Nature and Nurture

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Summary

Our project models the Nature Versus Nurture discussion and how various traits are affected by genetics and by our environment. The code is written in Starlogo, an agent-based program.

We looked at three sets of traits: Intelligence, Senses and Habits. These are representative of mental capacity, physical capacity and purely learned traits respectively.

We assumed that learning would be essencial to a mdel of nature and nurture, and our results confirmed that. We also discovered that a period in which individuals are dependent on a parent figure has major implications on whether or not the populations succeeds.

Intro

Nature versus Nurture is a classic argument about how learned traits and genetic traits make us who we are. Nature is our genetic makeup, refined through ages of natural selection. Nurture concerns the environment we grow up and live in.

It is well known that it is our environment that affects who survives in a species. Through natural selection a group can adapt to its surroundings and evolve to a better suited genetic model. If a specific trait is more beneficial to the individual who carries it, that individual is more likely to survive and reproduce. If a trait is less desirable, or limits the individual, they are less likely to survive to pass on genes to offspring.

The same can be said of cultural evolution. Habits and practices of a culture that are beneficial to the community as a whole are more likely to survive with the culture. If a community's practice is harmful, either the individuals who are not adept at conforming to the culture die out, or the custom itself does not survive.

To start understanding the debate we looked at traits that are essential to life and to evolution. We chose three groups to look at: Intelligence, which in our model is essential to finding resources, is representative of all the forms of cognition and mental capacity. Senses encompass the bodily functions and reflexes that define biological life and its physical implications. Hygiene and Diet are purely learned traits, and the health of a trogdor can be penalized for low scores in either of these.

Body

Our model uses two types of procedures: Functional procedures, which the turtles call to move and to progress, and Ruling procedures, which the functional procedures call on to organize the turtles and govern the traits they carry. We defined and created a trogdor life using stages similar to those of humans and other species. Trogdor life is made up of functional procedures that call a list of ruling procedures. The ruling procedures then determine the values and traits carried by the trogdor.

A trogdor starts life by setting values for the traits they live by. Senses and Intelligence have inheritable values. A newly hatched trogdor will imitate the inherent values with slight differences to allow for variation and mutation. They also inherit a susceptibility factor, which determines how easily the trogdor picks up habits. The habits themselves are set to zero at the start of life and are learned through life from other trogdor in the area.

The first stage a trogdor moves through is a gestation period. A trogdor is a child for a finite amount of time. During this stage, they follow a parent turtle and are dependent on them for resources. Although trogdor learn throughout life, the amount of resources and the level of senses might affect the development of a child's intelligence.

Health is dependent on a number of things. Primarily, it's set by the amount of resources a trogdor has. If they have inadequate intelligence, they may have trouble collecting resources. Health is also modified by habits. Low hygiene or diet scores will result in poor health, and smoking drinking and drugs also result in poor health and a higher probability of death.

Traits

Intelligence affects our genetic evolution and is a large part of who we are as a species. It takes a certain level of intelligence to gain resources. We learn from people in our community and they learn from us. If we don't get enough resources when we're children, our intelligence doesn't have an opportunity to fully develop.

Senses let us experience art and culture, while also helping us to adapt and survive. Our bodies and senses can learn to do, express and feel more through training. If a child has poor senses, they have a harder time learning mental skills. If our senses are not attuned to our environment, we have a higher mortality rate.

Habits are a large part of what we do. We pick them up from other people and assimilate them into our routines. They largely affect our health, and our chances of survival. Good hygiene habits make us less likely to get diseases. A healthy diet ensures that our bodies have everything they need to grow and replenish themselves.

Conclusions

Learning is central to the Nature - Nurture issue and we expected to find that this was an important part of our model. It controls most of the nurture side of the program. Without learning, the trogdor still evolve, but are less likely to reach a stable population, and the average value for senses and intelligence is signifigantly less than if learning is used

Interestingly, To Learn also seems to determine whether Senses or Intelligence evolves more. Running the program with learning usually produces a higher value for inherited senses and modest value for inherited intelligence. Running it without To Learn causes the inherited senses to drop often below zero, with high values for inherited intelligence.

