"Bees?"
A Large Scale, Co-operative Simulation Weighing Altruism and Selfishness

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Presentation Roadmap

Abstract

- Motivations: The Prisoner's Dilemna
- Attempting to investigate conditions for selfishness and altruism in a community of neural-net agents.
- Can we get co-operation from a large number of independent agents?

Hypothesis

The amount of altruism and selfishness demonstrated in NEAT-trained agents will be most affected by an individual fitness relying on overall group fitness.

The Bee model

- Many individual “bees” in a “hive”.
- Each bee is an individual NEAT agent.
- The hive has some “nectar reserves”.
- The nectar reserves are maintained by taking some nectar from the bees that brought back nectar.
- A penalty is assessed to the fitness of all bees if nectar drops below a certain level.

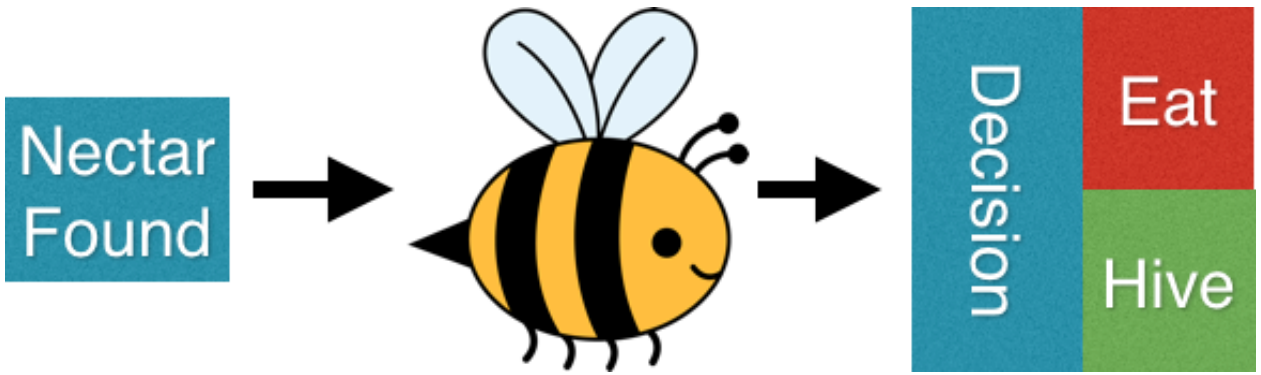
A day in the life of a bee

Every "day" in the simulation:

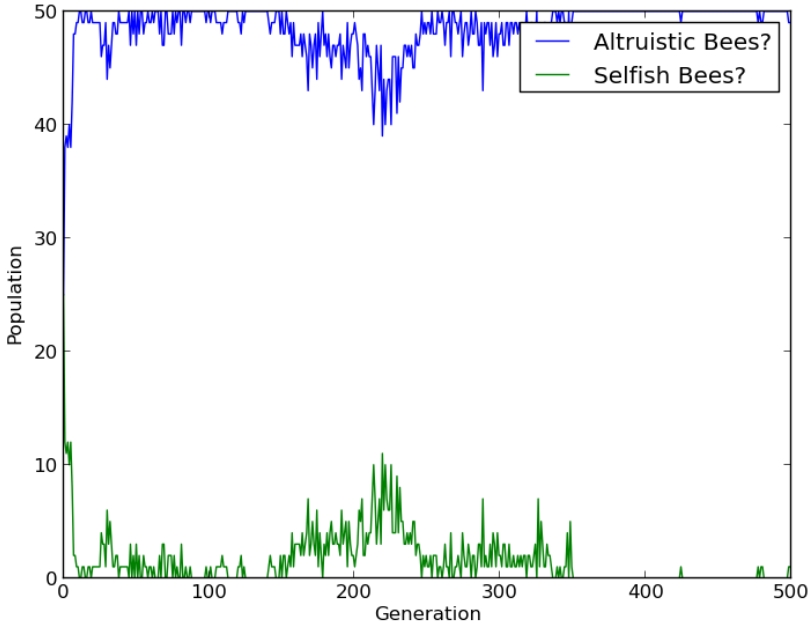
- Each bee goes out to get "nectar"
- Has the decision to eat the nectar there, or bring it back to the hive
- At the hive, the nectar brought back by the bees is shared equally between the bees that brought back nectar.

