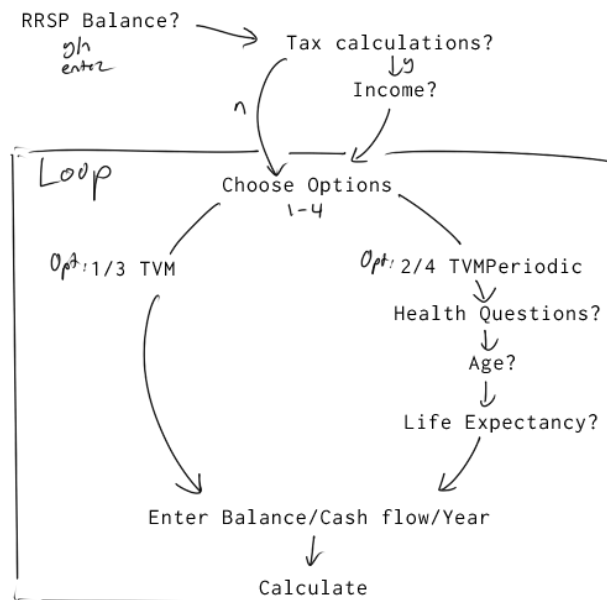


This is an RRSP Expert System written in Prolog. In many ways, it emulates an expert user with a financial calculator at hand to help with RRSP calculations. Summary of features:

- After-Tax calculations from <http://www.taxtips.ca/taxrates/mb.htm>
- Compounded monthly and up-to-date with current RRSP rates and Tax rates
- Life expectancy calculations with Health input
- Accurate time value of money calculations

## Diagram



## Equations

$FV$  = Future Value,  $PV$  = Present Value,  $t$  = current time,  $T$  = Number of compounding periods,  $r$  = effective rate,  $C_t$  = cash flow at time  $t$ ,  $t_i$  = Income tax

Eff. Annual Rate to Eff. Monthly

$$(1 + EAR)^{1/12}$$

Time Value of Money

$$FV_{t+T} = PV_t(1 + r)^T$$

Cash Flows

$$PV_t = \frac{C_{t+1}}{r} \left(1 - \frac{1}{(1+r)^T}\right)$$

After-Tax Income

$$Income_{AT} = Income_{BT}(1 - t_i)$$

Inside the system, we solve cases with unknown variables – generally  $C$ ,  $PV$ , or  $FV$ . Calculations are performed in the TVM/TVM-Periodic functions.

## Example calculation (Option 4)

RRSP Income = 20000, Age = 20, Retirement age = 65, Life Exp = 82

Current RRSP Balance = 0, No tax.

$$FV = PV_{65} = 20000 / 0.0040741 * (1 - 1 / ((1 + 0.0040741)^{(82-65)*12}))$$
$$= 2767242.85$$

$$FV = \left[ \left( \frac{C_{t+1}}{r} \left( 1 - \frac{1}{(1+r)^T} \right) \right) * (1+r)^T \right] - \text{Any FV of existing RRSP ( = 0 )}$$
$$= C_{t+1} / r * ((1+r)^T - 1)$$

$$C_{t+1} = (FV/r) * ((1+r)^T - 1) \text{ where } T = (65-20) * 12, r = 0.0040741, FV = PV_{65}$$
$$= 1411.92$$

Can be done on a **Financial calculator** by calculating:

1) PV65

2) Setting FV to PV and calculate PMT.

After-Tax, if specified, is applied to the RRSP income only.

## Life Tables

From WHO: <http://apps.who.int/gho/data/view.main.60290?lang=en>

## Calculation of Life Expectancy

We use data taken from research paper from Oxford to include health statistics into our life expectancy calculations. This option must be specified when asked, and will produce a range for your desired RRSP income or Balance.

“The reduction in life expectancy associated with moderate to heavy smoking ranged from 8 to 10 years. This range is similar to that reported for a single depressive episode or recurrent depressive disorder (7-11 years), but lower than that associated with substance use (9-24 years), personality disorders (13-22 years), schizophrenia (10-20 years), and bipolar disorder (9-20 years) (Table 3).” (Chesney et al., 2014)

## Going further

This program would be a good prototype to a Canadian Retirement Expert System that would include OAS, GIS, and RRIF with our RRSP calculator. Other possible improvements include including Investment income into RRSP calculations and month-specific calculations (Instead of starting every monthly contribution/income at the January of each year). However, the decision was made for this prototype to keep it simple and not have a complex scheme of user input.

## Relevant Papers:

Chesney, E., Goodwin, G.M., Fazel, S., 2014. Risks of all-cause and suicide mortality in mental disorders: a meta-review. *World Psychiatry* 13, 153–160. doi:10.1002/wps.20128