

How to *Exit* the Rat Race



You look around you. To the north, south, east, and west there are employees trying to sell you on working for their company. You are surrounded; there is no way out. **You need money to live, so how will you ever exit the rat race?** How do you win the game? You read the game manual for some Sage advice:

```
# define notation
target_savings, annual_savings, growth_rate, time = var('T', 's', 'r', 't')
total_savings = function('x')(time); assume(time > 0); assume(s > 0)
```

```
eq = (diff(total_savings, time) == growth_rate * total_savings + annual_savings); show(eq)
```

$$\frac{\partial}{\partial t} x(t) = r x(t) + s$$

Gee, *thanks*, game manual. Total (invested) savings increase exponentially over time and are also supplemented linearly by annual savings? How about you tell me something I *don't* know?!

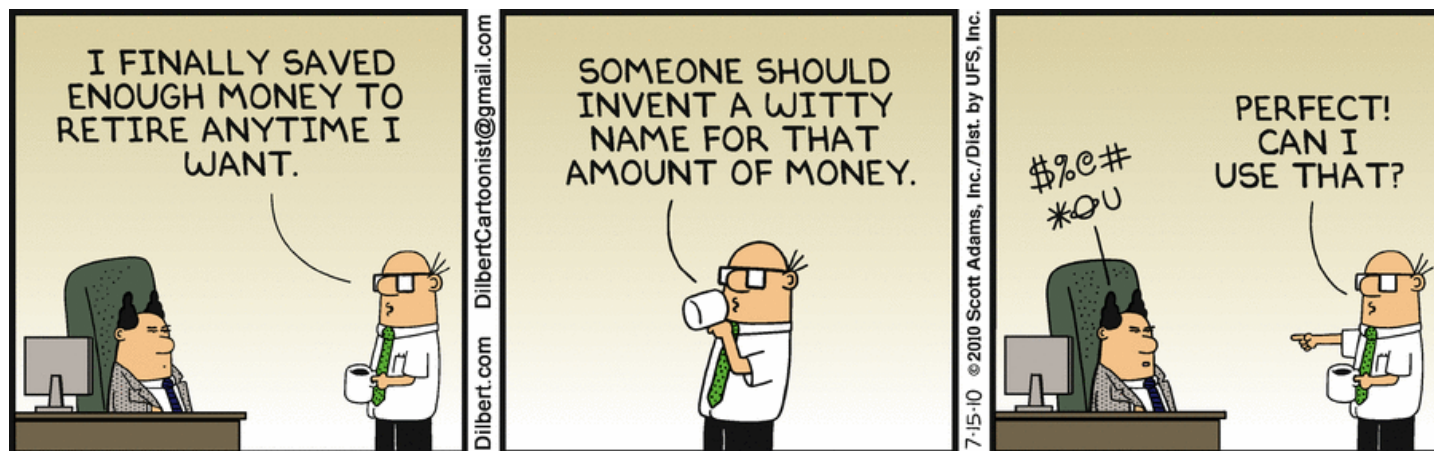
```
savings_over_time = desolve(eq, ics=[0,0], dvar=total_savings, ivar=time);
time_until_retired = solve(savings_over_time == target_savings, time)[0].right(); show(time == time_until_retired)
```

$$t = \frac{\log\left(\frac{Tr}{s} + 1\right)}{r}$$

...actually that's kind of cool. If I plug in my target savings for retirement, this tells me how long I need to work before I can retire! But what level of savings should I target?

