Economic Symbiosis

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Artesia High School

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1 Originally the team consisted of all girls: Nayelli Ramirez, Gracie Barber, and Kandese Spikes. Having to take on to much of the work, Kandese designated the help of Shane Wilson, who was still on the Wave Propagation team. Soon after both Kandese, and Shane's team mates dropped out of the Challenge, thus causing Shane to join Kandese's team. After the fall of two other challenge teams, Scooter McGee and Ethan Williams also joined the Economic's team.

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1 Abstract

Agents in a market can act in a wide variety behaviors with infinite motivations. In this project we start with a small number of abstracted behaviors to show how complex interactions can be produced by the use of emergence. The three levels of Symbiosis[2] represent the relationships between agents within a simulated stock market, by linking these to aspects of human nature. Through the study of the variables that define these interactions we will produce replications of what may have been the cause of some of the rises and drops in todays market.

2. Symbiosis is defined as the mutual cooperation between persons and groups in a society esp. when ecological interdependence is involved. (Webster's 2316)

2 Introduction

2a. Literature Review

Our Capitalist Economy is often seen as mutualist. For example, a businessman who bides his time, and creates jobs offers stability, and fair wages providing better livelihoods for others in the process. However, if competition comes into play, this mutalistic outlook can shift into a parasitic path. (Martian 1)Here we look at the basis of our project, which relies heavily on the theories produced by Behavioral Economics. The former view mentioned, however, was not the opinion of early behavioral economists. In the beginning there was the neoclassical view of economics. This view stated that maximization, equilibrium, and efficiency should be the three main focuses when looking at economics. This was useful to economists at that time, allowing them to utilize a theory based framework that could be applied to almost any form of economic behavior. Many other writings take a different focus in comparison. The two assumptions in a more standard theory take a direction of greater psychological realism. The neoclassical outlook does specify an indirect symbiotic out look; a careless out look on fairness (commensialisitic/parasitic), a pros cons way of looking at risky outcomes (commensialistic/ mutualistic), or to throw the future completely out the window[3] (parasitic)(Camerer 2)

Economics is seen as a world where calculations, and innate feelings thrive[4]. Two goals that have been designated by Behavioral Economists are: 1. Pinpointing ways that show how behaviors do not reflect that of the standard model. 2. Proving the importance of behaviors in the economic world. Many papers written on this subject discuss how the standard model is no longer appropriate in locating trends occurring within economics. As well as, how these trends are linked with human behavior, instead of a intimate view.

The three levels of symbiosis allow us to simulate a life like example of how investors coincide behaviorally to how well the market is doing. These essential parts of our program are defined as mutualism, commensialism, paracitism A few example, of these emergent behaviors are when both the stock market and the investor benefit is defined as mutualism (Brown). Agents in the program make to get the max amount of money by making the least investments possible.

3 Having mentioned the neoclassical outlook there is nothing in behavioral economics that creates a stigma to this one out look. In fact recent developments in the field bear a greater explanatory reasoning.

4 Homo Economicus. A way of describing neo-classical economics. Anti-behavioral.

2b. The Basis of our project

Our project involves a closer look at the behavioral relationship between the stock market and it's investors. Dependant on how great the gain or loss is on a certain stock effects the way investors invest in the market. Their behaviors can be narrowed down into three emergent behavioral characteristics; mutualism, commensialism, and paracitism. This will be discussed in further detail in the Approach section of the paper To begin we want to take a closer look at how the stock market works.

The investors[5] in the model also represent the Economic theory, which summarizes what is assumed/understood about the economic choices that people make and the economic performances of industries and nations based on models that have repeatedly passed the test of corresponding well with real-world data. In economics, the models built represent a simpler version of the reality they describe.(Bade 46)

NetLogo, compared to other Java based programs, was by far the quickest to learn and the easiest to use. Our projects basis relies heavily on the emergent behaviors of the investors. (Gilbert). NetLogo, which will be explained in further detail in the Program section of our paper, has allowed us to create examples of emergent behaviors that may have lead to similar rises and falls of todays market. As our program runs there is a graph that calculates, and keeps track of the results of our agents actions in comparison to how the market is doing. This allows us to compare our results to that of national averages such as NASDAQ[6], the Dow Jones[7], and the S&P 500[8].

5 Also called agents. They use emergent behaviors to decided which aspect of symbiotic nature they will conform to.

6 NASDAQ (The National Association of Security Dealers Automated Quotation System)

7 The Dow Jones Industrial Average (DJIA) is an index of thirty, blue chip stocks that are traded in the United States. It is assumed that by looking at the Dow will help predict how well the market is doing. The Dow is perhaps the most quoted and followed index in the world, and dates back to May 26, 1896 when if first appeared in the Wall Street Journal. It was then comprised of 12 stocks and opened at 40.94.

8 S&P 500 index (Standard & Poor Index) is an index of 500 stocks chosen for market size, liquidity and industry grouping, among other factors. The S&P 500 is designed to be a leading indicator of U.S. equities and is meant to reflect the risk/return characteristics of the large cap universe

3 Program

NetLogo is a multi-agent, programmable modeling environment for simulating natural and social phenomena. It is particularly useful for simulating complex systems that develop overtime, such as the stock market. Netlogo was an ideal modeling language for our model due to its ability to control multiple agents each with their own identities and knowledge. The model is portioned for greatest simplicity, existing of two main procedures, which control the world through their designated sub-procedures.