Without Learning:	
Inherited Intelligence:	17
Inherited Senses:	-4
With Learning:	
Inherited Intelligence:	4
Inherited Senses:	10

The effects of the gestation period, in particular the procedure To Follow, were not as expected. After seeing the effect, however, it makes sense. In a small population the chances of landing on the same patch as another trogdor are low, which reflects in the chances of nurturing a trait. To Follow provides a greater chance of landing on and learning from another; namely the parent.

```
to follow
if stage = child
[setheading towards
(xcor-of care) (ycor-of care)
fd 1]
end
```

We did run into one problem. The program is capable of putting out so much data that we couldn't write a paper on all of it.

There are three habits that are we programmed to spread like diseases through Susceptible, Infected, Removed (SIR) programming. We were unable to fully test that function or to make sure it acts in a realistic fashion. There are also a few lines that provide for bias in trogdor. While this aspect functions, we need to do more research into the causes of bias before it resembles actual cases.

We plan to continue work on the project up to and following the expo.

Bibliography

Ridley, Matt (2003). *Nature Via Nurture: Genes, Experience, and What Makes Us Human*. Harper Collins.

Leroi, Armand M. (2004). *Mutants: On the Form, Varieties and Errors of the Human Body*. HarperCollins.

Hoagland, M., & Dodson, B. (1998). *The Way Life Works: The Science Lover's Illustrated Guide to How Life Grows, Develops, Reproduces, and Gets Along.* Three Rivers Press.

Smith, John M. (1982). *Evolution and the Theory of Games*. Cambridge University Press.

Nature Versus Nurture. Wikipedia. http://en.wikipedia.org/wiki/Nature_versus_nurture

Game Theory. Wikipedia. http://en.wikipedia.org/wiki/Game_Theory

Blachford, S. (Ed.). (2005). *Gale Encyclopedia of Genetic Disorders* (2nd ed., Vol. 1-2). Thomson Gale.

Intelligence Quotient. Wikipedia. http://en.wikipedia.org/wiki/IQ

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Paige Prescott and Randy Merker

Who put up with us and let us use their classrooms.

Turtle Procedures

```
Turtles-own

[age
gen
health

inherit-int
intelligence
maxint
minint
int-diff

inherit-senses
senses
maxsenses
minsenses
senses-diff

mortality

bias
biasnear

susceptible?

hygiene
diet

smoking [yes no]
drinking [yes no]
drugs [yes no]

stage [child adult]
care

resource]


to setup
if breed = trogdor
[setxy (random 51) (random
51)
ifelse (random 100) < 50
 [setc blue]
 [setc purple]

setintelligence (random 11)
;;Intelligence starting value.
setinherit-int intelligence
setmaxint intelligence
setminint intelligence

setsenses (random 11)
;;Senses starting value.
setinherit-senses senses
setmaxsenses senses
setminsenses senses
setmortality (random 100) /
senses

setbias (random 11) ;;Bias
starting value.

setsusceptible? (random
11) ;;How easily a trogdor
picks up habits, starting
value.
sethygiene (random 11)
setdiet (random 11)
setsmoking no
setdrinking no
setdrugs no

sethealth (random 21)
setresource (random 5)]
setstage adult
end


to go
ifelse time < 100000
[if breed = peasant
[grow]
if breed = trogdor
[hunt
mooch
check]
settime time + 1]
[stopall]
if count-trogdor < 1 [stopall]
end


to grow
if breed = peasant
[move
if pc-ahead = green [stamp
green]]
end


to hunt
if stage = adult ;;children do
not hunt.
 [move
  if resource > 20 [stop]
  if pc = green and
intelligence > (random int-
check)
   [stamp black
    setresource resource +
1]]
if resource > 20
 [setresource 20]
end

 to move
 be-biased
 rt (random 90)
 lt (random 90)
 fd 1
 end
```

Key:

