Heart Attack

New Mexico

Supercomputing Challenge

Final Report

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Team 57

Hope Christian School

Team Members

Alexander Alvarez

Angela Wise

Elysia Berg

Teacher(s)

Pam Feather

Sue King

Mentor(s)

Pam Feather

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Executive Summary

Heart disease is the number one killer in the USA as well as other countries around the world. So isn't it important for people to know what their chance of having heart disease is so that they can take the appropriate action to stop it? That's what team Elementz believes and what motivated them to develop a program to calculate a person's risk of contracting heart disease.

Heart disease has been ravaging households for many years, and many of them just needed to be told they needed to be careful. The program developed by the Elementz can be used to give a person the idea that they might or might not be at risk for cardiovascular disease. The project asks each person a series of questions which will trigger a result in the addition or subtraction of the plaque in the model of the blood stream, which is to the right of the questions. After the questions are answered, the person sees an example of how their blood stream looks with the amount of plaque according to the answers given. The blood stream "lives" for a certain amount of time, and the plaque continues to build. After the plaque reaches a certain number and overloads the white and red blood cells, the program tells the person he/she is at high risk and after a few more years on the program running, the person is given a warning that he/she has died.

The Elementz used the program NetLogo to create both the program of the blood stream with the questions as well as a program that will play as the people answer the questions. The team used algorithmic code to accomplish the overall effect that is now the program. Many variations of the questions had to be included in the code, and mathematics had to be included to determine which factors were contributors to heart disease.

Introduction

General Overview

There is a silent killer in the United States of America. Every year, this murderer takes over six hundred thousand lives, more than any serial killer on record; more than even cancer, one of the leading diseases that is fatal. It strikes at the moment of its choosing, and the results can be minor or they can claim lives. Yet, it always strikes at the heart of its victims. Heart attacks affect 1.25 million people per year.

Throughout the United Kingdom, the United States, and Europe, heart disease is the highest killer in all ethnic groups (American Heart Association). Heart disease is not inherited as with balding or eye color; it is contracted through life style choices and habits that then produce the disease, and eventually a heart attack.

A “heart attack” is best defined as when plaque completely blocks off an artery or vein. When this happens, blood can no longer get back to the lungs to be oxygenated, nor can it travel to other areas of the body. It is similar to having a clogged pipe; nothing can move until the blockage is dealt with. But also like build up in a pipe, it can be controlled.

The easiest way to avoid a heart attack is through proactive prevention, and by keeping track of the risk presented to the individual. Many factors influence a person’s risk; the better they are informed as to that risk, the more action they can take to remain off the mortality list from this disease.

Team 57, the Elementz, has put together a model that shows the person’s risk of a heart

attack through a NetLogo modeling program compiled by one of the members. This program uses true/false questions to add and subtract plaque from the simulated blood stream, and used regression algorithms to determine how results were directly influenced from each factor.

Problem

Heart disease kills 652,091 American's every year, which is 27% of all deaths in the United States over one year. However, many people do not realize the risk that they have of contracting this disease. Thus, the purpose of the project was: to show a person's likelihood of getting the disease, to persuade the tested people to get advice from real doctors and surgeons on how to prevent them from getting this disease and to provide further statistics based on the results.

The Problem Being Addressed

The main problem that this project addressed is that many people do not realize when they are at high risk for coronary heart disease. Heart attacks, which develop from prolonged build up of plaque in the veins, is a direct result of coronary heart disease and takes billions of dollars of funding each year for corrective surgery. Heart disease is the top killer of Americans; rapidly it is becoming the top killer in the world, second only to cancer. Yet, prevention of death is possible when the condition is recognized early.

Problem Solution

The project's goal was to help people identify the risk that was posed by their life style and genetics. Once the problem was identified, people would likely seek ways to lower their risk of contracting the disease or suffering fatal consequences. Computationally, the team would be

writing the program that will calculate the risk that was posed to the individual user. This coding was to be done in an interactive manner to captivate interest using a preexisting compiler. In doing so, it was hoped that more people were willing to use the questionnaire.

Project Overview

Heart disease is the number one killer in the United States of both men and women. It can easily be prevented with a better lifestyle.

The project's goal was to create a modeling program that predicted the probability of coronary heart disease for a specific individual based on the answers to a provided questionnaire. The program would then model the results according to the information input by the user:

-Age

-Gender

-Ethnicity

-Diet/Exercise

-Family history of heart disease

-Cholesterol levels

-Alcohol

-Tobacco

-Blood Pressure

-Diabetes

Though it would not be as accurate as a doctor's diagnosis due to the limited factors, this program would give the general population the likelihood that they would be affected by one of the leading killers in the United States. This project would also be using information current health references.

Background Research

Heart Disease

Heart disease has not received the general coverage of other high killers in the United States such as Cancer. Yet, statistics show that it has a growing mortality rate. According to the World Health Organization 12.5 million of the estimated 32 million worldwide heart attacks are fatal. An estimated 40-75% of all victims die before reaching hospital after the attack. In the United States, 1,400 people die each day from a heart attack (W.H. Howard, M.D., M.S., F.A.C.C., F.A.C.P., How to protect your heart from your doctor).

The Elementz chose the factors from the American Heart Association's list of risk factors. A risk factor calculation tool was found online that allowed for the calculation of how much plaque to add to the blood stream based upon each factor. Numbers were then adjusted to fit the model.

As research was found the team found that a heart attack is called Myocardial infarction (MI), and consists of the interruption of blood supply to part of the heart, which then causes cells to die. Heart

attacks are caused by blockage of a coronary artery when white blood cells and fatty acids build up. The result is a restriction in blood supply and oxygen shortage. If left untreated, this causes damage and possible death of the heart muscle tissue.

Research also showed that there were two common types: transmural, which involve a major coronary artery, and subendocardial, which only involves a small area. In most cases, the symptoms of the heart attack occurred over several minutes. (American Heart Association)

One half of those who experience heart attacks experience either chest pain, shortness of breath, nausea, vomiting, sweating, anxiety, weakness, or fatigue. One fourth suffers no symptoms, which is what has dubbed the “silent” heart attack. Pain was most common in the red areas along the chest, with light red areas as other possible places that it was experienced. (World Health Organization)

To help with prevention, most organizations and doctors recommend taking a low dose of aspirin, cession of smoking, regular exercise, a sensible diet for patients with heart disease, and limiting alcohol intake. When a heart attack has already occurred, medication is usually given as well. (American Heart Association)

Conclusions Drawn

After research, the Elementz expected to accomplish the following. First, the team hoped to complete a working program that outputs questions about a person's lifestyle and that will input the answers. Second, a working model or visualization that shows the results of the questionnaire would be compiled. This visualization would show a pumping heart and an artery. As the user input answers that denoted a less healthy lifestyle, the artery would get more and more clogged up with plaque. Once no more blood was able to flow through the ‘artery’,

the heart would stop for a brief time.

Procedure

General Overview

One bite at a time is the best way to work through a full course meal. Utilizing this method to approach the project, the team broke the tasks down using a Gantt chart, assigning work, and working according to what each member specialized in. In general, progressively working and improving on that which they had already done was the decided approach.

Like with every project, the team had kept it simple by starting at the base line and gathering research. After extensive internet, in person, and physical research, the team chose the coding software. The baseline of the project was Net Logo. Beginning with a simple program that showed the blood stream, the team then began to add in the various elements, namely white and red blood cells, and plaque.

The development of a heart model was likewise done in stages, beginning with the movement of the particles, turning the turtles from red to blue, and having them die after a specific amount of time such as would happen within a standard person's body were worked on. This bite sized process was considered best because it allowed for gradual increase to the complexity of the model, which then created a deeper understanding of the code. Likewise, learning the coding processor over a period of two weeks helped to break up the monotony of simply programming code and troubleshooting errors. By learning parts of the new compiler each week, the team was able to refresh their minds into new ideas and plan logical goals.

Algorithmic work was also done gradually. From Nick Bennett, the team learned to use

the estimated line algorithm in Microsoft Word Excel to determine which factors affected the age at which a person suffered a heart attack. By using this method with a hundred samples, the team was able to verify the weights provided by the calculator, which was found online.

Working on individual assignments, but for a common goal, was also a method employed. This allowed each member of the team to work on that which they were most comfortable, and insured that goals were completed in a timely manner. By utilizing a daily log, progress was able to be tracked throughout the weeks; plans then were able to be developed based on that which remained to be done and the time remaining. Efficiency was critical due to outside time constituents that limited the access to the computers. The daily log also allowed the team to keep track of deadlines.

Statistical Methods

Using Microsoft Excel 2007 (copyright to Microsoft Inc.), the team input statistical data they had gathered from real life cases that had occurred. Columns were used to denote the various risk factors. If the case was affected by that risk, a one was added to that column. If not, then a zero was added. In the final column, the age of the first heart attack was then input. By created a line through the majority of the points, utilizing the risk factor for the x-axis value and the age of the heart attack as the y-axis value, the team was able to calculate the effect that it had to the age. By repeating the process for each factor, the team was able to determine which factors held the most relevance to the project, as well as verify the amount of plaque to be added to the heart model when a person had an unhealthy lifestyle.

Coding Methods

With only limited experience of previous coding, the team began in Bloodshed Dev C++

to learn the basic syntax structure. Basic programs such as “Hello World” allowed for growth into more complex programming. The team then began their work in Net Logo, using the Model Library to gain ideas on how to model their code. A trial and error process, along with help from another team which had already utilized the program before, eventually led to the creation of a base line program. Unsatisfied with this result, two programs were then derived off of it. One was a blood stream model which would model the plaque in a person’s blood stream based on the lifestyle input. The other was to be a beating heart model. However, after several failures, it was revised to model how the blood stream reacts during a heart attack.