The first main call[9] procedure is the setup procedure. In Netlogo the setup procedure builds the world that the agents will interact in, setting up the model to run. The setup procedure calls four sub-procedures, they are as follows (refer to Appendix II):

- Setup Constants
- Setup Stocks
- Setup Investors
- Setup Plots

The first sub-procedure called[10] by the setup procedure, is the procedure to setup constants. In our model, the setup constants procedure does a number of things. This procedure sets the worlds limit and capacity, assigns values to global variables, and sets the values needed to control the marketing world. Globals are overall variables in the model, while sometimes dependent on the agents and conditions in the model, they are not reported by a single agent but are rather the overall picture.

The setup procedure also calls the sub-procedures that create stocks and investors. Stocks are created with random values (inside a given range) and given a starting value and direction (up or down). Computational agents are placed randomly in the world and assigned initial values.[11] Finally the setup procedure creates the set or parameters which will be displayed as graphs on the Netlogo interface.

The second main call procedure is the 'go procedure'. The 'go procedure' compiles the rest of the sub-procedures and controls the running of the interactions in the model. The 'go procedure' is completed in four steps:

- Update Agent Tendencies
- Run Interactions
- Update Stockmarket Values
- Update Plots

One of the hardest decisions for coding was deciding under what conditions agents should update tendencies. Tendencies for the agents are based on a numerical scale of -1 to 1. Agents with tendencies from -1 to -1/3 are mutualistic, agents with values of the next 2/3's are

9 For a list of Global Variables, please refer to appendix 2b.

10 Netlogo models are developed in a series of procedures, much like classes in jave. When a procedure is 'called' in Netlogo, as in java and other languages, the main procedure uses a single line of code asking or calling the sub-procedure in question to run.

11 For a list of Investor Values and tendencies refer to Appendix 2c.

commensalistic, and the agents with the upper 1/3 to 1 values are parasitic. The two initial tendencies can be applied through the equations:

- nt = ct(1 + vct)
- vct = awt((Pc - Mc)/100)

  - nt = New Tendency
  - ct = Current Tendency
  - vct = Variable Changing Tendency
  - awt = Average World Tendency
  - Mc = Initial Mutualistic Tendency
  - Pc = Initial Parasitic Tendency

The Mutualistic starting tendency minus the parasitic starting tendency gives a decimal between -1 and 1. Depending on the values of these two sliders determines the average tendency of the market. If the two sliders are close together in value, giving a number between -1/3 and 1/3, the average tendency of the market will be of commensalistic nature. The varying fact that determines if they update their tendency further towards their own consistency on the -1 to 1 scale is their positions and earnings in the market.[12]

Once agents have updated their tendencies, they will invest if they have the money. The direction they take in investing is deterministic upon their tendency; the closer the values to the extremities of each behavior, the more extreme their investing becomes on that type of tendency.

The stockmarket value can be thought of as a 'Dow Jones' representation in our model. The overall value is a sum of the stock values, so is representative of the market as a whole. This data is then exported by Netlogo onto the interface as a graphical representation.

12 Refer to the diagram in appendix 2e for a more indepth view on the process.

4 References

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an-elementary-explanation-of-the-symbiotic-relationship-between-tax-relief-and-bailout.html>.