- Intelligence
- Senses
- Bias
- Habits
- Children

Turtle Procedures

```
    to be-biased
    if breed = trogdor and
stage = adult
    [setbiasnear first
    (who-min-of-turtles-with
      [(color not= color-of
myself) and (stage = adult)]
      [distance xcor-of myself
ycor-of myself])
    if (random 100) < bias
     [setheading towards
(xcor-of biasnear) (ycor-of
biasnear)
      rt 180]]
    end

to mooch
if stage = child
[if (resource-of care) > 20
 [set resource-of care 20]
setresource-of care
(resource-of care / 2)
setresource resource +
resource-of care
follow]
if resource > 20
 [setresource 20]
end



to follow
if stage = child
[setheading towards (xcor-
of care) (ycor-of care)
fd 1]
end



to check
progress

if health < 1 [poll]
if (random 100) < mortality
[poll]
```

```
if stage = adult ;;children do
not reproduce.
 [if resource > hatch-
threshold and count-trogdor
< 100
  [baby]

  if (random 100) < bias
   [grab one-of-turtles-here-
with [(color not= color-of
myself) and (stage = adult)]
    [ifelse senses >=
senses-of partner
     [kill partner]
     [die]
     setbias-death bias-death
+ 1]]]



if stage = child
 [if resource < 5
   [setintelligence
intelligence - (random 5
- resource)]
  if senses < 5
   [setintelligence
intelligence - (random 5
- senses)]]



setmortality (random 100) /
senses

if hygiene < 3
 [sethealth health - ((health
/ 100) * 20)]
if diet < 3
 [sethealth health - ((health
/ 100) * 20)]

if smoking = yes [sethealth
health - ((health / 100) *
30)]
if drinking = yes [sethealth
```

```
health - ((health / 100) *
30)]
if drugs = yes [sethealth
health - ((health / 100) *
30)]

if intelligence > maxint
[setmaxint intelligence]
if intelligence < minint
[setminint intelligence]

if senses > maxsenses
[setmaxsenses senses]
if senses < minsenses
[setminsenses senses]

setint-diff (maxint - minint)
setsenses-diff (maxsenses
- minsenses)
end

  to progress
  sethealth health - 1
  if resource > health
   [setresource resource / 2
    sethealth health +
resource]

  setage age + 1
  if age > 3 and stage =
child
   [setstage adult
    setc (pick [115 105])]

  learn
  end



    to learn
    grab one-of-trogdor-here
     [setintelligence
intelligence + (random
(intelligence-of partner -
intelligence))
```

Turtle Procedures

```
    setsenses senses +
(random (senses-of partner
- senses))
    setbias bias + (random
(bias-of partner - bias))
    sethygiene hygiene
+ (random (hygiene-of
partner - hygiene))
    setdiet diet + (random
(diet-of partner - diet))]
  check-habit
  end


to check-habit

if smoking = yes
[if breed = trogdor
[setc yellow
sethealth health - (health /
100) * 30
grab one-of-trogdor-here
 [if (random 100) <
susceptible?-of partner
  [setsmoking-of partner yes
   sethealth-of partner
health-of partner - ((health-
of partner / 100) * 30)]]]]

if drinking = yes
[if breed = trogdor
[setc yellow
sethealth health - (health /
100) * 30
grab one-of-trogdor-here
 [if (random 100) <
susceptible?-of partner
  [setdrinking-of partner yes
   sethealth-of partner
health-of partner - ((health-
of partner / 100) * 30)]]]]

if drugs = yes
[if breed = trogdor
[setc yellow
sethealth health - (health /
100) * 30
grab one-of-trogdor-here
 [if (random 100) <
susceptible?-of partner
  [setdrugs-of partner yes
   sethealth-of partner
health-of partner - ((health-
of partner / 100) * 30)]]]]
end



 to baby
 hatch
  [inherit
   setstage child
   setc red
   get-parent]
 end

   to inherit
     setage 0
     setgen gen + 1
     sethealth (random 21)

     setinherit-int inherit-int
+ (random variation)
     setinherit-int inherit-int
- (random variation)
     setintelligence inherit-
int
     setmaxint inherit-int
     setminint inherit-int

     setinherit-senses
inherit-senses + (random
variation)
     setinherit-senses
inherit-senses - (random
variation)
     setsenses inherit-
senses
     setmaxsenses inherit-
senses
     setminsenses inherit-
senses
     setmortality (random
100) / senses

     setbias 0

     setsusceptible?
susceptible? + (random
variation)
     setsusceptible?
susceptible? - (random
variation)

     sethygiene (random 10)
     setdiet (random 10)

     setsmoking no
     setdrinking no
     setdrugs no
   end

 to get-parent
 grab one-of-turtles-here
  [setcare partner]
 end


to smoke
setxy (random 51) (random
51)
 ifelse count-trogdor-here
> 0
  [grab one-of-trogdor-here
   [setsmoking-of partner
yes
    die]]
  [smoke]
end
to drink
setxy (random 51) (random
51)
 ifelse count-trogdor-here
> 0
  [grab one-of-trogdor-here
```

Observer Procedures

Turtle Procedures Continued:

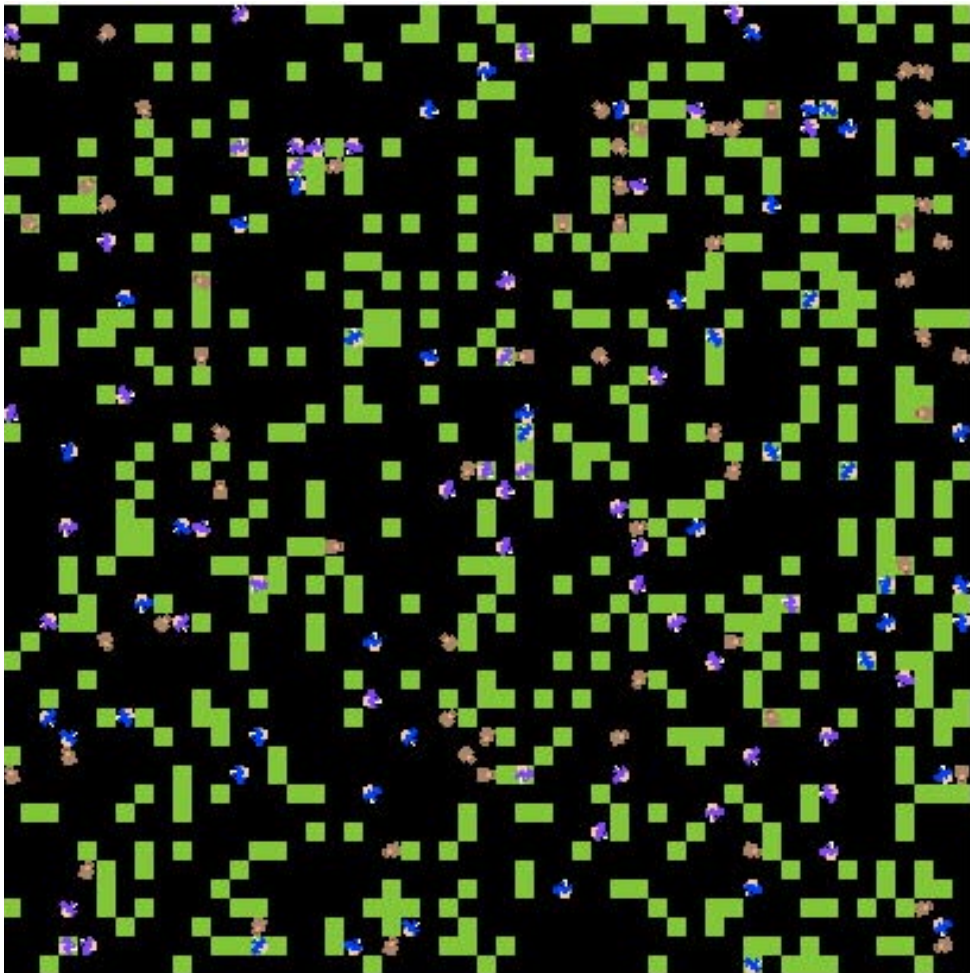
```
   [setdrinking-of partner
yes
    die]]
  [drink]
end


to do-drugs
setxy (random 51) (random
51)
 ifelse count-trogdor-here
> 0
  [grab one-of-trogdor-here
   [setdrugs-of partner yes
    die]]
 (Turtle Procedures Cont.)

 [do-drugs]
end

to poll
ifelse health < 1
[sethealth-death health-
death + 1
if hygiene < 3 [sethygiene-
death hygiene-death + 1]
if diet < 3 [setdiet-death
diet-death + 1]
if intelligence < int-check
[setint-death int-death + 1]]
[setmortality-death
mortality-death + 1]
die
end
```

Observer Procedures:

```
globals
[nature-int nurture-int
nature-senses nurture-
senses

smoking-death
drinking-death
drugs-death

hygiene-death
diet-death

bias-death

health-death
mortality-death
int-death

time]


breeds [trogdor peasant
trigger]


to setup
setnature-int 0
setnurture-int 0
setnature-senses 0
setnurture-senses 0
setsmoking-death 0
setdrinking-death 0
setdrugs-death 0
sethygiene-death 0
setdiet-death 0
setbias-death 0
sethealth-death 0
setmortality-death 0
settime 0

ca
```