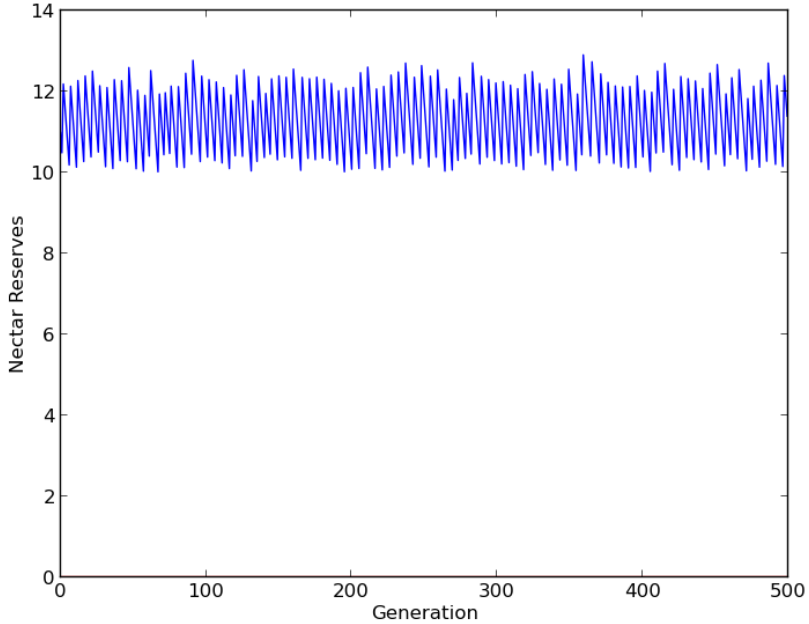
Fitness is determined by the average nectar that a bee accumulates throughout its lifetime.