5 Code

```
breed [stockholders stockholder]
breed [stockmarkets stockmarket]

turtles-own
  [ age-stock ;; how many weeks old the stock is
    age-stockholder ;; how many weeks the stockholder has been in the market
    ]

globals
[
  %mutualistic         ;; what % of the population is mutualistic
  %commensalistic      ;; what % of the population is commensalistic
  %parasitic           ;; what % of the population is parasitic
  ecotermspan          ;; the average timespan that a turtle will stay in the stockmarket floor
  average-newcomers    ;; the average number of newcomers that might come to the stock market
per existing person per unit of time a turtle could have
  carrying-capacity    ;; the number of turtles that can be in the stockmarket at one time
  stockmarket-price
  stockmarket-value
  population
]

stockholders-own [
    mutualistic?
    commensalistic?
    parasitic?
    mutualistic-count
    commensalistic-count
    parasitic-count
    tendency
    money
    investment-mutual
    investment-commensalistic
    investment-parasitic
    win-loss-ratio
    tendency-percent
    work-ability
    current-money-ratio
    initial-money
    ]

;; The setup is divided into three subroutines
```

```
to setup
  ca
  no-display
  set-default-shape stockholders "person"
  set carrying-capacity 750
  set average-newcomers random 5
  setup-constants
  setup-turtles
  ;setup-stocks
  update-plot
  update-global-variables
  display
end


to setup-constants
  set carrying-capacity 750
  set average-newcomers random 5
end


;; We create a variable number of turtles of which 10 are parasitic,
;; and distribute them randomly
to setup-turtles
set-default-shape stockholders "person"
   set-default-shape stockmarkets "circle"
  crt people
    [ setxy random-xcor random-ycor
      setup-owns]
   set stockmarket-value sum [money] of turtles
end

to setup-owns
      set breed (stockholders)
      set age-stockholder random age-stockholder
      set parasitic-count 0
      set commensalistic-count 0
      set work-ability 0
      set money 1000
      set initial-money 1000
      become-mutualistic
      set size 1.5  ;; easier to see
      set age-stockholder random 100
      set breed (stockholders)
```

```
      set-initial-tendency
   end
to setup-stocks
   crt initial-stocks
     [setxy random-xcor random-ycor
      set breed (stockmarkets)
      set age-stock random age-stock
      set size 1.5  ;; easier to see
      set breed (stockmarkets)]
end

;; set up only procedures end here, the following procedures are used both in setup and running
the model

to become-parasitic ;; turtle procedure
  set parasitic? true
  set commensalistic? false
  set mutualistic? false
  set color red
  set win-loss-ratio .25
  set work-ability 0
end


to become-commensalistic ;; turtle procedure
  set parasitic? false
  set commensalistic? true
  set mutualistic? false
  set color yellow
  set win-loss-ratio .50
   set work-ability 0
end


to become-mutualistic ;; turtle procedure
  set parasitic? false
  set commensalistic? false
  set mutualistic? true
  set color blue
  set win-loss-ratio .75
   set work-ability 0
end

to update-plot
```

```
  set-current-plot "Populations"
  set-current-plot-pen "parasitic"
  plot count stockholders with [parasitic?]
  set-current-plot-pen "commensalistic"
  plot count stockholders with [commensalistic?]
  set-current-plot-pen "mutualistic"
  plot count stockholders with [mutualistic?]
  set-current-plot-pen "total"
  plot count stockholders

  set-current-plot "stocks"
  set-current-plot-pen "stockmarket-value"
  plot stockmarket-value
end


to update-global-variables
  if count turtles > 0
  [
    set %mutualistic (count stockholders with [mutualistic?]) / (count turtles) * 100
    set %commensalistic (count stockholders with [commensalistic?]) / (count turtles) * 100
    set %parasitic (count stockholders with [parasitic?]) / (count turtles) * 100
  ]
end

to go
tick
  ask turtles[
update-tendency
calculate]
update-stockmarket-value
update-plot
end

to set-initial-tendency
let initial-tendency ((parasitic-tendency - mutualistic-tendency))
    ifelse (initial-tendency = 0)[
      set tendency (random 3)
      ifelse (tendency = 1) [
        become-mutualistic
      ] [
        become-parasitic
      ]
      if (tendency = 0) [
```

```
      become-commensalistic]
    ][
     set tendency (random-float 2 - initial-tendency)
     if tendency >= 1.25 [become-mutualistic]
     if tendency <= .75 [become-parasitic]
     if (tendency < 1.25) and (tendency > .75) [become-commensalistic]
     ]
end

to calculate
  update-money
  integrate-community

end

to update-money
   ifelse (money  > 0)[
     ifelse (mutualistic?) [
       set investment-mutual (random money * .01)
       set investment-commensalistic (0)
       set investment-parasitic (0)
       let dice-roll ((random-float 2) + (work-ability * .01))
       ifelse (dice-roll >= 1)[
         set tendency-percent (tendency-percent + 3)
         set money (money + investment-mutual)
         set work-ability (work-ability + 2)
        ] [
         set tendency-percent (tendency-percent - 1)
         set money (money - investment-mutual)
         set work-ability (work-ability - 1)
        ]
      ][]
       ifelse (commensalistic?) [
         set investment-mutual (0)
         set investment-commensalistic (random money * .048)
         set investment-parasitic (0)
         let dice-roll ((random-float 2) + work-ability * .01)
         ifelse (dice-roll >= 1)[
           set tendency-percent (tendency-percent + 2)
           set money (money + investment-commensalistic)
           set work-ability (work-ability + 1)
          ] [
           set tendency-percent (tendency-percent - 2)
           set money (money - investment-commensalistic)
```

```
          set work-ability (work-ability - 1)
         ]
        ][]
         if (parasitic?) [
          set investment-mutual (0)
          set investment-commensalistic (0)
          set investment-parasitic (random money * .075)
          let dice-roll ((random-float 4) + work-ability * .01)
          ifelse (dice-roll >= 3)[
           set tendency-percent (tendency-percent + 7)
           set money (money + investment-parasitic)
           set work-ability (work-ability + 5)
          ] [
           set tendency-percent (tendency-percent - 3)
           set money (money - investment-parasitic)
           set work-ability (work-ability - 1)
          ]
         ]
        ]  [
     fd 1
     let roll3 (random 5)
     let number (list 3)
     if (roll3 = 4) [
      die]
     if (roll3 = number) [set money (money + random 10000)]
   ]
          let dice-roll2 (random 10)
        if (dice-roll2 = 1) [
         set money ((random money) * 2)
         set work-ability 0]
   set current-money-ratio (money / initial-money)
end

to integrate-community
  set population (count turtles)
  if population < people [ask patch random-xcor random-ycor [sprout-stockholders 1 [setup-
owns] ]]


end
to update-tendency
  let initial-tendency ((parasitic-tendency - mutualistic-tendency))
    ifelse (initial-tendency = 0)[
      let tendency-roll (random 3)
```

```
    ifelse (tendency-roll = 2) [
      set tendency-percent (tendency-percent - 1)
    ] [
      set tendency-percent (tendency-percent + 1)
    ]
   ; if (tendency = 0) [
     ; set tendency-percent (tendency-percent)
  ][
    set tendency (current-money-ratio - initial-tendency)
    ifelse (tendency > 5)[
    let tendency-roll2 (random 3)
    ifelse (tendency-roll2 = 2) [
      if tendency >= 1.25 [become-mutualistic]
      if tendency <= .75 [become-parasitic]
      if (tendency < 1.25) and (tendency > .75) [become-commensalistic]
      ][]
    ] [
    ]
    ]
 end

to update-stockmarket-value
 set stockmarket-value sum [money] of stockholders
end
```