The Trinity Study [1] is a study that examined historical stock market performance to estimate what percent of your savings you can withdraw annually in retirement without going broke. The principal is invested in the S&P 500 and bonds (various breakdowns are examined), and the study accounts for inflation-adjusted expenses. In the calculations below, we will assume that you save until your annual expenses (i.e. annual withdrawal) are 3% of your total savings, following the most conservative plan in the study. 4% is a more common choice (and will yield shorter retirement times -- the study is often called "The 4% Rule" for a good reason!), but we will use 3% here to avoid potential criticism of not being cautious/safe enough.

```
expected_r = 0.07 # Used as an estimate pre-retirement; if the market is bad you'll have to work a little longer
retirement_r = 0.03 # Annual withdrawal rate -- rerun with 4% if you're interested in those results
```



```

# define example budgets and salaries, so we can compute years to retirement for each
def expenses(lifestyle, salary, working):
    # Housing: cheap/Cambridge 3br shared/Cambridge solo
    expenses = [500*12, 1200*12, 3000*12][lifestyle]
    # Food: always cook/2 restaurants per week/restaurants every lunch and dinner
    expenses += [70*52, 110*52, (15 + 20)*365][lifestyle]
    # Transit: bike + weekly MBTA round trip/MBTA monthly pass/car ownership (+ downtown parking at work) [2]
    expenses += [50 + (2*2.40)*52, 90*12, 16e3 if working else 10.8e3][lifestyle]
    # Misc + luxuries: travel, clothes, tech subscriptions, gym memberships, consumable supplies, etc
    expenses += [150*12, 500*12, 1000*12][lifestyle]
    # medical insurance, possibly subsidized by Obamacare, "free" (hidden part of salary) if not retired yet
    taxable_income = salary if working else expenses; FPL=12490; obamacare_cost = taxable_income * (.0206 if taxable_income > FPL else 0)
    expenses += 0 if working else min([300, 300, 500][lifestyle] * 12, obamacare_cost)
    # taxes 5.5% MA ($7400 of personal+rent deductions), progressive federal tax (12400 standard deduction)
    taxable_income = salary if working else expenses; ma_income = max(0, taxable_income - 7400); fed_income = max(0, taxable_income - 12400)
    est_fed_rate = .1 if fed_income < 9700 else .115 if fed_income < 39475 else .171 if fed_income < 84200 else .20
    expenses += ma_income * .0505 + fed_income * est_fed_rate
    return expenses, ["Frugal", "Standard", "Yolo"][lifestyle] + " Expenses"

salaries = [('High Income', 150e3), ('MIT Average', 100e3), ('MIT Grad Stipend', 40e3), ('US Median', 33e3)]
for lifestyle in [0,1,2]:
    for salary_label, salary in salaries:
        retirement_target = expenses(lifestyle, salary, False)[0] / retirement_r;
        working_expenses, lifestyle_label = expenses(lifestyle, salary, True);
        retirement_eta = time_until_retired(r=retirement_target, s=salary-working_expenses, T=retirement_target).n()
        retirement_eta = "{:4.1f}".format(float(retirement_eta)) if retirement_eta in RR else "∞"
        print("{:17s} (= {:3d}k pre, {:2d}k post), {:16s} (= {:3d}k): retire on ${:4d}k after {} years{}".format(lifestyle_label, salary_label, retirement_eta, retirement_target, salary_label, retirement_eta))

```

Frugal Expenses	(= 47k pre, 12k post),	High Income	(= 150k): retire on \$ 407k after 3.5 years
Frugal Expenses	(= 34k pre, 12k post),	MIT Average	(= 100k): retire on \$ 407k after 5.1 years
Frugal Expenses	(= 16k pre, 12k post),	MIT Grad Stipend	(= 40k): retire on \$ 407k after 11.4 years
Frugal Expenses	(= 15k pre, 12k post),	US Median	(= 33k): retire on \$ 407k after 13.8 years
Standard Expenses	(= 62k pre, 32k post),	High Income	(= 150k): retire on \$1084k after 8.9 years
Standard Expenses	(= 49k pre, 32k post),	MIT Average	(= 100k): retire on \$1084k after 13.1 years
Standard Expenses	(= 32k pre, 32k post),	MIT Grad Stipend	(= 40k): retire on \$1084k after 33.6 years
Standard Expenses	(= 30k pre, 32k post),	US Median	(= 33k): retire on \$1084k after 51.4 years
Yolo Expenses	(= 112k pre, 92k post),	High Income	(= 150k): retire on \$3075k after 27.1 years
Yolo Expenses	(= 99k pre, 92k post),	MIT Average	(= 100k): retire on \$3075k after 82.3 years
Yolo Expenses	(= 81k pre, 92k post),	MIT Grad Stipend	(= 40k): retire on \$3075k after ∞ years
Yolo Expenses	(= 80k pre, 92k post),	US Median	(= 33k): retire on \$3075k after ∞ years

Wow! I thought I had to be 65 to retire! But if I can be at all frugal, there's no reason I can't **retire in under 15 years**, even if I don't get an unusually high-paying job. That sure cuts down on career fair pressure! ...but does it really work?

Yes, it works. You should do some financial planning.

- [1] Trinity Study: <https://www.aaii.com/journal/199802/feature.pdf>. Accessible/readable with no background
- [2] Car ownership costs based on <https://www.thebalance.com/true-car-ownership-costs-4165784>, and adjusted for Cambridge mileage/gas/parking costs
- [3] Lifestyle+finance blog: <https://www.mrmoneymustache.com/2013/02/22/getting-rich-from-zero-to-hero-in-one-blog-post/>
- [4] Rich, Broke, or Dead: online calculator for the Trinity Study that plots success probabilities next to the chance of you dying by that age. <https://engaging-data.com/will-money-last-retire-early/>
- [5] The source code for this paper. You can personalize the numbers and rerun it in an ipython notebook with Sage. https://davidkaufman.nfshost.com/projects/exit_rat_race/exit_the_rat_race.ipynb
- [6] Discuss with fellow students on exit-rat-race@mit.edu

But what if I don't want to retire after so few years of work?

Then don't! Keep working when you hit your retirement threshold, get really rich, and all the while celebrate that you obviously love your job because if didn't you could quit and retire comfortably at any time. It's a great option to have.