NEAT Wiring

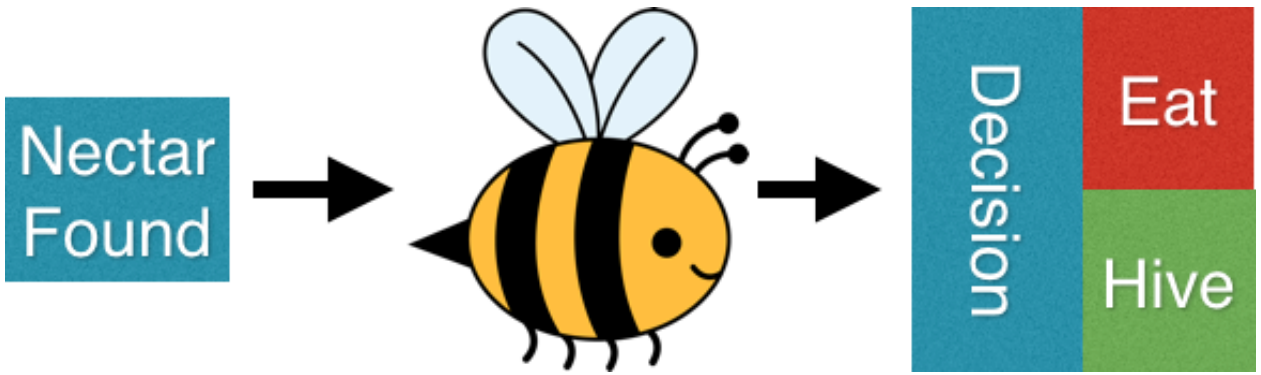


It is possible: Explicit Penalty

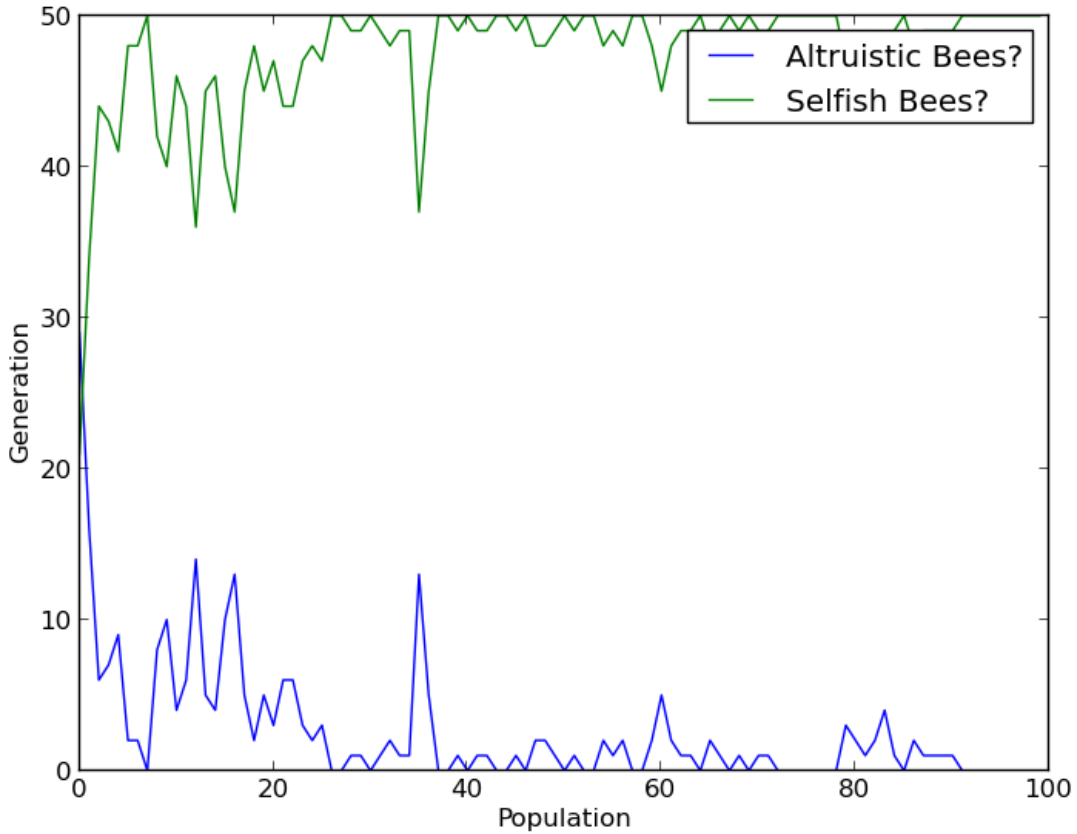




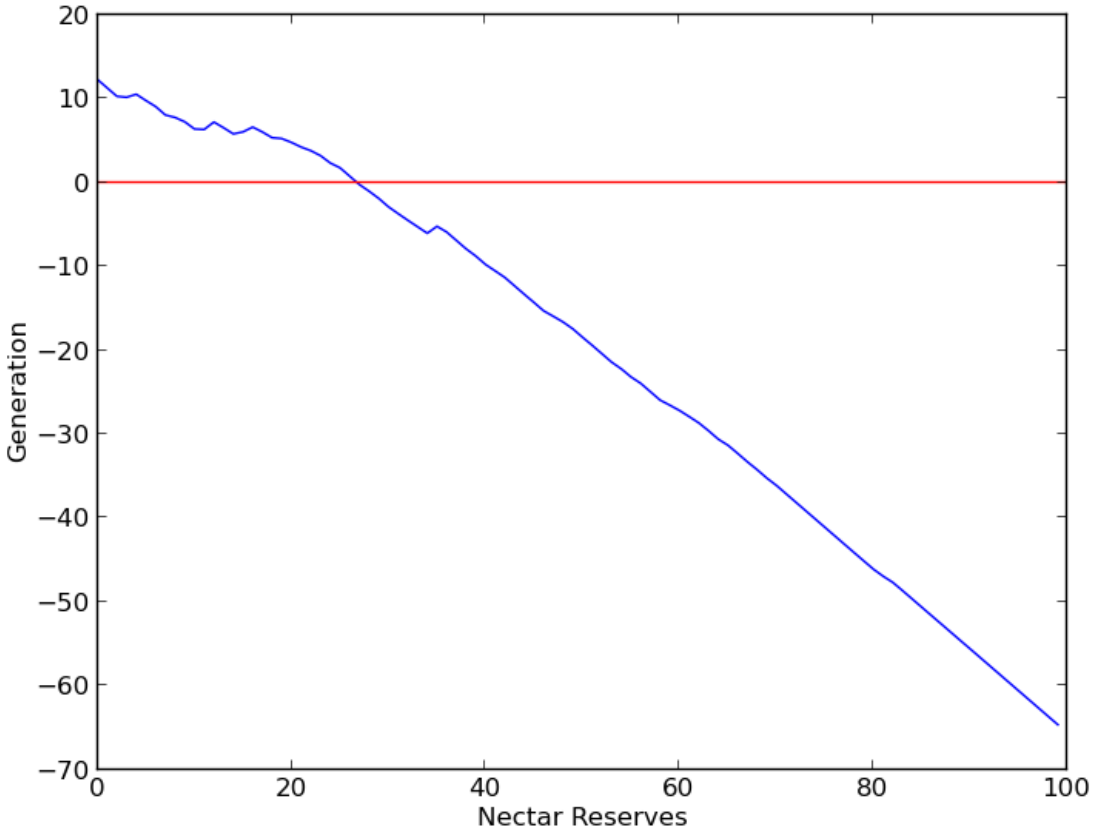
Applied to Both Bees



Hive Fitness