6 Appendix I. Model Flowcharts

Appendix II is designed to help further clarify the modeling and coding used. The flowcharts give a simplistic yet in-depth explanation of the code and should be referred to as a pseudo-code .

I. Table of Contents
- a. Setup Procedures
- b. Globals
- c. Investor Values/Tendencies
- d. Running the Model (The GO Procedure)
- e. Updating Investor Tendencies
- f. Running the Interactions
- g. Updating Stockmarket Values

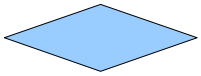
II. Explanation of Symbols Used

Main Procedure- The call procedure or 'class' including the commands/procedures given to the agents or the world itself.

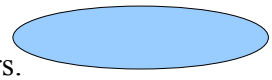
Sub Procedures- These are procedures executed within the main procedure, or separate procedures called by the main procedure

Variables- This symbol represents a variable; either a number or condition set/changed through the action of a procedure.

Decision Boxes- These represent decisions in an agents behavior set, in example what strategy to use in investing.

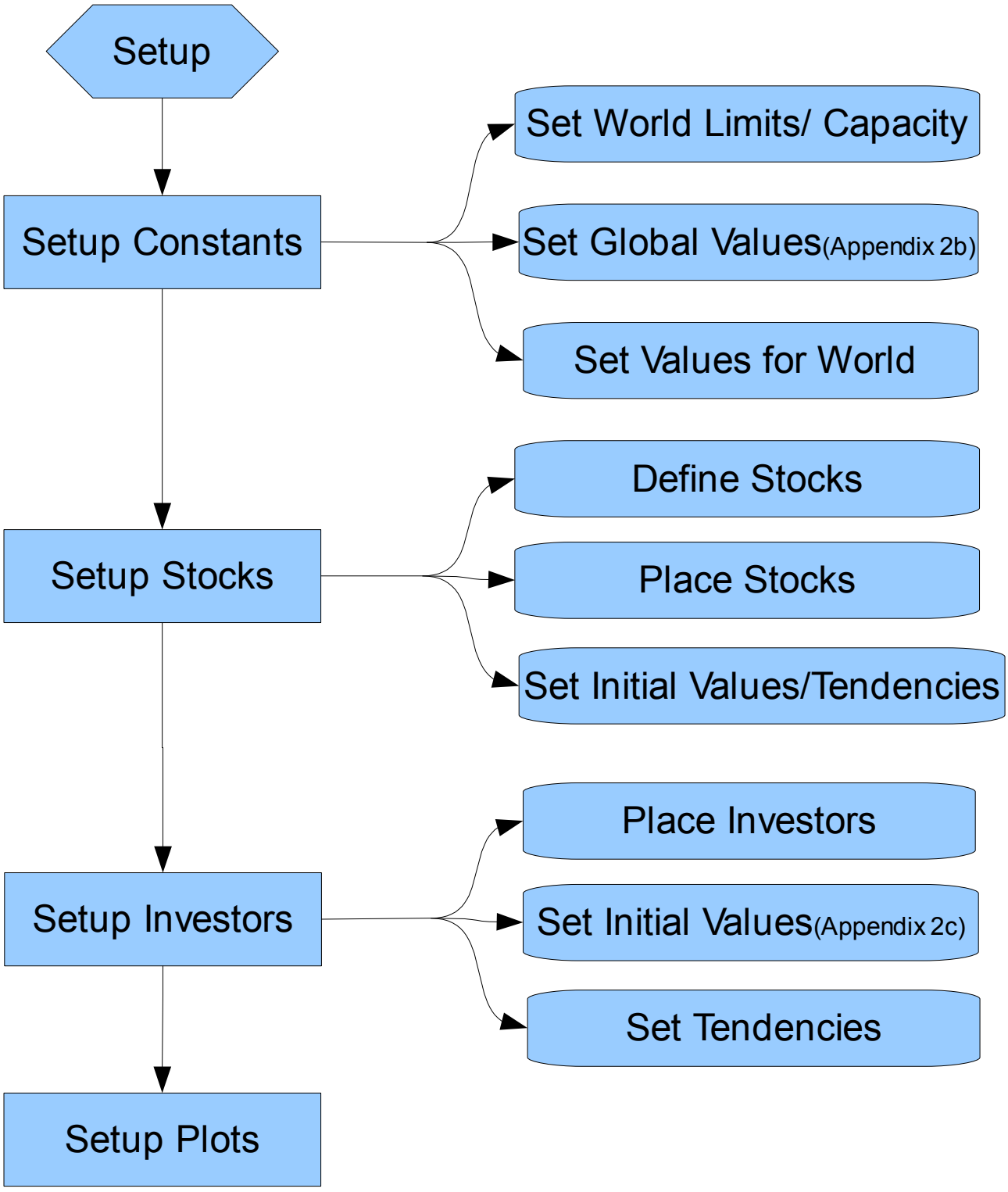


Data- These stand as a placeholder, and are the summation of procedures and variables in a designated set or parameters.