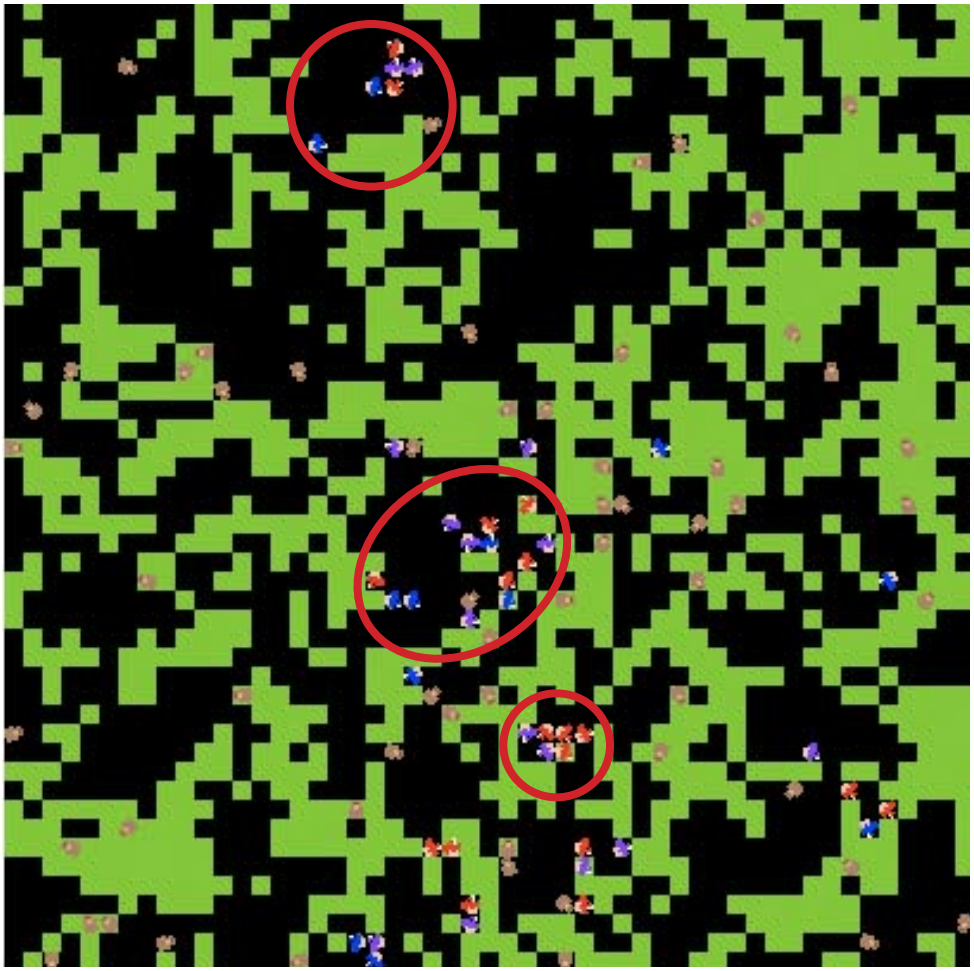
```
create-trogdor-and-do 100
 [setshape trogdor-shape
  setup]
create-peasant-and-do
resource-rate
 [setshape peasant-shape
  repeat 10
   [setxy (random 51)
(random 51)
    stamp green]]
end


to add-smoke
create-trigger-and-do 20
[smoke]
end


to add-drink
create-trigger-and-do 20
[drink]
end


to add-drugs
create-trigger-and-do 20
[do-drugs]
end
```

Screen Shots



The turtles start out spread randomly across the patch, with a modest amount of resources (the green squares) already seeded and no children.