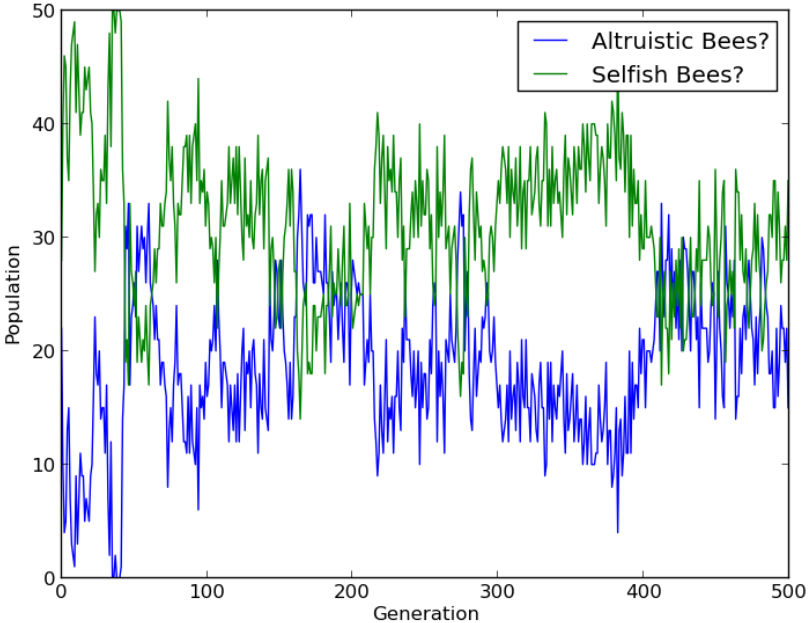
Nectar Reserves Over Time

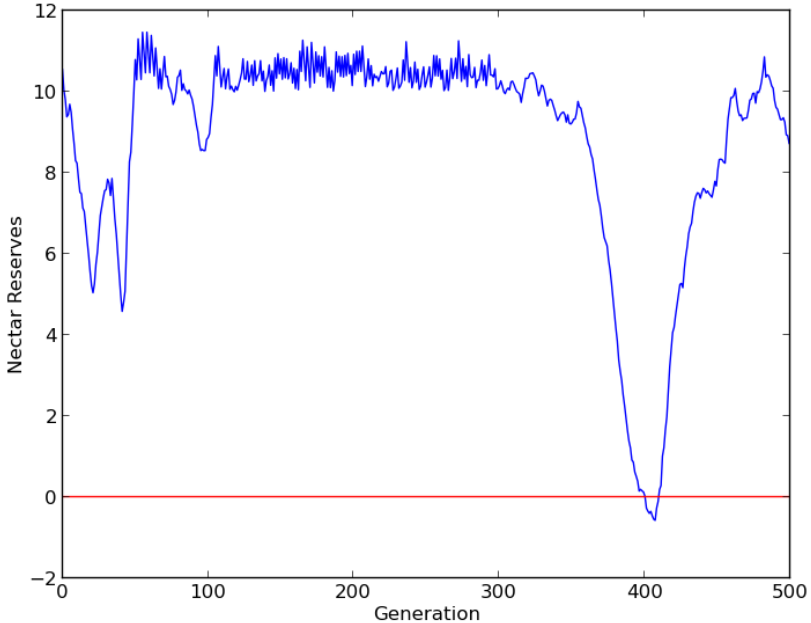


Why are the bees still selfish?

- 0.005 is still better than 0.001
- Insurance only works if there are a large number of people paying in