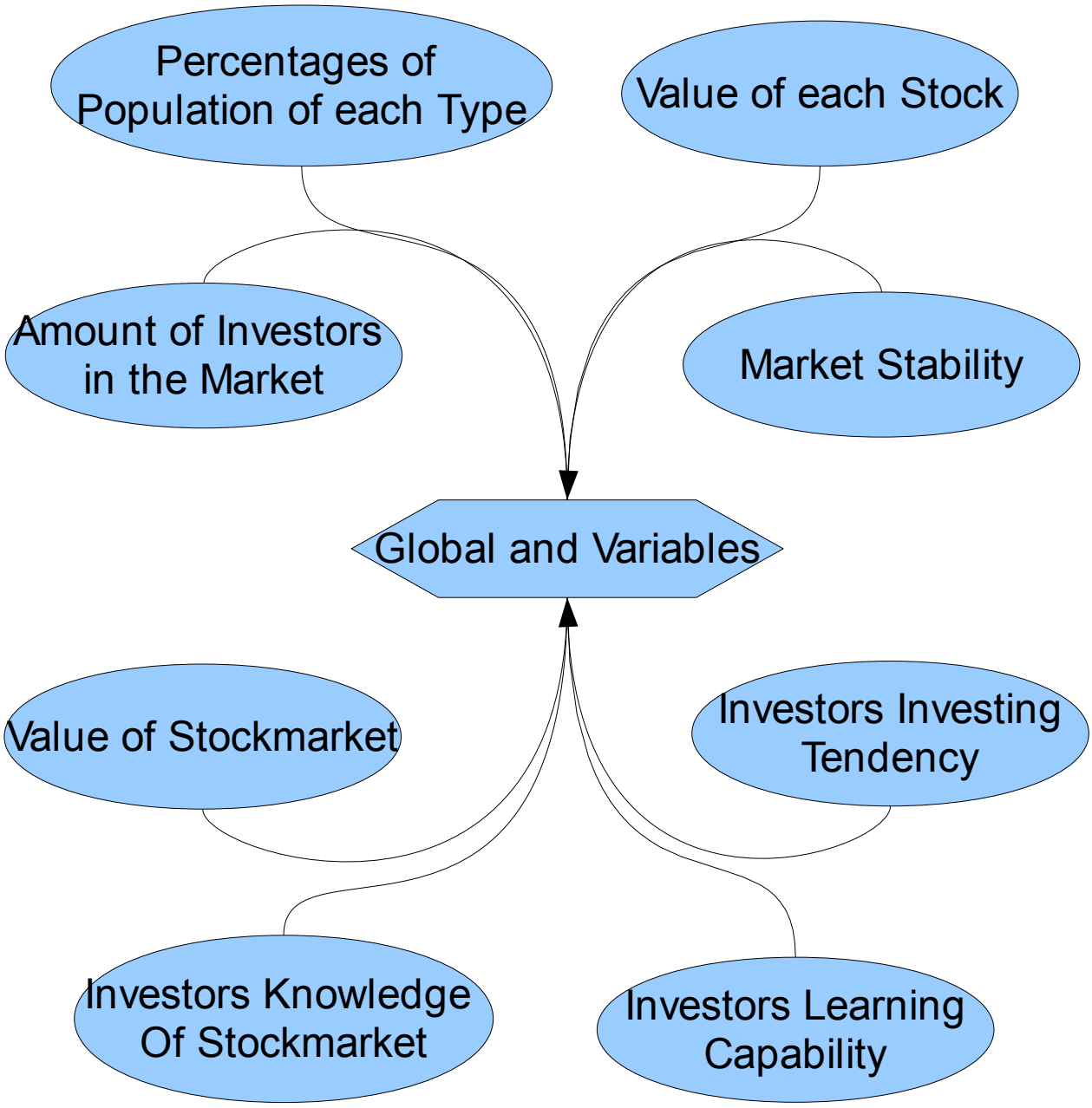


Appendix 1a. Setup Procedure Flow Chart[13]

13 The Setup Procedure in Netlogo is the procedure that sets a model up to run, it builds the world the run cycle will take place in.