The model of the blood stream was begun by creating the agents (the objects which move and follow the codes commands of movement and interaction) in the center of the plot area, and separating them into two groups of separate colors: ‘random-min’ and ‘random-max’. Movement functions then defined that the agents could not pass through walls and added a ricochet effect, while permitting them to move during the ticks. From there, a die command was added that killed random-min cells when they could no longer move forward one. A graph tracked the number on screen, displaying the rate at which they “died”. Later on, the team decided to add a display message to terminate the program and change the death to that of time instead of agent caused.

The second model began with a study of population movement and control. From there, the populations, agents which move and are affected as a group rather than individuals, were turned into the separate cell groups in a blood stream. Custom shapes were utilized to allow for a better visual effect, and the background was then turned to red. Each population was then given a heading to allow it to simulate the bloods flow through the body as it moved. Questions then

were added on the main screen in the form of true and false questions to help personalize the model based on each individual's lifestyle. In the coding, blocks of code began to be added for each possible combination of factors that could be true or false and the effects of them to the model. After a certain period of time for each varying condition the model would display a message to tell the person that they were at high risk for a heart attack. Five ticks, or loops of command, later a message of a heart attack would be displayed. From there, all agents would be cleared from the screen to denote death. One, two, and three factor combinations were added. As the code was discovered to be rather large, the programmer looked at a method to revise its factors. Eventually, it was decided that each factor would have a simple if-statement which would add plaque if it was negative in a person's life style, which created a condensed code that provided the same functions as the previous.

Determining Factors

The original factors were chosen from a list provided by the American Heart Association. Each factor seemed to be connected to the others, and seemed acceptable. However, utilizing regression, a technique that determines the effect of a variable to the result, the team determined that each factor had a unique amount it affected the probability of a heart attack. By inputting data gathered from 100 people into a Microsoft Excel spread sheet, the team was able to use a diverse sample to gain a thorough method to utilize in verifying the chance calculations provided online and calculate how much plaque to add to the blood stream in their model.

Conclusion

In this project, the team learned how to successfully code in NetLogo to produce a

working agent-based model as well as how to implement algorithms into their coding methods. They learned how to implement the knowledge of regression to further upgrade their models to a realistic level. During this project, the skill of writing engineering reports was also achieved.

The team managed to compile models that had both working and demonstrative purposes. The models in themselves allowed for a greater understanding of risks that affected the probability of a heart attack, as well as what happens when the plaque blocks off an artery or other blood vessel. They also managed to use a true-false system which added or removed plaque according to the responses, thereby creating a more accurate portrayal of the user's blood stream.

Possible Extensions

A continuation of the project would likely take the models to more advanced levels using other compilers. The continuation may also use more advanced algorithms in order to accurately portray a blood stream's condition and movement, using factors such as blood pressure and heart rate. Finally, additional in-depth research could be used to create a more accurate model and the most accurate percentage of risk for the program by using more life cases.

Most Significant Achievement

The most significant achievement of the project was gaining the ability to work on this project without a mentor while achieving the desired results. Though it was difficult in the beginning, as progress was made, it gradually became second nature to do trouble shooting on a personal level. Fixing the mistakes that had been made without help allowed for a better understanding of the code and the ability to fully comprehend everything that had been done by each individual. This project also provided a deeper insight for the team.

Acknowledgements

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Attack Project: the team's mentor Mrs. Feather, their teacher Mrs. King, the consultants at the SCC who reviewed and offered suggestions on the project, the SCC for hosting the challenge, Hope Christian School for providing materials, transportation to events and space to work, NetLogo for the use of their software, Mrs. Davis for technical support, the various artists who provided music to cut the silence on the I-pod, and Jesus for giving us the minds and drive to work for his glory.

References

American Heart Association. American Heart Association - Main. 2009. 28 October 2009 <http://www.americanheart.org/presenter.jhtml?identifier=1200000>.

Bennett, Nick. C++ Statistical Presentation March 2010.

Center for Disease Control. CDC - DHDSP - Heart Disease. 15 October 2009. 28 October 2009 <http://www.cdc.gov/heartdisease/>.

DeVane, Dr. Matthew S. Heart Smart. Hoboken: John Wiley & Sons Inc., 2006.

Heart Disease Statistics. 2009. 28 October 2009 <http://www.mamashealth.com/Heart_stat.asp>.

John Hopkins Bloomberg School of Public Health. "Invited Commentary: Trends in Coronary Heart Disease Mortality—Location, Location, Location." American Journal of Epidemiology (2003).

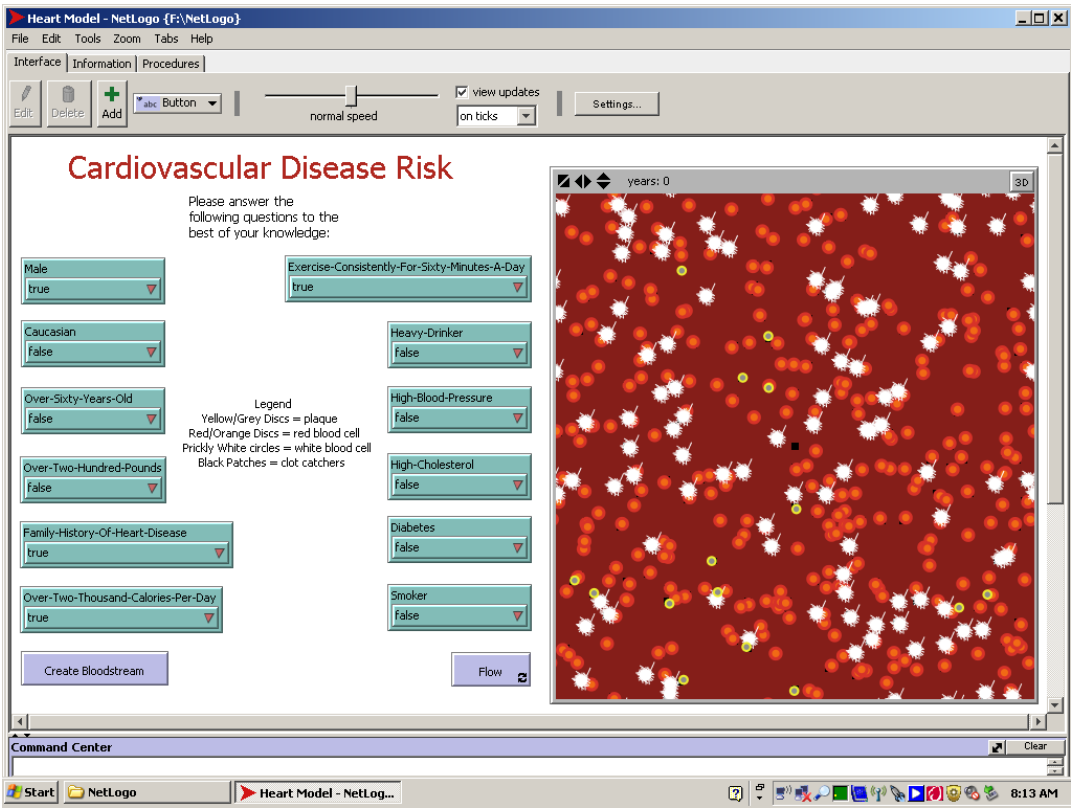
MIDAS. "Impact of Availability of Hospital-based invasive services on racial differences in the use of these services." 1999.

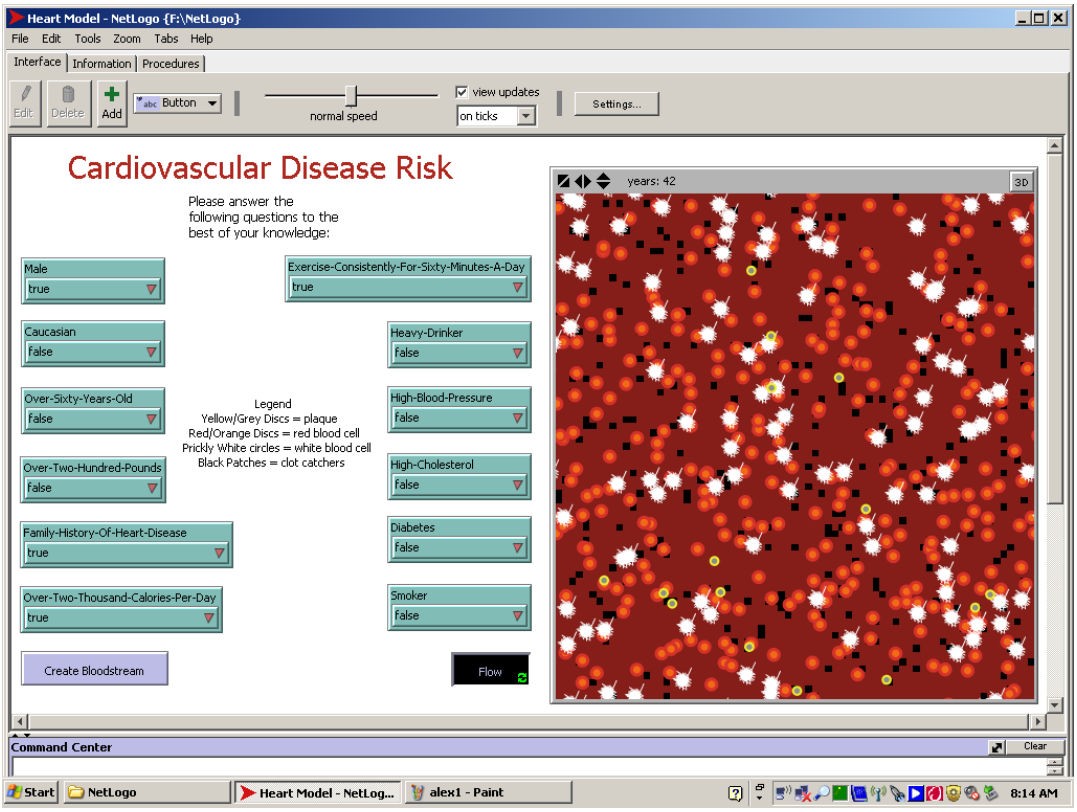
US Government. Heart Disease a Leading Cause of Death Worldwide. 24 July 2008. October 28 2009 <http://www.america.gov/st/health-english/2008/July/20080724175631abretnuh0.9819757.html >.