It is possible: Apply to only one bee





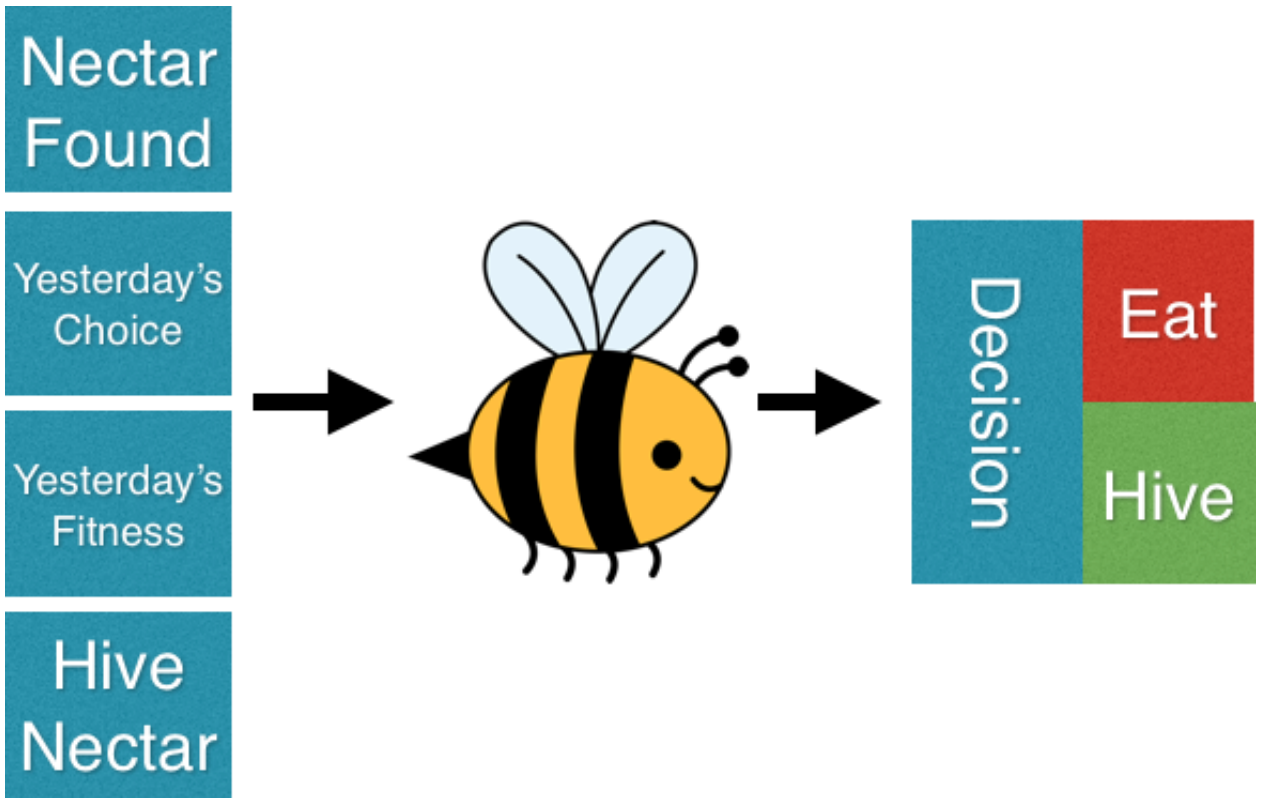
Rationale

- Bees live more than one day, why shouldn't our simulated bees?
- Drawing inspiration from evolutionary game theory
  - Iterated prisoner's dilemma.

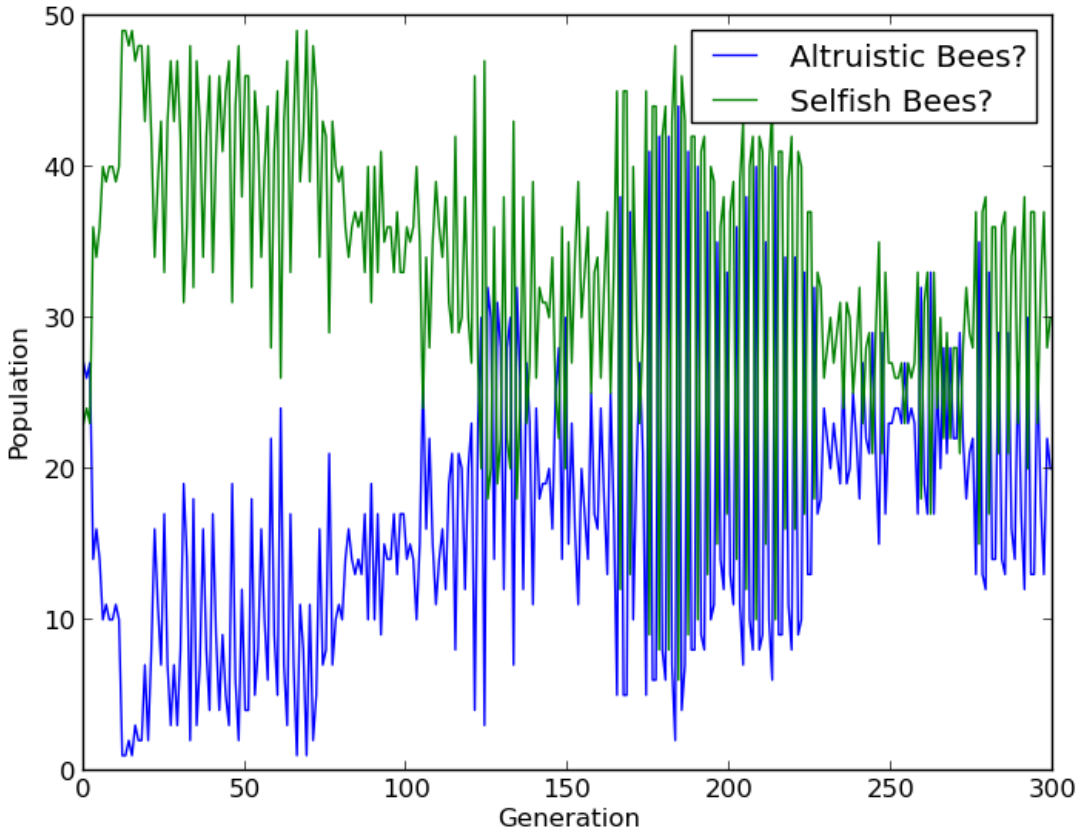
NEAT Wiring

- Bees live for a “week”
- Each “day”, they go out to find nectar
- In addition to the nectar they find, they also have a number of recurrent inputs
- Fitness calculations then proceed as normal