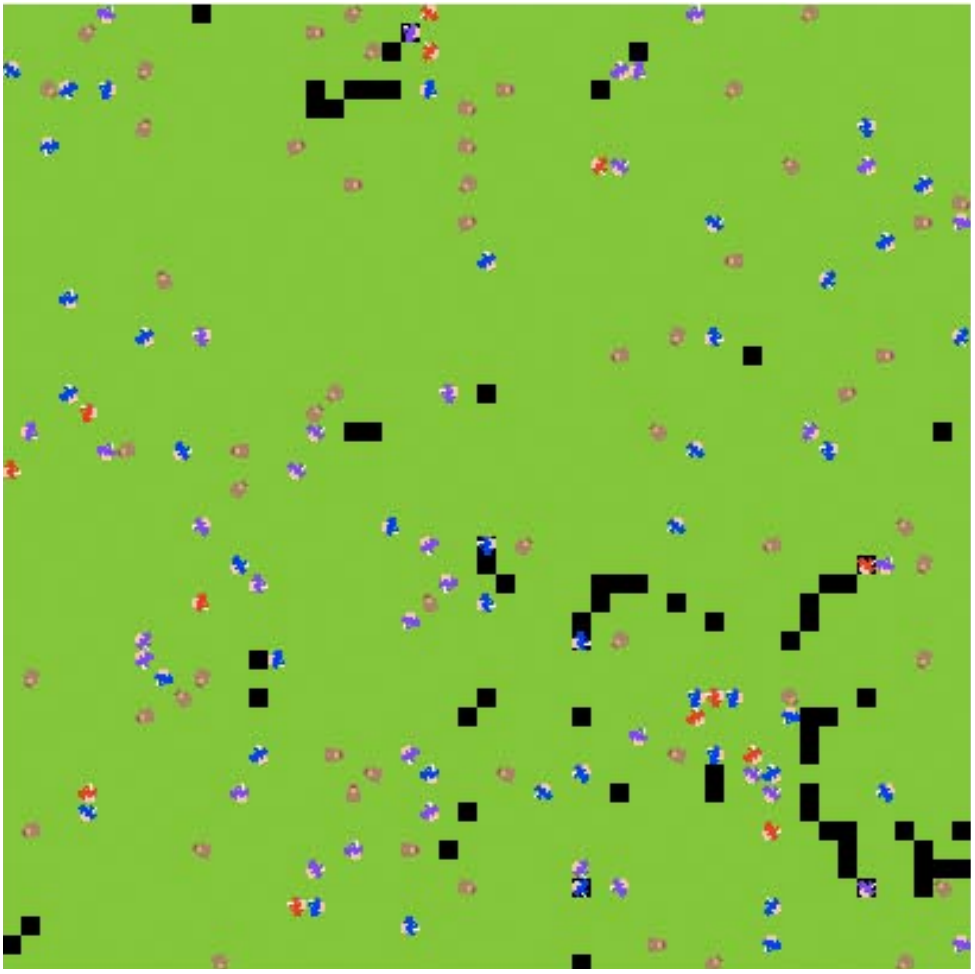
Screen Shots



This is shortly after the program has started (time = 5048).

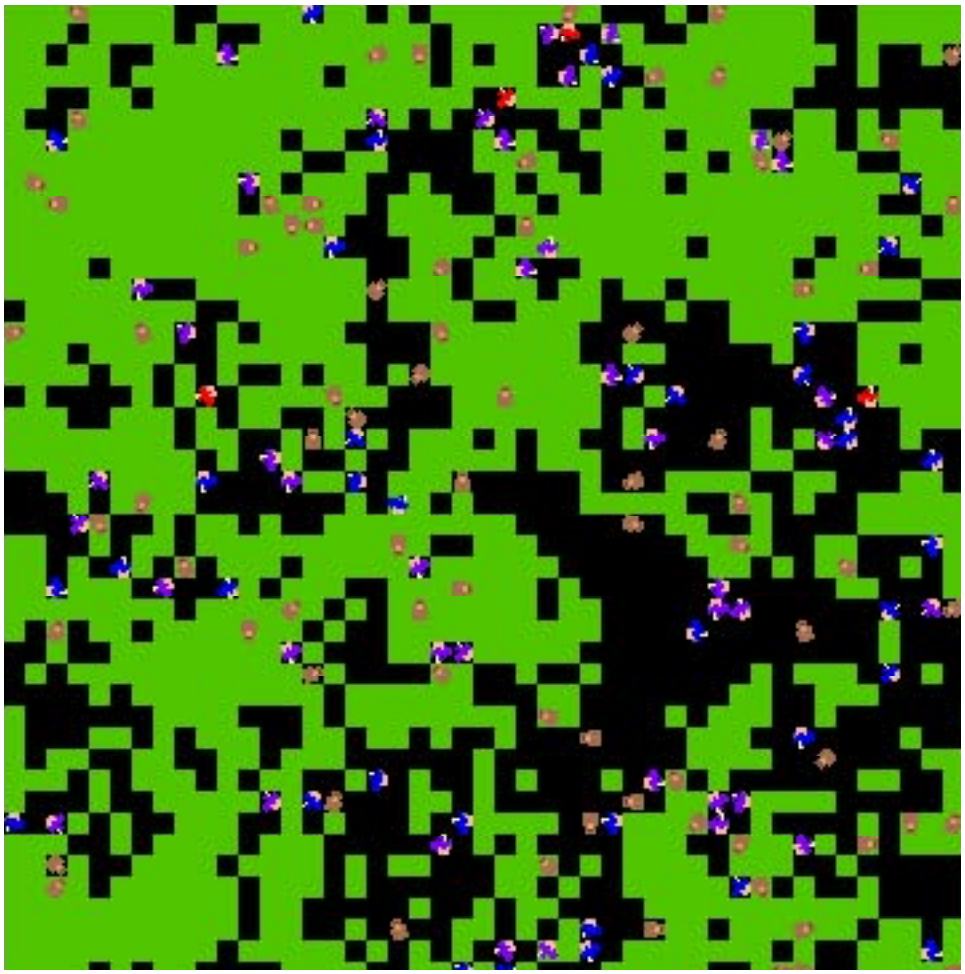
The Screen shows three groupings of trogdor. It is likely that they are families. The red agents are children, while the blue and purple are adults.