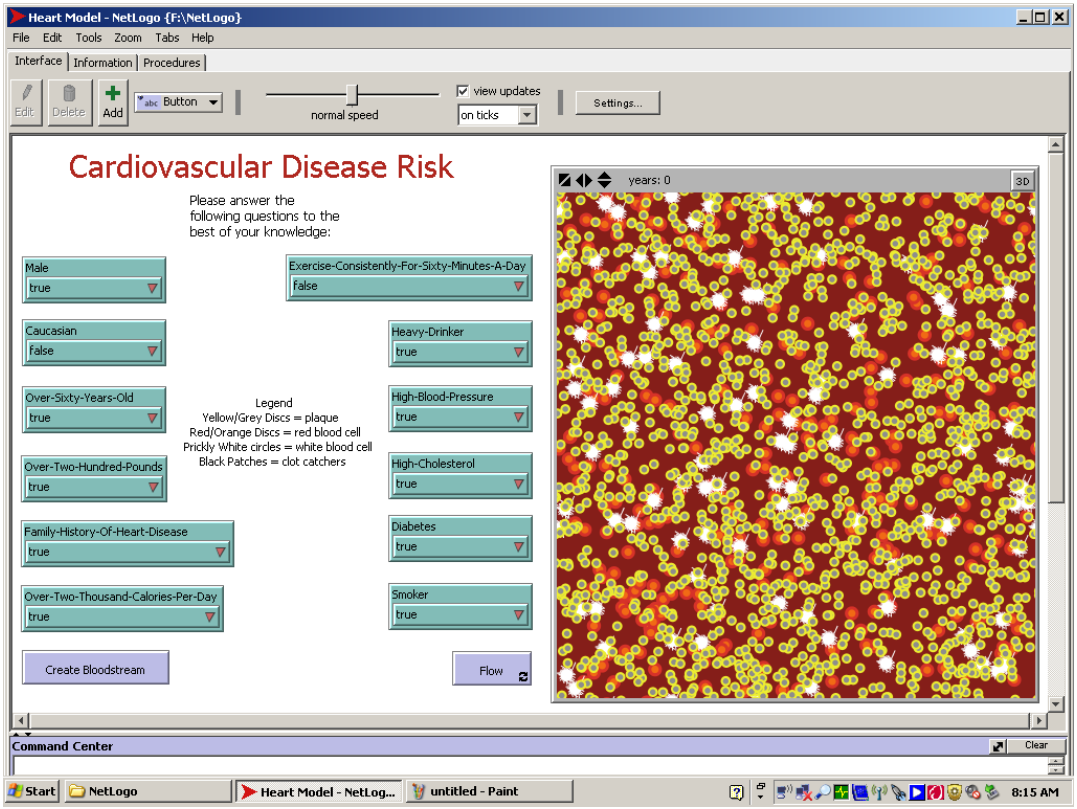
World Health Organization. WHO Data and statistics. 2009. 28 October 2009 <http://www.who.int/research/en/>.

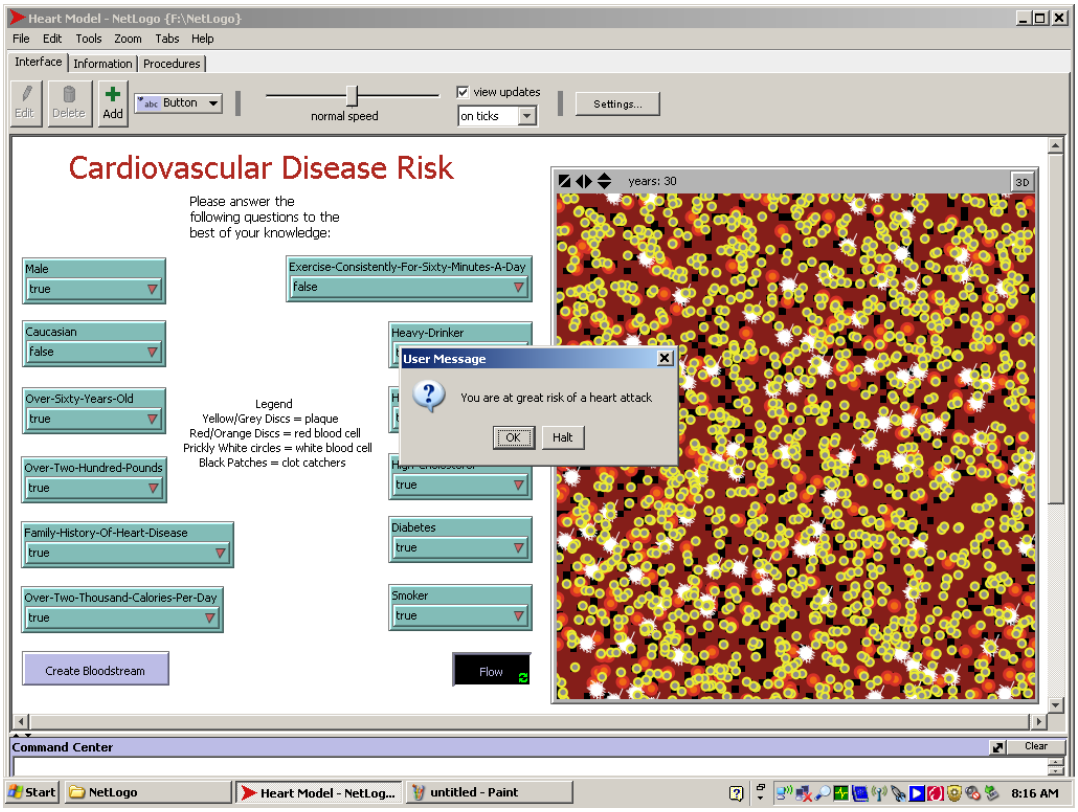
Appendix A: Screen Captures

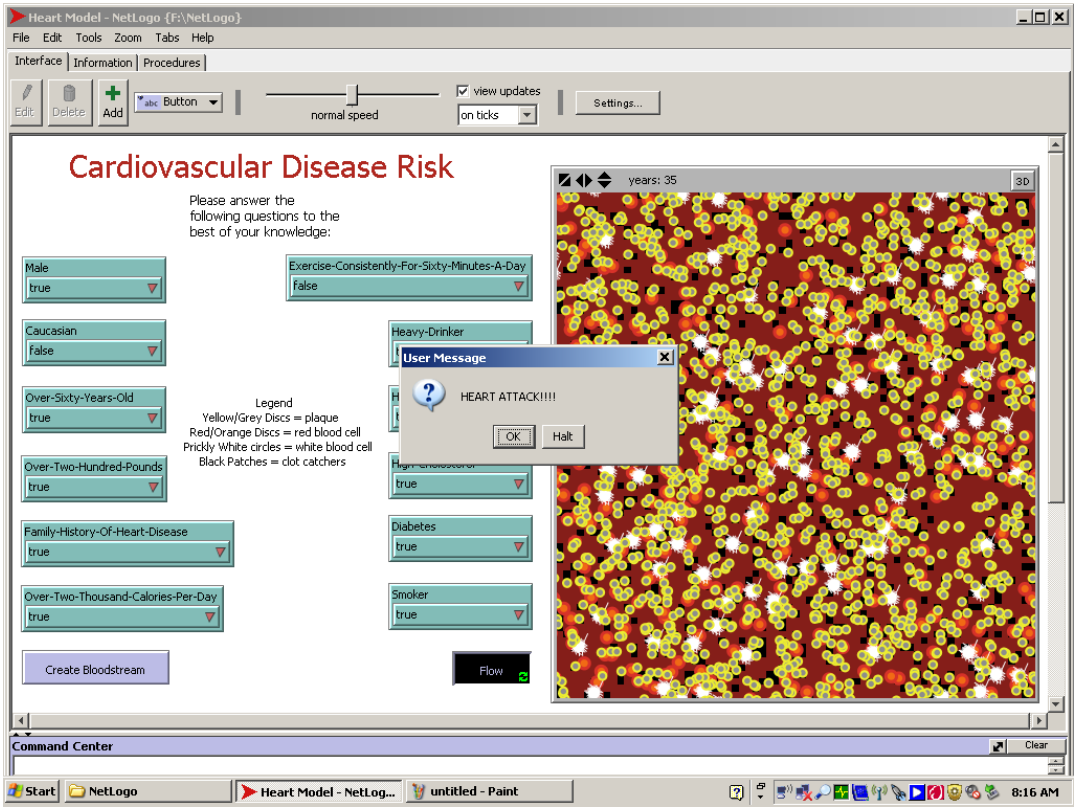
Version 1 of Heart Model




Heart Model - NetLogo {F:\NetLogo}
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button normal speed view updates on ticks Settings...
Cardiovascular Disease Risk
Please answer the following questions to the best of your knowledge:
Male true
Exercise-Consistently-For-Sixty-Minutes-A-Day true
Caucasian false
Heavy-Drinker false
Over-Sixty-Years-Old false
Legend
Yellow/Grey Discs = plaque
Red/Orange Discs = red blood cell
Prickly White circles = white blood cell
Black Patches = clot catchers
High-Blood-Pressure false
Over-Two-Hundred-Pounds false
High-Cholesterol false
Family-History-Of-Heart-Disease true
Diabetes false
Over-Two-Thousand-Calories-Per-Day true
Smoker false
Create Bloodstream
Flow
years: 42
3D
Command Center
Clear
Start NetLogo Heart Model - NetLog... alex1 - Paint 8:14 AM


