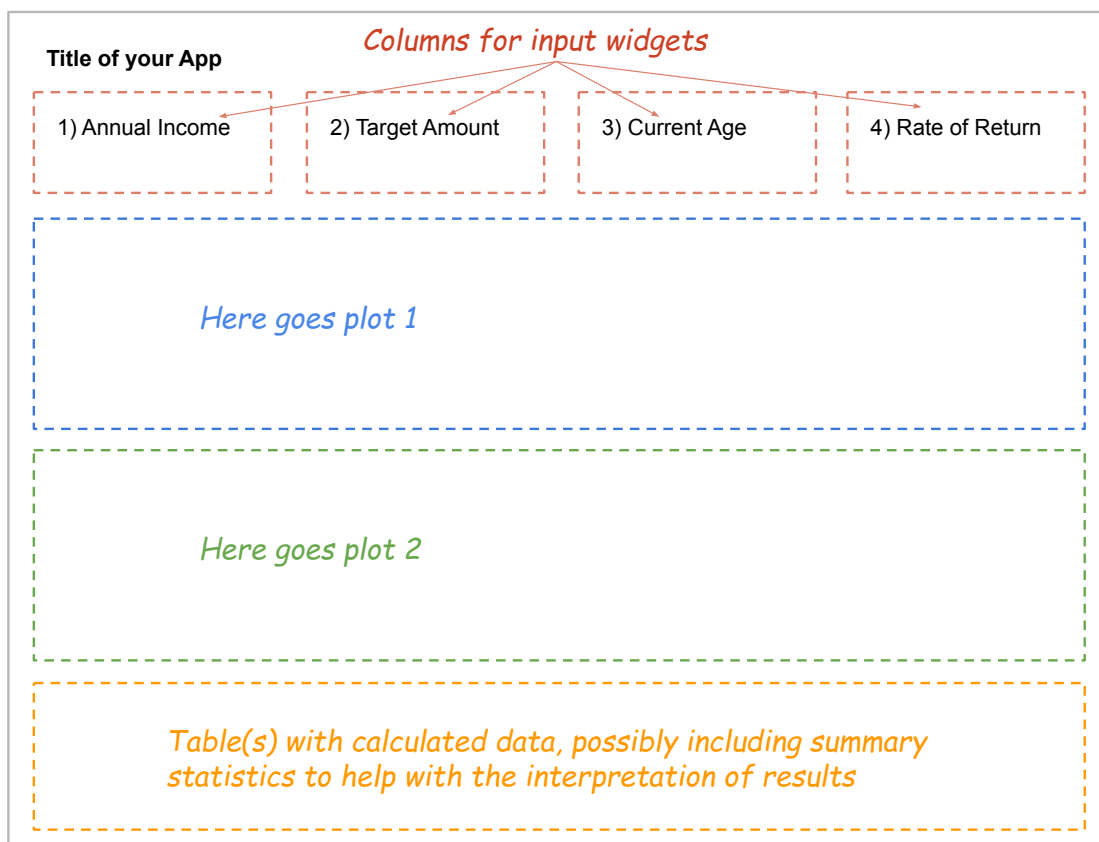
As you can tell from the above diagram, the layout of the app involves five distinctive sections—see template file `app-template.R`:

- **title**: main title for your app (give it a meaningful name)

- **input widgets**: widgets arranged in four columns

- **plot-1**: an output graph for the first dataviz

- **plot-2**: an output graph for the second dataviz

- **table(s)**: an output area (e.g. for a table) to display calculated data, possibly including summary statistics.

2.1) Input widgets

Your app should include widgets for the inputs listed below. You are given freedom to decide what type of widgets (e.g. `numericInput()`, `sliderInput()`, `radioButtons()`, etc) to include in the shiny app. You are also allowed to include more widgets in addition to the required ones.

1) the **annual income**, default value of 50,000

2) the **target amount**, default value of 1,000,000

3) the **current age**, default value of 25

4) the **rate of return**, default value of 5%

> You are allowed to include more widgets that enhance the user experience, or that provide deeper insight into understanding the impact that savings rates, with a given rate of return, has on the number of years to reach a target amount.

3) Submission

1) **R file**: You will have to submit the source `app.R` file (do NOT confuse with an `Rmd` file) containing the code of your app.

2) **Link of published app**: You will also have to submit the link of your published app in shinyapps.io (the free version). This publication process is fairly straightforward, and you can watch Garret Grolemund's video on how to do this: https://vimeo.com/rstudioinc/review/131218530/212d8a5a7a/#t=30m35s. Share the link with us in the comments section of the submission in bCourses.

3) **Video**: In addition to the `app.R` file and the link of your published app, you will also have to record a video—maximum length of 3 minutes—in which you show us your published shiny app, how to use it, and a description of its outputs. Share the **public link** with us in the comments section of the submission in bCourses.

Make sure that the video does not exceed 3-minutes, that its resolution is okay, without too much background noise, avoiding very low volume or inaudible audio. Above all, record a

video in which **both your screen and your face are captured**. We want to see your app, and we also want to see your face.

3a) Ideas for your video. You can tell us:

- How changing the rate of return (say from 5% to 6% or higher) affects the number of years needed to reach a target amount.

- How increasing or decreasing the annual income affects the number of years needed to reach a target amount.

- What could be some of the (main) limitations when trying to use this calculator in "real" life?

4) **Important:** You do NOT have to submit any Rmd or html files this time. Also, **we will not accept any content sent by email**. We will only grade the `app.R` file submitted to bCourses, the public link of the video, and the link of your app in `shinyapps.io`.

Resources

You may want to take a look at the Shiny gallery:
https://shiny.rstudio.com/gallery/

Shiny widgets gallery:
https://shiny.rstudio.com/gallery/widget-gallery.html

Share you app with `shinyapps.io`:
https://vimeo.com/rstudioinc/review/131218530/212d8a5a7a/#t=30m35s

Of course, you can take a look at other apps displayed in the Shiny gallery to get some inspiration.