Screen Shots



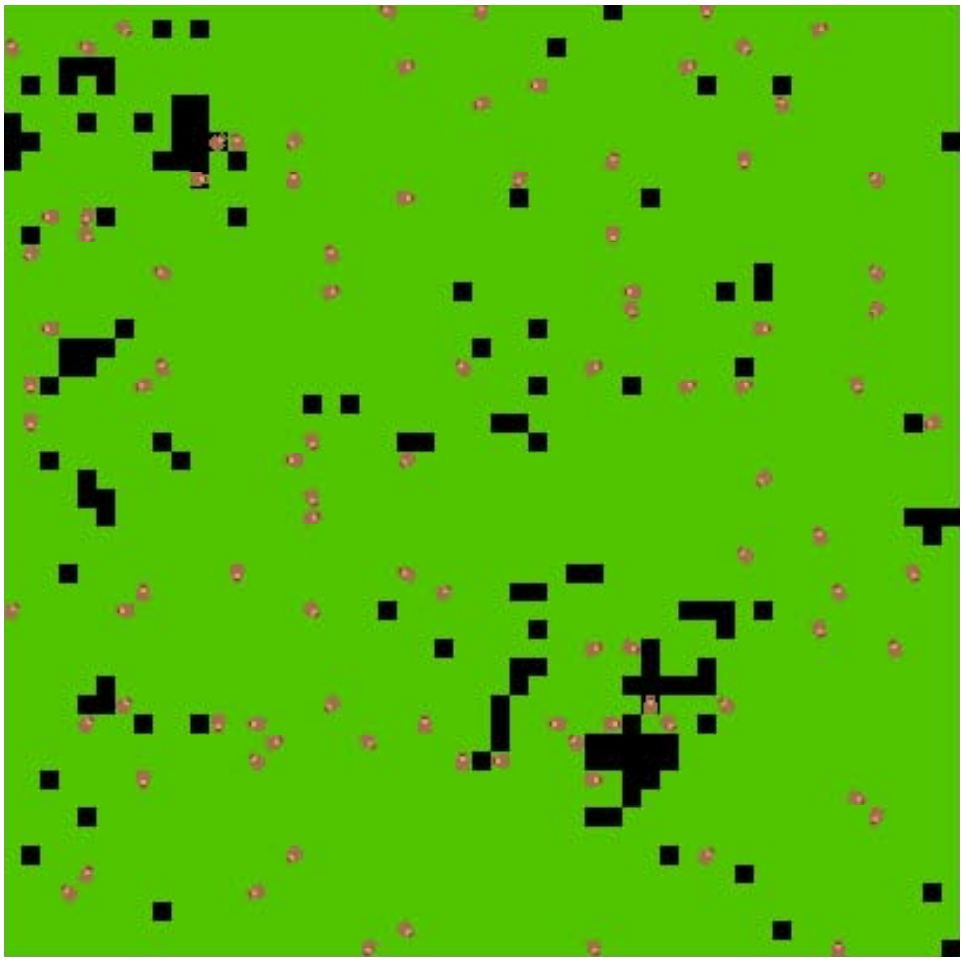
Populations with low intelligence scores do not consume resources quickly.

Screen Shots



Some populations survive and are successful...

Screen Shots



Many populations die off prematurely.