Heart Model - NetLogo {F:\NetLogo}
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button normal speed view updates on ticks Settings...
Cardiovascular Disease Risk
Please answer the following questions to the best of your knowledge:
Male true
Exercise-Consistently-For-Sixty-Minutes-A-Day false
Caucasian false
Heavy-Drinker true
Over-Sixty-Years-Old true
Legend
Yellow/Grey Discs = plaque
Red/Orange Discs = red blood cell
Prickly White circles = white blood cell
Black Patches = clot catchers
High-Blood-Pressure true
Over-Two-Hundred-Pounds true
High-Cholesterol true
Family-History-Of-Heart-Disease true
Diabetes true
Over-Two-Thousand-Calories-Per-Day true
Smoker true
Create Bloodstream
Flow
years: 0
3D
Command Center
Clear
Start NetLogo Heart Model - NetLog... untitled - Paint 8:15 AM


Heart Model - NetLogo {F:\NetLogo}
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button normal speed view updates on ticks Settings...
Cardiovascular Disease Risk
Please answer the following questions to the best of your knowledge:
Male true
Exercise-Consistently-For-Sixty-Minutes-A-Day false
Caucasian false
Heavy-Drinker
Over-Sixty-Years-Old true
Legend
Yellow/Grey Discs = plaque
Red/Orange Discs = red blood cell
Prickly White circles = white blood cell
Black Patches = clot catchers
Over-Two-Hundred-Pounds true
Family-History-Of-Heart-Disease true
Diabetes true
Over-Two-Thousand-Calories-Per-Day true
Smoker true
Create Bloodstream
Flow
years: 30
3D
User Message
You are at great risk of a heart attack
OK Halt
Command Center
Clear
Start NetLogo Heart Model - NetLog... untitled - Paint 8:16 AM

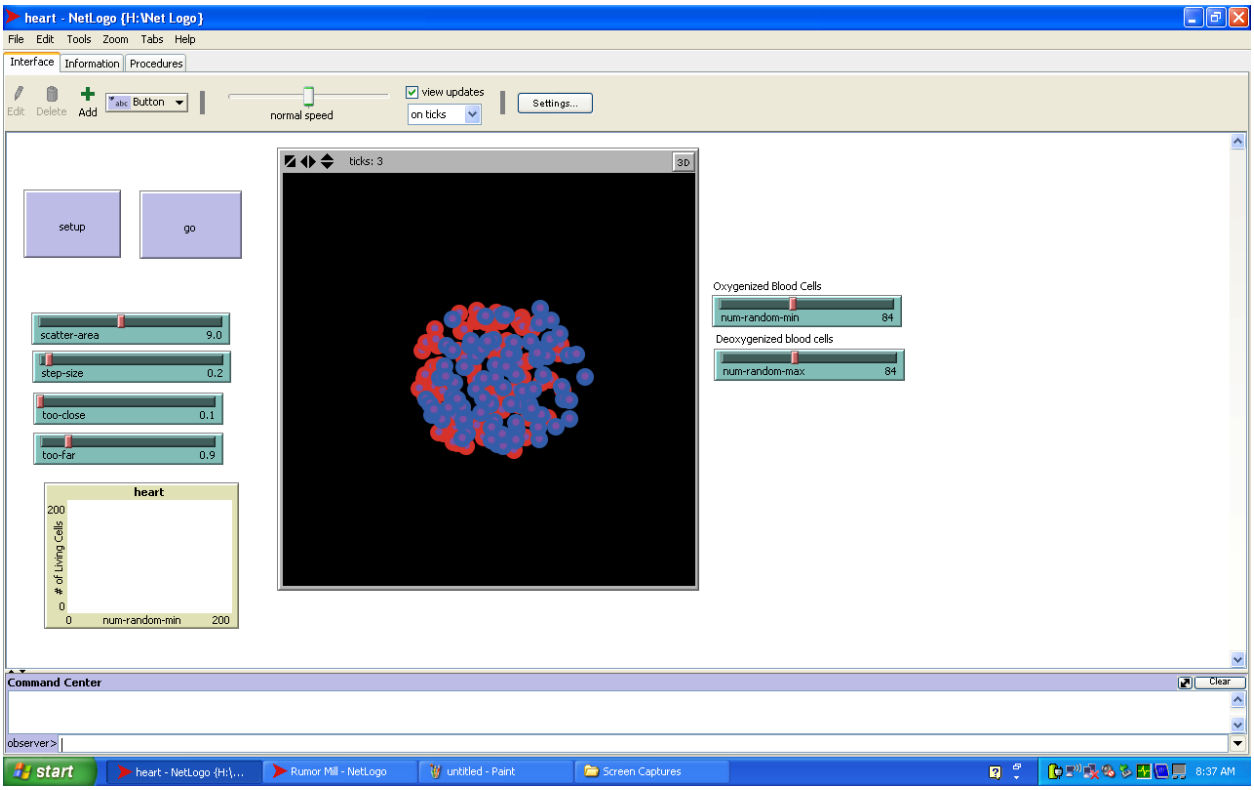

Heart Model - NetLogo {F:\NetLogo}
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button normal speed view updates on ticks Settings...
Cardiovascular Disease Risk
Please answer the following questions to the best of your knowledge:
Male true
Exercise-Consistently-For-Sixty-Minutes-A-Day false
Caucasian false
Heavy-Drinker
Over-Sixty-Years-Old true
Legend
Yellow/Grey Discs = plaque
Red/Orange Discs = red blood cell
Prickly White circles = white blood cell
Black Patches = clot catchers
Over-Two-Hundred-Pounds true
Family-History-Of-Heart-Disease true
Diabetes true
Over-Two-Thousand-Calories-Per-Day true
Smoker true
Create Bloodstream
Flow
years: 35
3D
User Message
HEART ATTACK!!!!
OK Halt
Command Center
Clear
Start NetLogo Heart Model - NetLog... untitled - Paint 8:16 AM