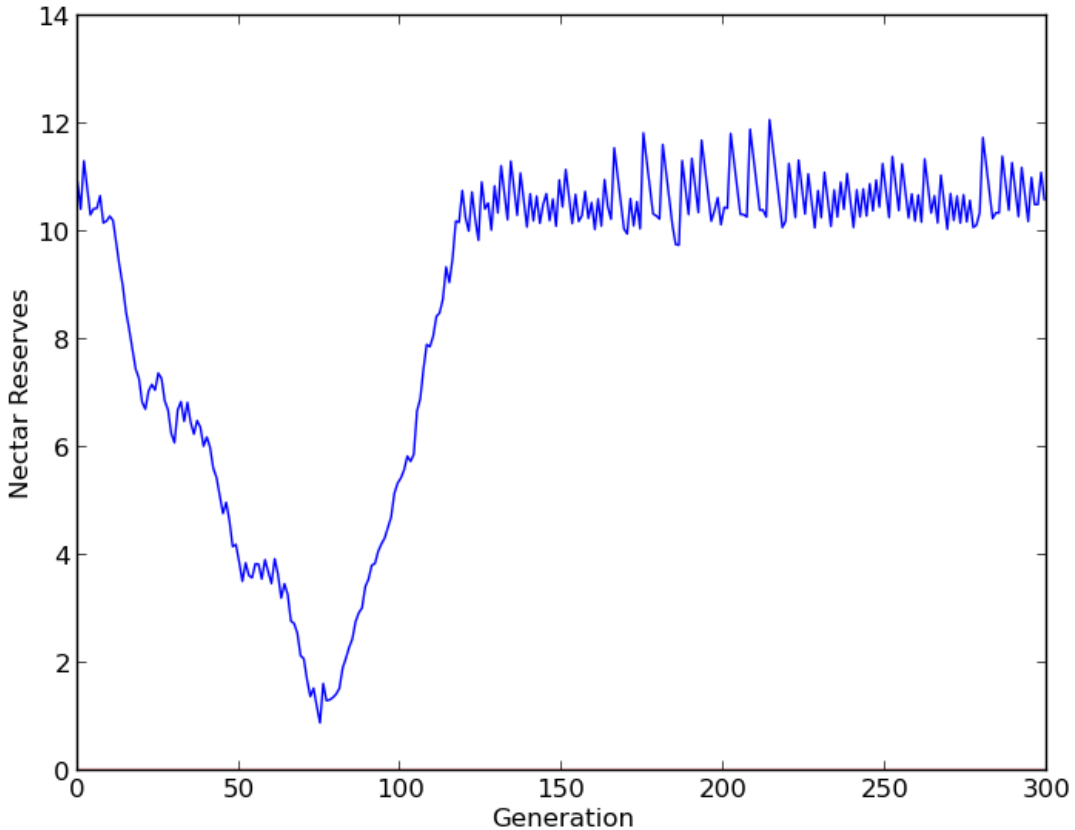
NEAT Wiring


Nectar Found
Yesterday's Choice
Yesterday's Fitness
Hive Nectar
Decision
Eat
Hive

Recurrent Bees?