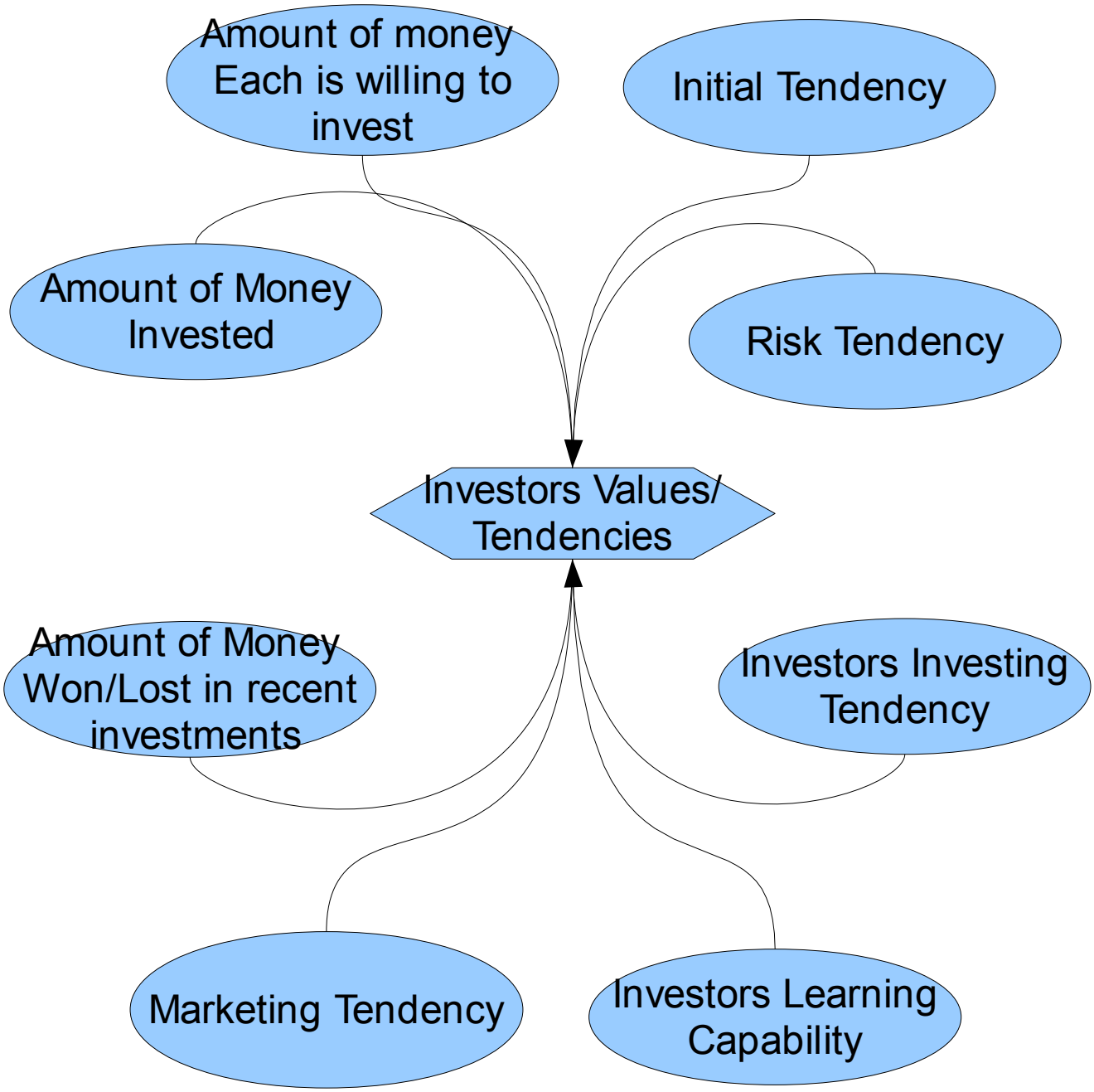

Setup
Setup Constants
Set World Limits/ Capacity
Set Global Values(Appendix 2b)
Set Values for World
Setup Stocks
Define Stocks
Place Stocks
Set Initial Values/Tendencies
Setup Investors
Place Investors
Set Initial Values(Appendix 2c)
Set Tendencies
Setup Plots

Appendix 1b. Globals Flow Chart[14]



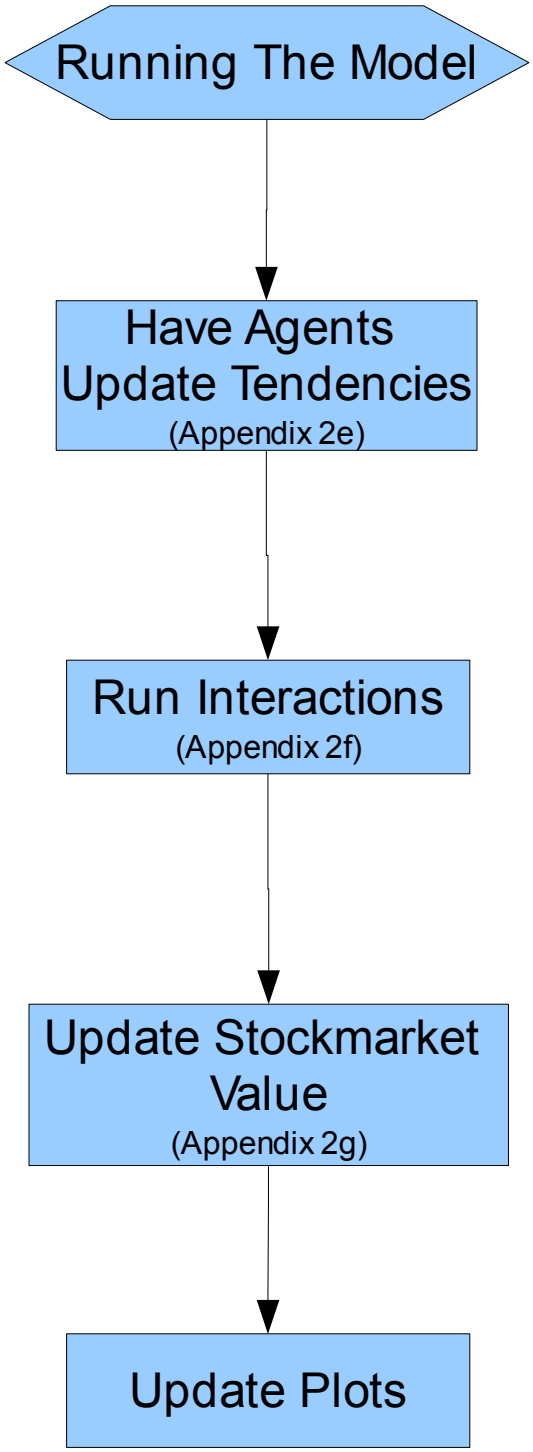
14 Globals are overall variables in the model, while sometimes dependent on the agents and conditions in the model, they are not reported by a single agent but are rather the overall picture.