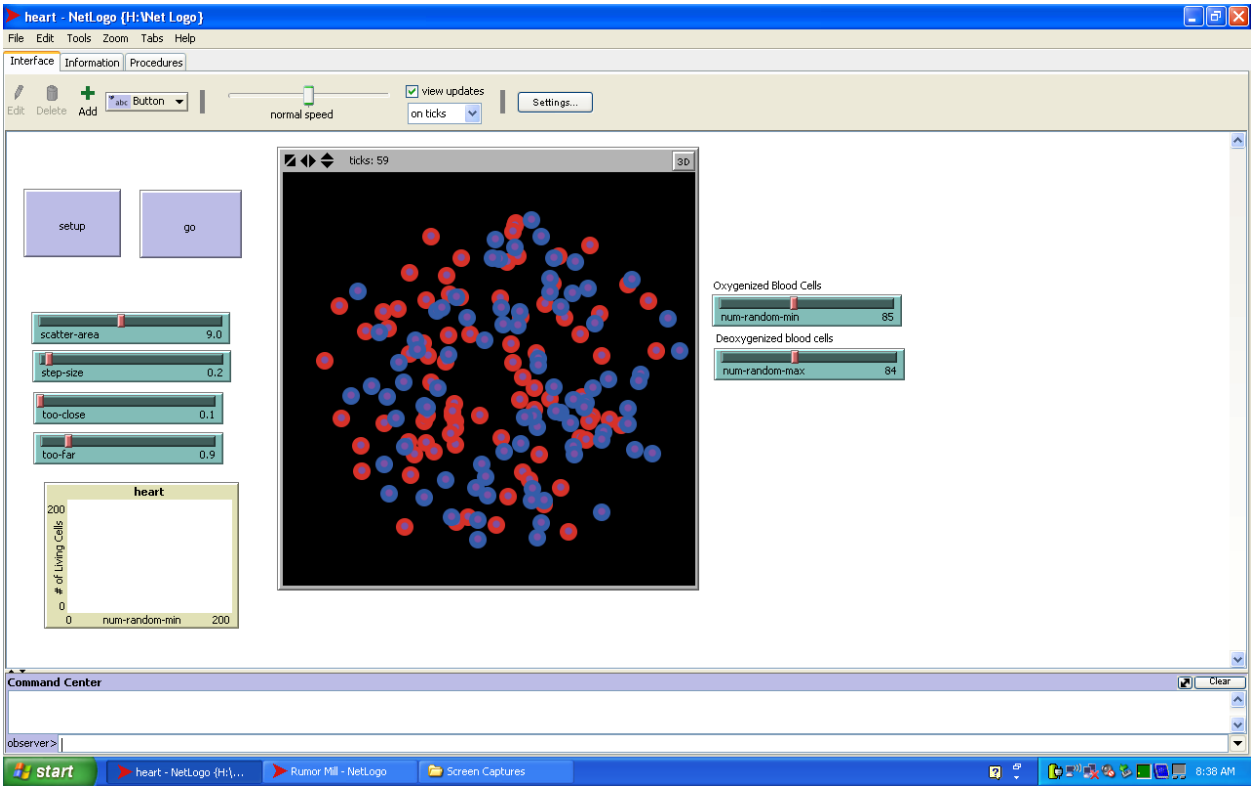
Coding for Blood Stream Model

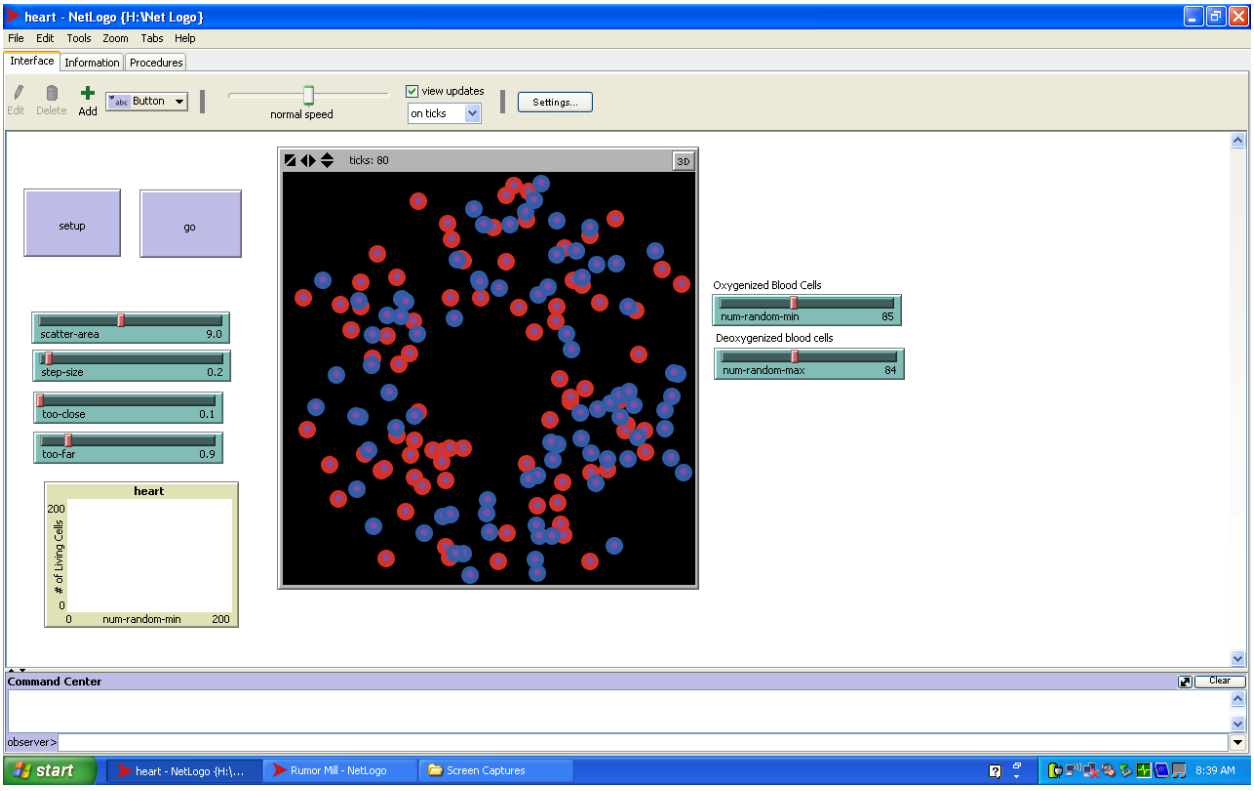
```
turtles-own
[
  nearby-classmates         ;; agentset of turtles within some specified radius
  closest-classmate         ;; the nearest turtle
  stopped?                  ;; if the turtle hasn't moved
  rule                      ;; the turtle's rule (the rules are named by strings)
  origin                    ;; the turtle's original position
  close-classmates          ;; turtles within the too-close range
  far-classmates      ;; total distance moved by the turtle
  previous-patch
  total-distance-moved         ;; patch the turtle was previously on
]

globals
[random-min
random-max
]


;;
;; SETUP AND HELPERS
;;

to setup
  ca
  set-default-shape turtles "circle"
  make-turtles
  end

to make-turtles
  if [count patches in-radius scatter-area] of patch 0 0 < num-turtles-to-create
  [ user-message (word "There aren't enough patches in scatter-area to create the number "
                       "of turtles you've asked for.  Please make scatter-area larger or decrease "
                       "the number of turtles.")
    stop ]
  ask patch 0 0 [
      create-initial-turtles num-random-min  "random-min" red ]
ask patch 1 0 [
          create-initial-turtles num-random-max "random-max"   blue]
  set-common-variables
end

;; reports the total number of turtles the user has requested
to-report num-turtles-to-create
  report num-random-min +
         num-random-max + 1
end

;; ask n random patches without a turtle on them that are within scatter-area of the
;; asker to sprout a turtle with the rule set to turtle-rule and color to turtle-color
to create-initial-turtles [n turtle-rule turtle-color]
  ask n-of n (patches in-radius scatter-area with [not any? turtles-here])
  [ sprout 1
   [ set rule turtle-rule
     set color turtle-color
     set size 2

     ] ]
end

;; initializes turtle variables
;; also moves the turtles a bit so that they are a bit more randomly scattered
to set-common-variables
  ask turtles
  [ set xcor xcor - 0.5 + random-float 1
    set ycor ycor - 0.5 + random-float 1
    set origin patch-here
    set stopped? false
    set total-distance-moved 0 ]
end


;;
;; GO AND TURTLE STRATEGIES
;;
```

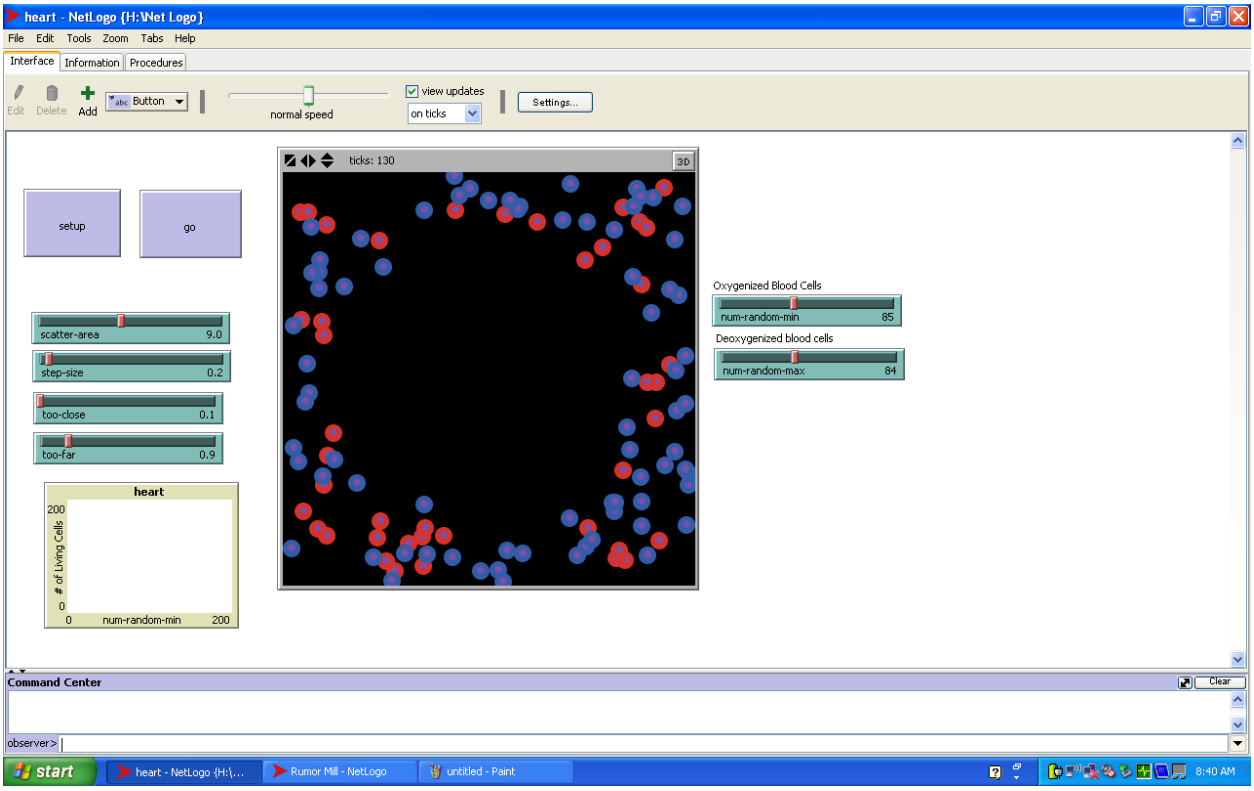
```
to go
  if all? turtles [stopped?] [ stop ]
  ask turtles [
    set previous-patch patch-here
    if rule = "random-min"    [ move-random-min ]
    if rule = "random-max"       [ move-random-max ]
    set total-distance-moved (total-distance-moved + (distance previous-patch))
  ]
  tick

end
;;MOVEMENT AND FUNCTIONS OF TURTLES
to move-random-min ;; turtle procedure
  avoid-walls
  fd step-size
end

to move-random-max
  set nearby-classmates other turtles in-radius too-close
  ifelse any? nearby-classmates  ; if there aren't turtles nearby
    [
   fd step-size
    set stopped? false
    turn-blue

    ]
  [avoid-walls
    fd step-size
    turn-blue
    ]
end

;; if a turtle gets to a wall, it turns around
to avoid-walls ;; turtle procedure
  if not can-move? 1[
    die
  ]
end
 to turn-blue
ifelse can-move? 1
[set color blue][lt random 360]
end
```