Nectar Reserves Over Time



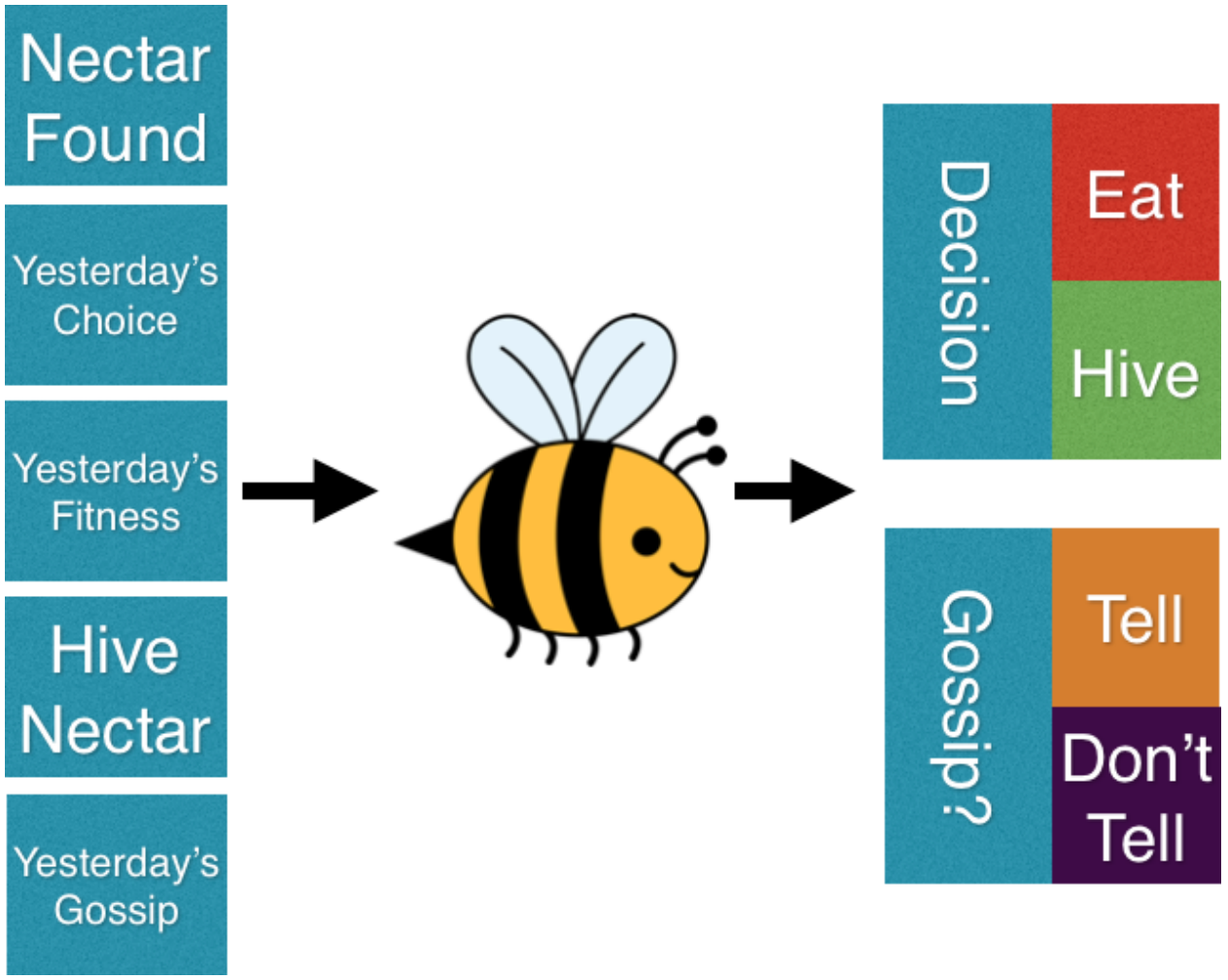
Just altruistic enough

- The majority of the bees oscillate just enough to maintain the hive.
- Relatively stable behavior.
- Does not show up in every single trial, but in the majority.

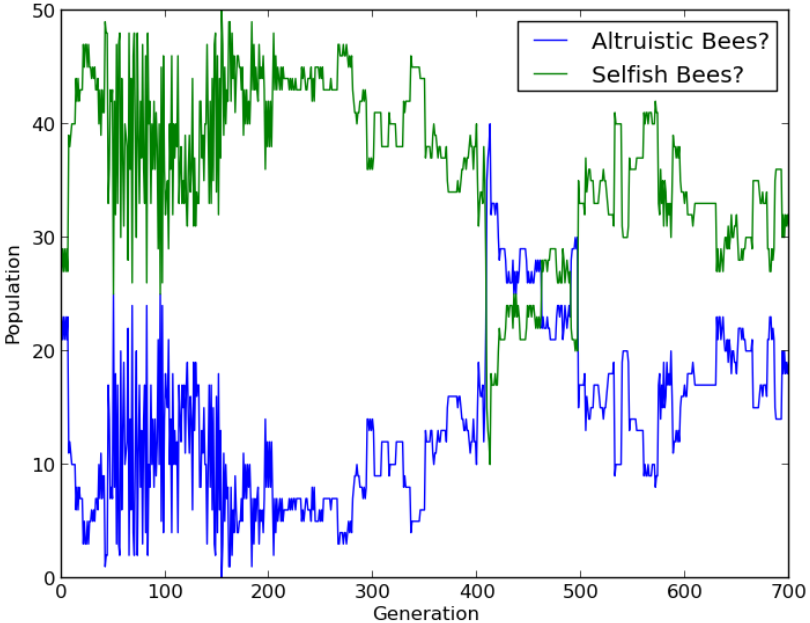
Interbee Communication

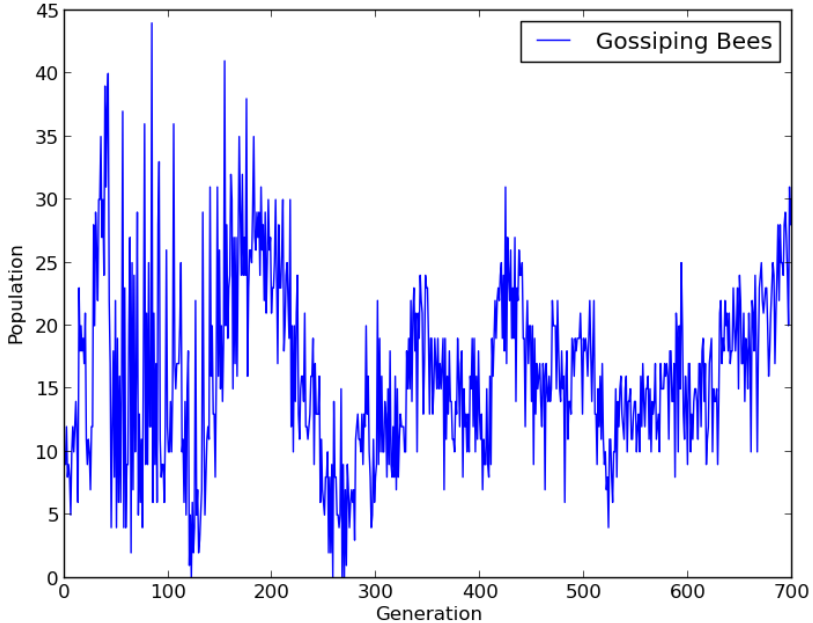
- So far, bees do not have any direct iteraction with each other.
- Second output specifies whether or not the bee wants to direct the next bee to the same nectar source.
- Nectar found by next bee depends on the last bee's decision AND the amount of nectar they had found on their turn