Appendix 1c. Investors Values/Tendencies Flow Chart[15]



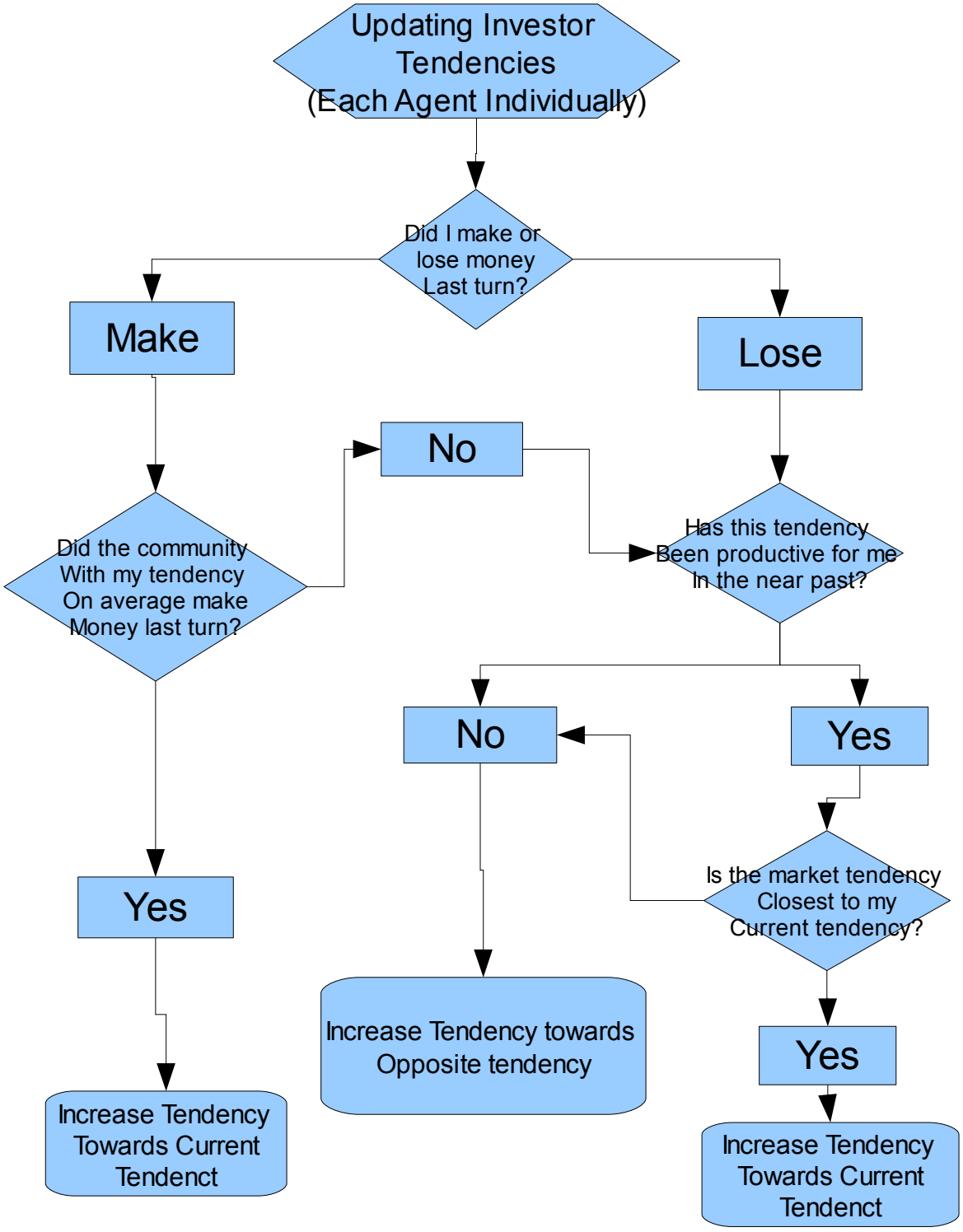
15 Each Investor has his own set of variables, tendencies, and synthetic knowledge that they make their decisions based off of. Their initial tendency is set in the interface. Once they start interacting, the investor keeps track of whether he is winning or losing, his current position in the market, the overall scheme of the market (up or down), and his current money balance. The agent will review his previous decisions and if upon finding similarities in repeated methods(including stock and investing strategy) leading to both wins and losses, the agent will then decide if he wants to go with his most recent positive winning strategy, or try a new strategy.