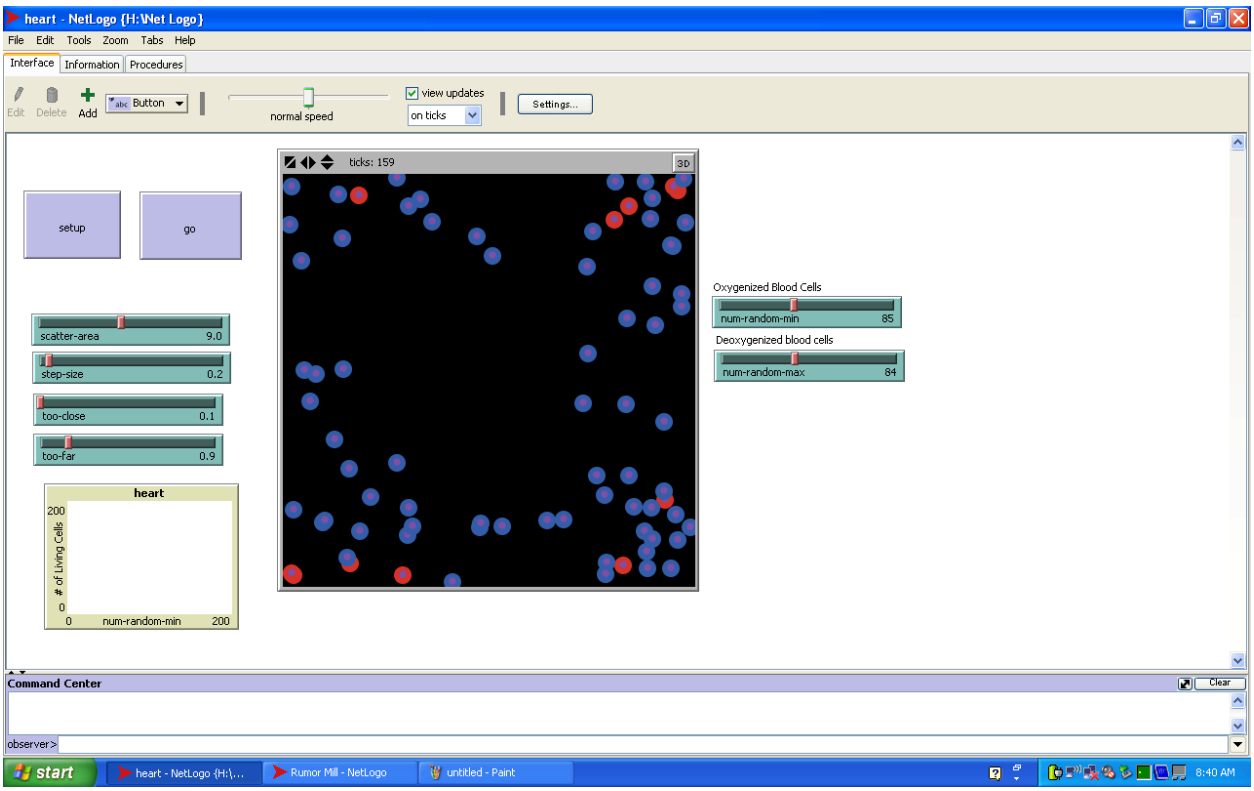
Blood Stream Model

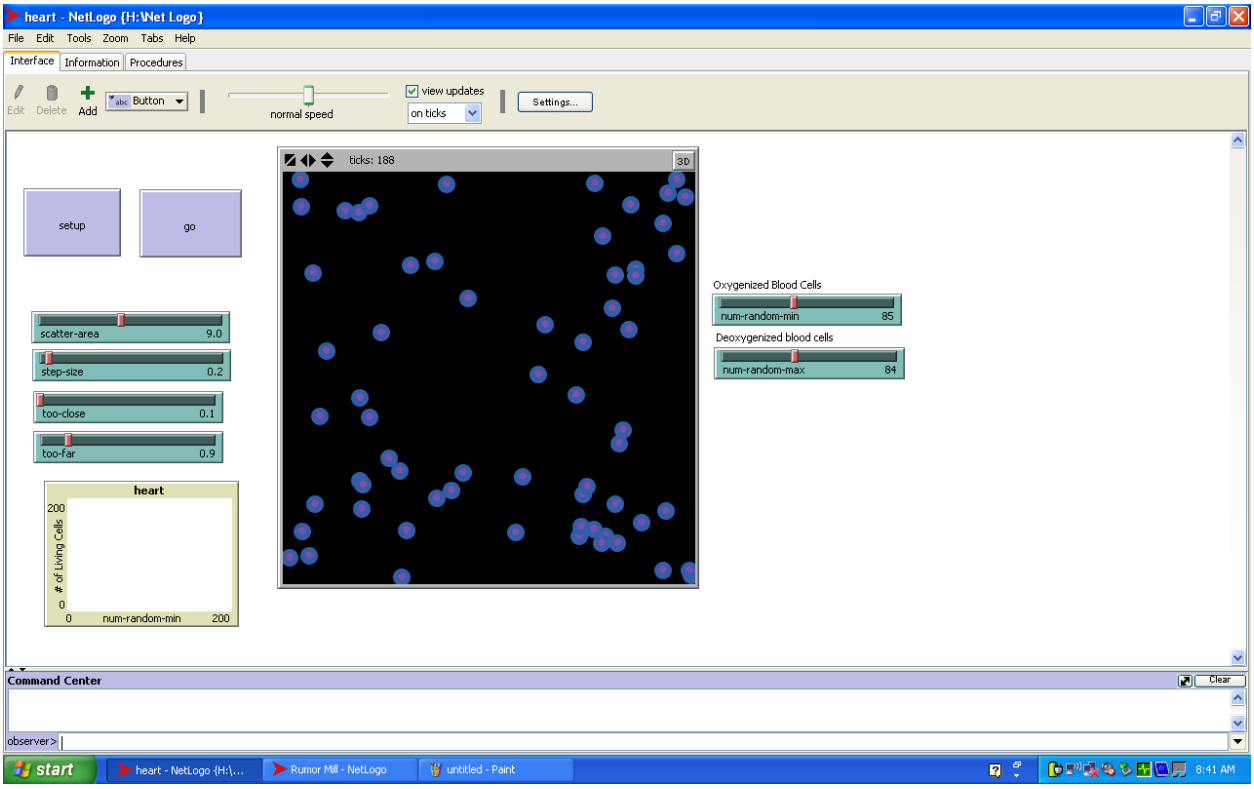


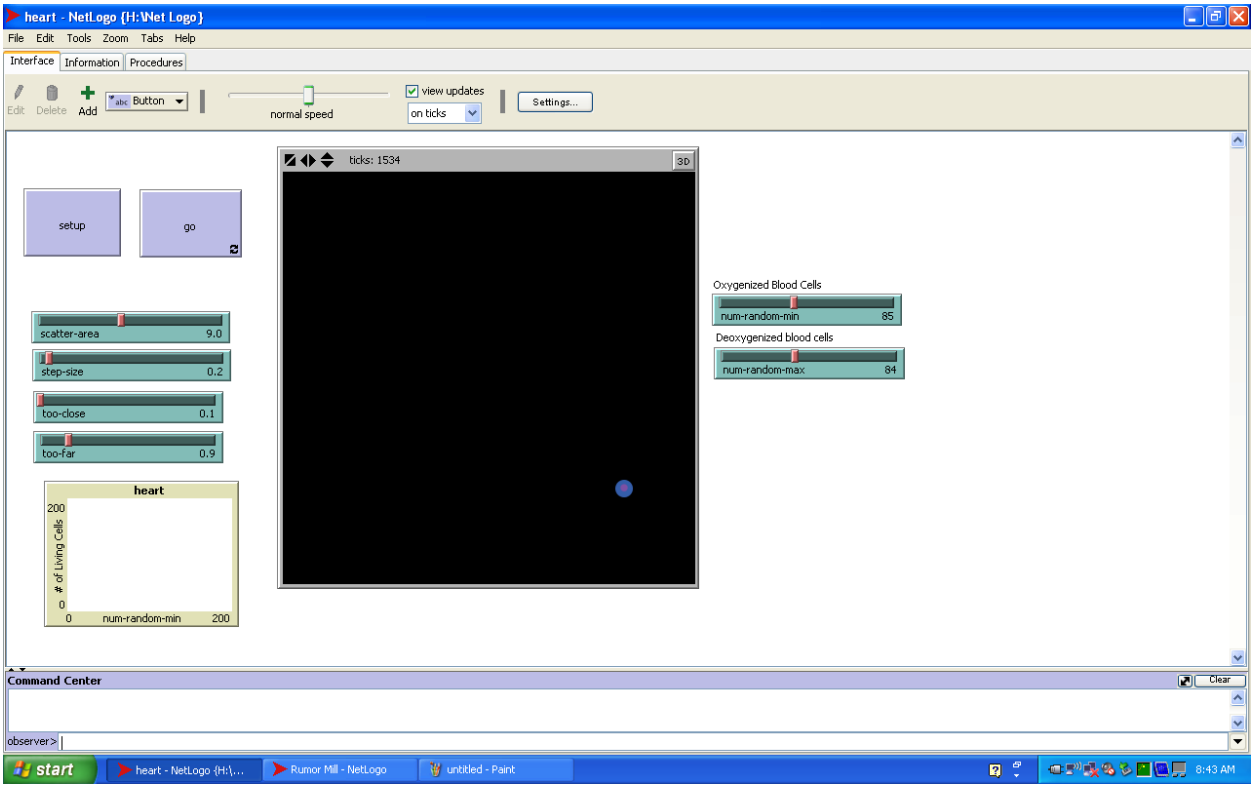

heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 59
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0
num-random-min
200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
Screen Captures
8:38 AM