NEAT Wiring

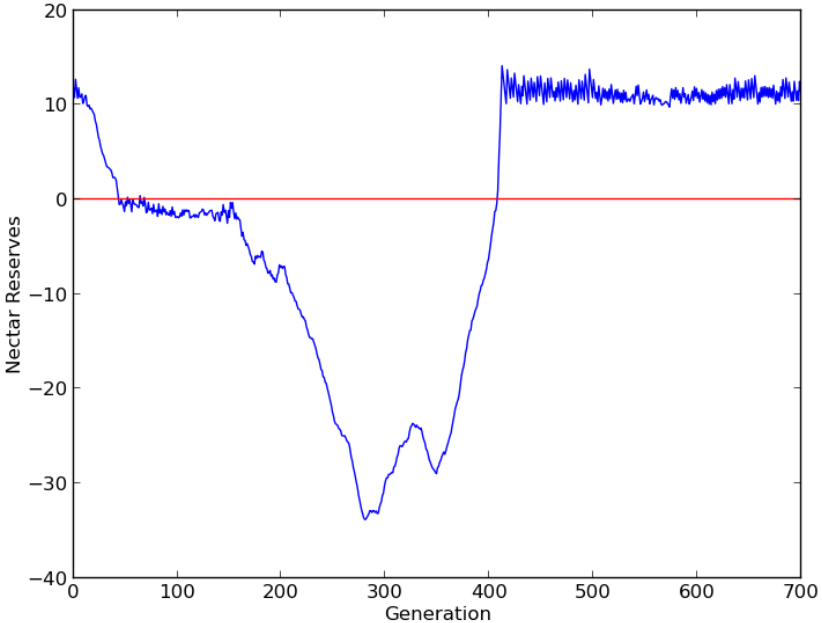

Nectar Found
Yesterday's Choice
Yesterday's Fitness
Hive Nectar
Yesterday's Gossip
Decision
Eat
Hive
Gossip?
Tell
Don't Tell

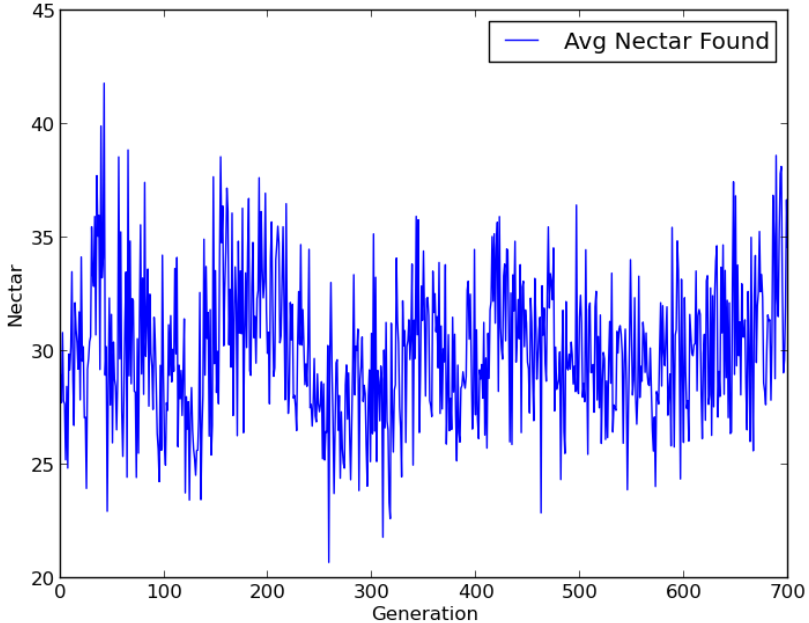
Results


Altruistic Bees?
Selfish Bees?
Population
Generation
0
10
20
30
40
50
0
100
200
300
400
500
600
700


Gossiping Bees
Population
Generation
0
5
10
15
20
25
30
35
40
45
0
100
200
300
400
500
600
700

Results


Nectar Reserves
Generation
20
10
0
−10
−20
−30
−40
0
100
200
300
400
500
600
700


Avg Nectar Found
Nectar
Generation
45
40
35
30
25
20
0
100
200
300
400
500
600
700

Discussion

- The guidance itself doesn't especially encourage bees to not make selfish decisions. It does often prompt either:
  - Selfish bees "helping" altruistic bees keep the hive fitness up
  - OR Guided bees realizing the above-average amount of found nectar is more beneficial to them if they are selfish.

Conclusions

- Unless explicity rewarded for doing so, artificial agents will not exhibit cooperation/altruism in a community.
- However, agents can learn to balance selfishness with altruism, if only to briefly combat negative effects of selfishness.
- Agents prefer a selfish nature even when fitness is negligible rather than chance an action whose fitness relies on others.

Questions?

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