Appendix 1d. Running The Mode (Go Procedure) Flow Chart[16]



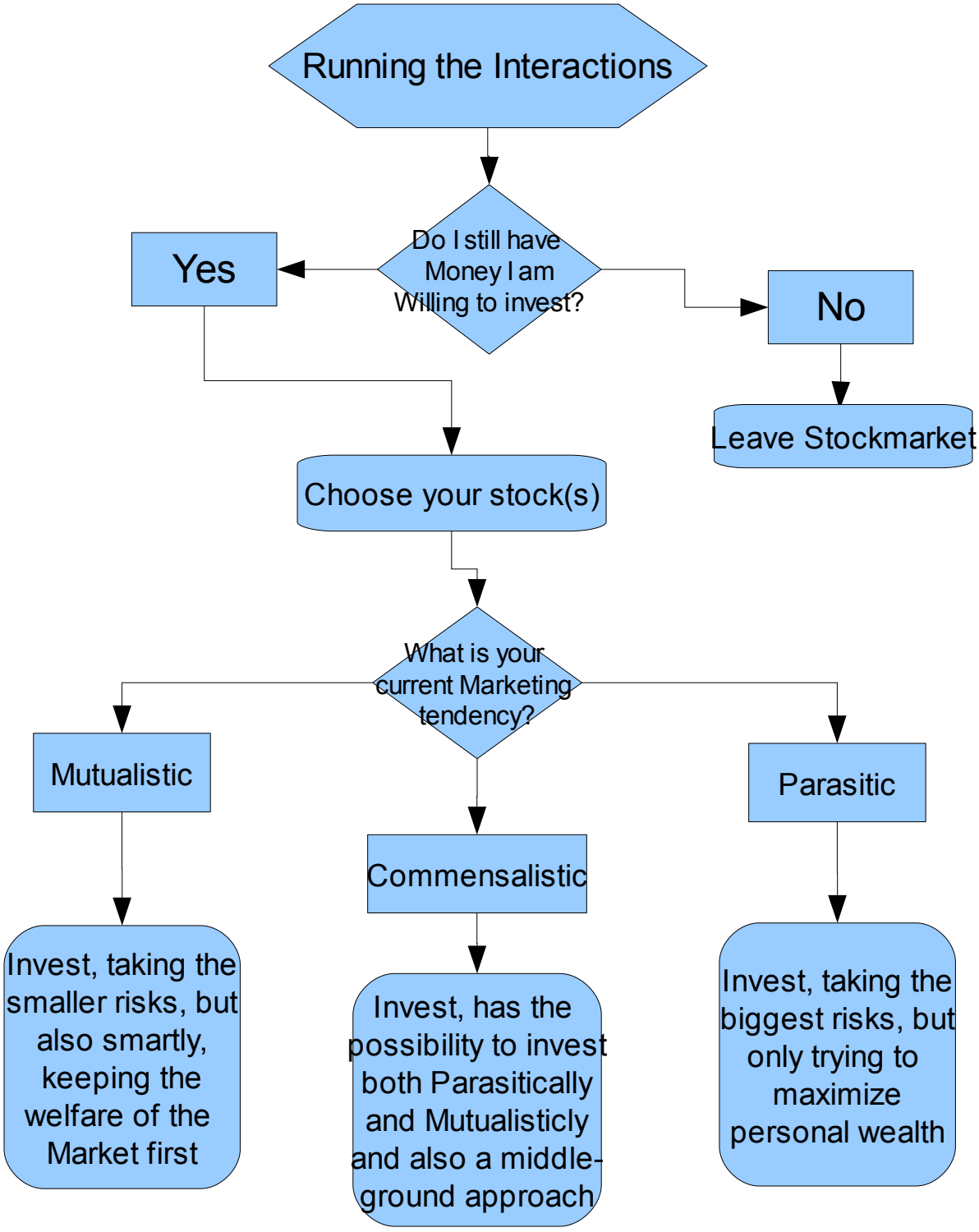
16 This is the equivalent of a compiler. This is the main action procedure, refer to appendices 2e-2g for a more indepth view of the varying components.

Appendix 1e. Updating Investor Tendencies Flow Chart[17]



17 Each of the agents in the model does this procedure. If the agent ends up changing his tendency, he doesn't automatically change (ie from Mutualistic to Commensalistic). He changes gradually on a percent like scale, for more information refer to the coding section of the report.

Appendix 1f. Running The Interactions Flow Chart[18]



18 The investing portion is fairly simple. Investments range by stock, and the number of shares bought/sold is directly related to their marketing tendency.

Appendix 1g. Updating Stockmarket Values Flow Chart