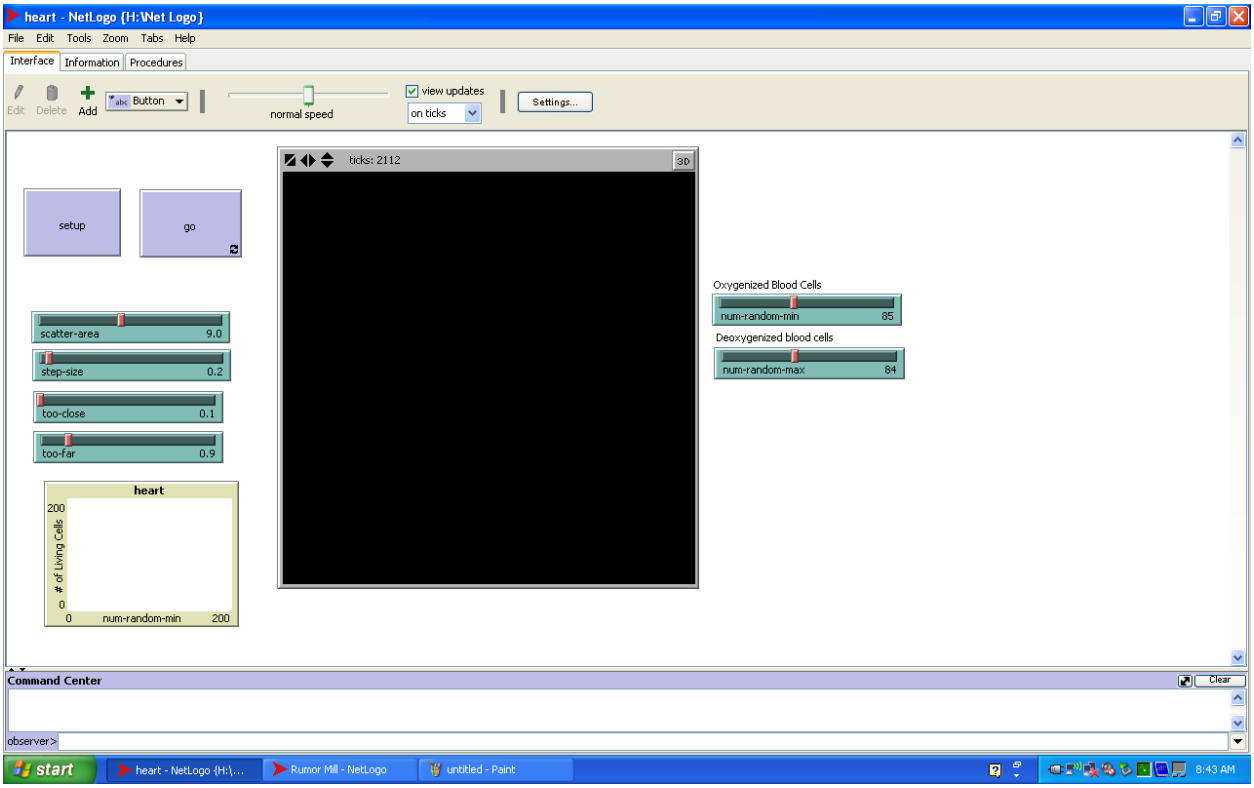

heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 80
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0
num-random-min
200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
Screen Captures
8:39 AM


heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 130
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0 num-random-min 200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
untitled - Paint
8:40 AM

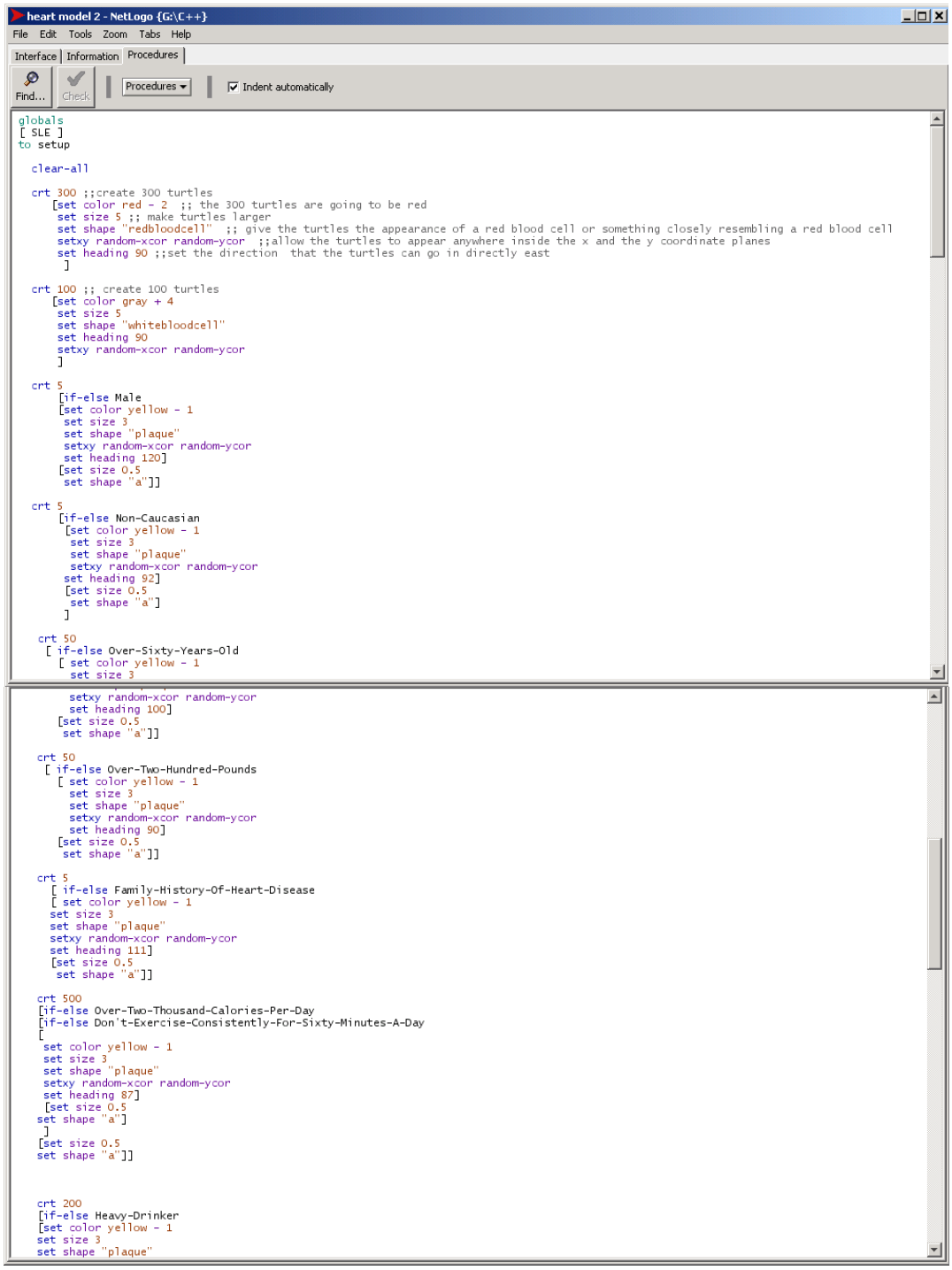

heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 159
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0 num-random-min 200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
untitled - Paint
8:40 AM


heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 188
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0 num-random-min 200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
untitled - Paint
8:41 AM


heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
ticks: 1534
3D
setup
go
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0 num-random-min 200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
untitled - Paint
8:43 AM


heart - NetLogo (H:\Net Logo)
File Edit Tools Zoom Tabs Help
Interface Information Procedures
Edit Delete Add Button
normal speed
view updates
on ticks
Settings...
setup
go
ticks: 2112
3D
scatter-area 9.0
step-size 0.2
too-close 0.1
too-far 0.9
heart
200
# of Living Cells
0
0
num-random-min
200
Oxygenized Blood Cells
num-random-min 85
Deoxygenized blood cells
num-random-max 84
Command Center
Clear
observer>
start
heart - NetLogo (H:\...
Rumor Mill - NetLogo
untitled - Paint
8:43 AM

Coding for Heart Model Version 2



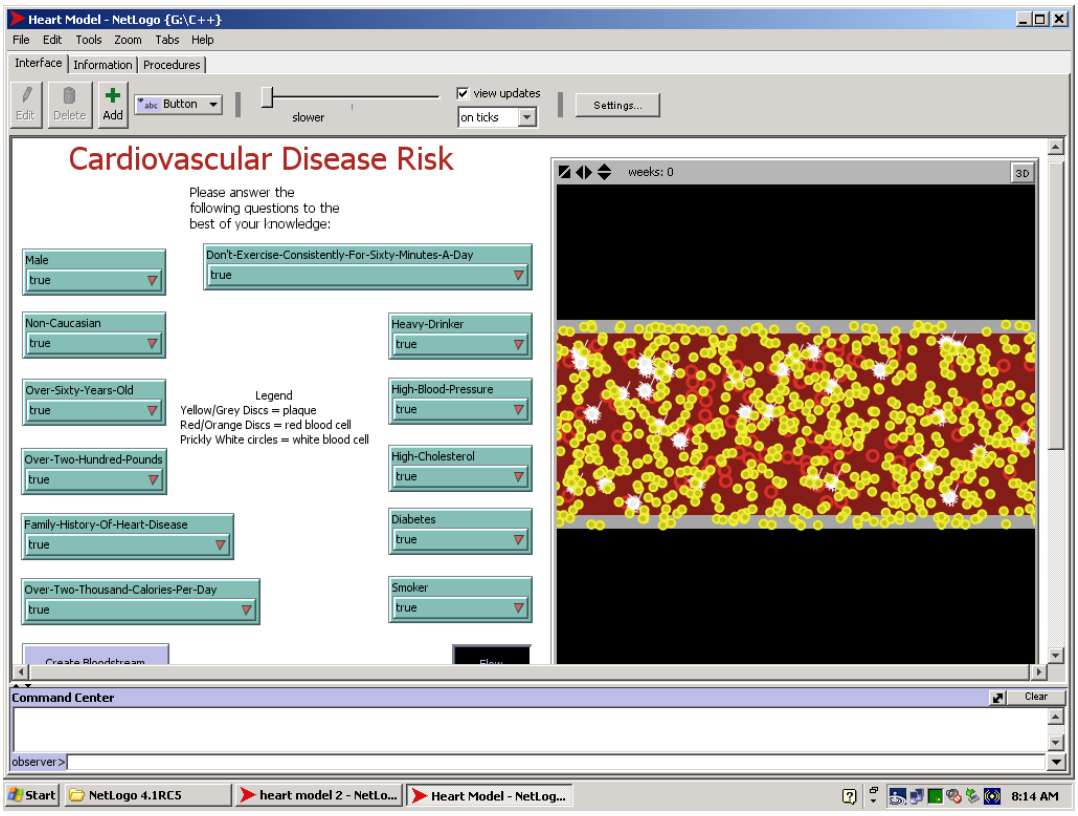

```
globals
[ SLE ]
to setup

  clear-all

  crt 300 ;;create 300 turtles
     [set color red - 2  ;; the 300 turtles are going to be red
      set size 5 ;; make turtles larger
      set shape "redbloodcell"  ;; give the turtles the appearance of a red blood cell or something closely resembling a red blood cell
      setxy random-xcor random-ycor  ;;allow the turtles to appear anywhere inside the x and the y coordinate planes
      set heading 90 ;;set the direction  that the turtles can go in directly east
       ]

  crt 100 ;; create 100 turtles
     [set color gray + 4
      set size 5
      set shape "whitebloodcell"
      set heading 90
      setxy random-xcor random-ycor
      ]

  crt 5
      [if-else Male
      [set color yellow - 1
       set size 3
       set shape "plaque"
       setxy random-xcor random-ycor
       set heading 120]
      [set size 0.5
       set shape "a"]]

  crt 5
      [if-else Non-Caucasian
       [set color yellow - 1
        set size 3
        set shape "plaque"
        setxy random-xcor random-ycor
       set heading 92]
       [set size 0.5
        set shape "a"]
       ]

   crt 50
    [ if-else Over-Sixty-Years-Old
      [ set color yellow - 1
        set size 3
        setxy random-xcor random-ycor
        set heading 100]
      [set size 0.5
       set shape "a"]]

   crt 50
    [ if-else Over-Two-Hundred-Pounds
      [ set color yellow - 1
        set size 3
        set shape "plaque"
        setxy random-xcor random-ycor
        set heading 90]
      [set size 0.5
       set shape "a"]]

   crt 5
     [ if-else Family-History-Of-Heart-Disease
     [ set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 111]
     [set size 0.5
      set shape "a"]]

   crt 500
   [if-else Over-Two-Thousand-Calories-Per-Day
   [if-else Don't-Exercise-Consistently-For-Sixty-Minutes-A-Day
   [
    set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 87]
     [set size 0.5
   set shape "a"]
    ]
   [set size 0.5
   set shape "a"]]



   crt 200
   [if-else Heavy-Drinker
   [set color yellow - 1
   set size 3
   set shape "plaque"
```

```
    setxy random-xcor random-ycor
    set heading 80]
    [set size 0.5
    set shape "a"]]

    crt 200
    [if-else High-Blood-Pressure
    [set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 110]
    [set size 0.5
    set shape "a"]]

    crt 200
    [if-else High-Cholesterol
    [set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 110
    ]
    [set size 0.5
    set shape "a"
    ]]

    crt 50
    [if-else Diabetes
    [set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 110]
    [set size 0.5
    set shape "a"]]

    crt 200
    [if-else Smoker
    [set color yellow - 1
    set size 3
    set shape "plaque"
    setxy random-xcor random-ycor
    set heading 95]
    [set size 0.5
     set shape "a"]]
```

```
setup-patches
end

to setup-patches
ask patches [set pcolor red - 2]
ask patches  [if pycor > 15 or pycor < -15 [set pcolor black]]
ask patches [if pycor = 14 or pycor = -14 [set pcolor gray + 1]]
ask patches [if pycor = 15 or pycor = -15 [set pcolor gray + 1]]
end

to go
move-plaque
move-whitebloodcellpopulation
move-redbloodcellpopulation
finish
terminate
tick go
end

to move-plaque
ask turtles [if shape = "plaque" [if-else ycor > -15 and ycor < 15 [if-else pcolor = gray + 1 [forward 0][jump 2]][die]]]
end
to move-redbloodcellpopulation
ask turtles [if shape = "redbloodcell" [if-else ycor > -12 and ycor < 12 [if-else pcolor = gray + 1[die][jump 2]][die]]]
end
to move-whitebloodcellpopulation
ask turtles [if shape  = "whitebloodcell" [if-else ycor > -12 and ycor < 12 [if-else pcolor = gray + 1[die][forward 1]][die]]]
end

to terminate
set SLE 76
if not Male [ set SLE  76 + 4 ]
if not Over-Sixty-Years-Old [set SLE 76 + 5 ]
if Non-Caucasian [set SLE 76 - 1]
if Over-Two-Hundred-Pounds [set SLE 76 - 2]
if Don't-Exercise-Consistently-For-Sixty-Minutes-A-Day [set SLE 76 - 2]
if High-Cholesterol [set SLE 76 + 2]
if High-Blood-Pressure [set SLE 76 - 1]
if Smoker [set SLE 76 - 2]
if Family-History-Of-Heart-Disease [set SLE 76 - 4]
if Diabetes [set SLE 76 - 4]
if not Over-Two-Thousand-Calories-Per-Day [set SLE 76 + 3]
if Heavy-Drinker [set SLE 76 - 2]
end

to finish
```

```
to setup-patches
ask patches [set pcolor red - 2]
ask patches  [if pycor > 15 or pycor < -15 [set pcolor black]]
ask patches [if pycor = 14 or pycor = -14 [set pcolor gray + 1]]
ask patches [if pycor = 15 or pycor = -15 [set pcolor gray + 1]]
end

to go
move-plaque
move-whitebloodcellpopulation
move-redbloodcellpopulation
finish
terminate
tick go
end

to move-plaque
ask turtles [if shape = "plaque" [if-else ycor > -15 and ycor < 15 [if-else pcolor = gray + 1 [forward 0][jump 2]][die]]]
end
to move-redbloodcellpopulation
ask turtles [if shape = "redbloodcell" [if-else ycor > -12 and ycor < 12 [if-else pcolor = gray + 1[die][jump 2]][die]]]
end
to move-whitebloodcellpopulation
ask turtles [if shape  = "whitebloodcell" [if-else ycor > -12 and ycor < 12 [if-else pcolor = gray + 1[die][forward 1]][die]]]
end

to terminate
set SLE 76
if not Male [ set SLE  76 + 4 ]
if not Over-Sixty-Years-Old [set SLE 76 + 5 ]
if Non-Caucasian [set SLE 76 - 1]
if Over-Two-Hundred-Pounds [set SLE 76 - 2]
if Don't-Exercise-Consistently-For-Sixty-Minutes-A-Day [set SLE 76 - 2]
if High-Cholesterol  [set SLE 76 + 2]
if High-Blood-Pressure [set SLE 76 - 1]
if Smoker [set SLE 76 - 2]
if Family-History-Of-Heart-Disease [set SLE 76 - 4]
if Diabetes [set SLE 76 - 4]
if not Over-Two-Thousand-Calories-Per-Day [set SLE 76 + 3]
if Heavy-Drinker [set SLE 76 - 2]
end

to finish
if ticks = 100  [user-message (word "Your life expectancy is "  SLE) ]
end
```

Heart Model Version 2



Appendix B: Statistical Table

Estimated Line Algorithm Results

Column1	Diabetes?	High blood pressure?	60 yrs or older?	Noncaucasian?	Over 200lbs?	Family History of Heart Disease?	Exercises Consistantly?	Eats Heathy?	Smokes?	High Cholesterol?	Heavy Drinker?	Age of Heart attack
Case 1	0	0	1	0	0	1	0	1	1	1	0	65
Case 2	1	0	1	0	0	0	1	1	0	1	0	67
Case 3	1	0	0	1	0	0	1	1	0	1	0	52
Case 4	1	1	0	1	0	0	1	0	0	0	0	58
Case 5	0	1	0	1	0	0	0	0	0	0	0	47
Case 6	1	1	0	1	0	1	1	0	1	1	0	49
Case 7	1	1	1	1	0	1	1	1	1	0	0	61
Case 8	1	1	1	1	0	1	1	0	0	1	0	84
Case 9	0	1	0	0	0	0	1	0	1	0	1	59
Case 10	1	1	0	0	1	1	1	1	1	0	0	56
Case 11	0	1	1	1	1	0	1	0	1	1	0	67
Case 12	1	1	1	1	0	0	1	1	1	1	1	85
Case 13	0	1	0	1	1	0	1	0	0	1	1	34
Case 14	1	0	0	0	0	0	1	1	0	1	0	23
Case 15	0	0	1	1	1	0	1	1	0	0	1	66
Case 16	0	1	1	0	1	0	0	0	0	0	0	68
Case 17	0	1	1	1	0	0	0	0	0	1	1	78
Case 18	1	1	1	1	1	0	1	1	1	0	0	79
Case 19	0	1	0	1	0	1	1	1	0	1	0	50
Line	2.066666667	7.9	24.44444444	5.974358974	1.820512821	0.602564103	-5.166666667	-0.044444444	8.125	-2.295454545	5.4	