Welcome to Lab #1: Tue, May 7

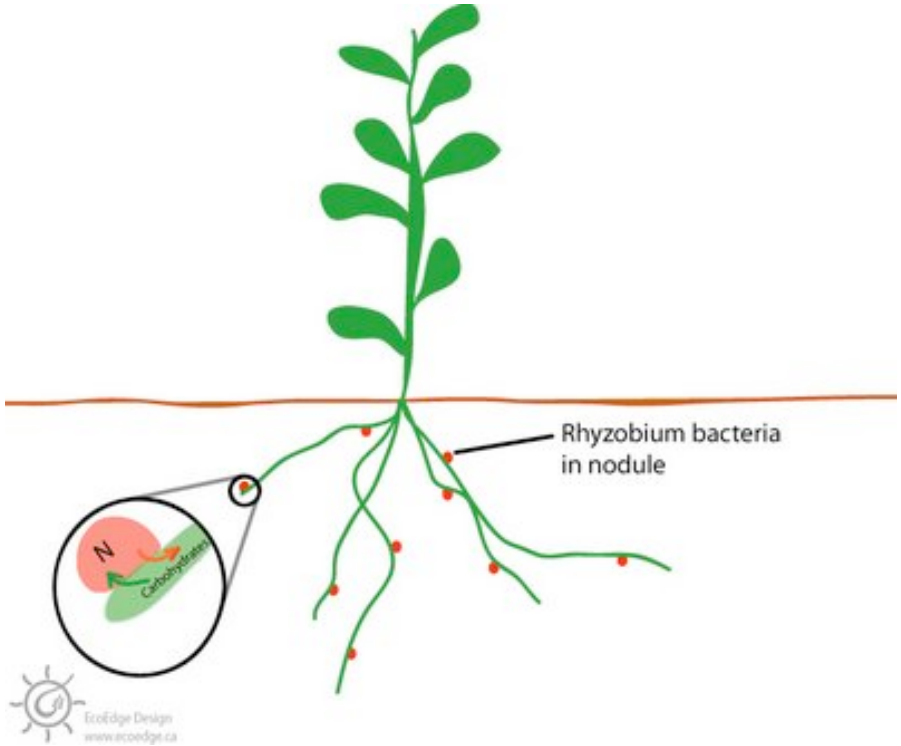
- **Feedback on Monday's programming task**

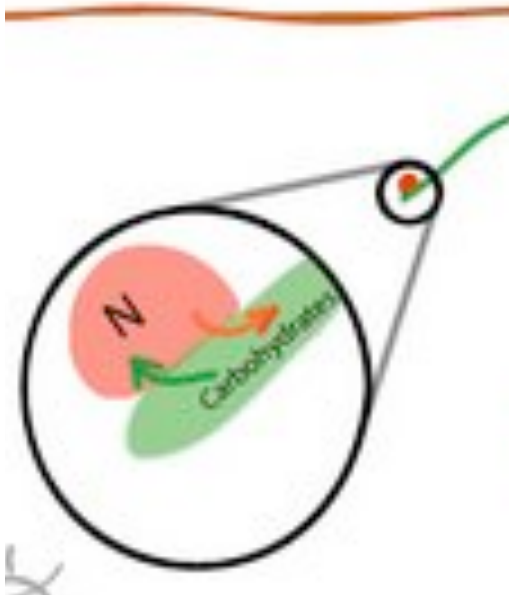
- **Let's continue with Prisoner's Dilemma**

Why More on PD?

- **It is a very simple but common model**
  - **Studies cooperation**
  - **Examples in biology**
    - » **Plant-Rhizobium mutualism**

Plant-Rhizobium Mutualism





Plant produces air and carbohydrates
Rhizobium uses carbohydrates as nutrient
Rhizobium produces nitrogen in soil
Plan uses nitrogen

Lab #1 Tuesday, May 7

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Why More on PD?

- **It is a very simple but common model**
  - **Studies cooperation**
  - **Examples in biology**
    - » **Plant-Rhizobium mutualism**
  - **Also examples in society**
    - » **can you think of any examples?**

Why Do Plant-Bacteria Cooperate?

- Why don't the plants defect on Rhizomes?
- Why don't Rhizobiums defect on plants?
- How did they come to cooperate?
  - Answer 1: Different "game"
    - » Answer: Alice plays many different opponents (Bob, Alan, etc)
    - » Answer: Alice plays each opponent unpredictable number of times
    - » Answer: Alice "remembers" playing each opponent
  - Answer 2: How?
    - » Evolution
      - Population of mixed strategies
      - Some are better, have more offspring than weaker
      - Offspring differ a little from parent sometimes
      - Population of 1 strategy evolves over time
- Can we simulate a model of this evolution of cooperation?

Evolving NIPD Strategies

- **N: different opponents**
- **I: Iterated**

Generation Loop

- **Population of different organisms**
  - » **Each has a strategy, mixed collection**
- **Organisms play k iterations, random opponents**
  - » **OrganismFitness = total payoff**
- **Fitter organisms have higher rate of replication than weaker ones**

EndLoop

Playing NIPD

1. Get an ID
2. Pick up a strategy (named by letter)
3. Find an opponent
4. Play and track fitness until we say “stop”
5. Write your fitness and strategy name where your ID is on white board
6. We will replicate fitter strategies more than weaker
   - New population
- Repeat at 1 with new population

NIPD Strategies

A. Always Cooperate
Cooperates during every round regardless of what previous moves the opponent has made.

B. Always Defect
Defects during every round regardless of what previous moves the opponent has made.

C. Tit-for-Tat
Starts off cooperating and then plays whatever move the opponent played in the previous round.

D. Pavlov
Starts off cooperating and only cooperates if both players played the same move in the previous round.

E. Mistrust
Starts off defecting and then plays whatever the opponent played in the previous round.

F. Spiteful
Starts off cooperating and defects for the remainder of the match once the opponent has defected.

G. Soft Majority Starts off cooperating and then plays each subsequent round with whatever move has been used most frequently by its opponent.
Cooperates if the opponent has cooperated and defected with equal frequency.

H. Hard Majority

- **Starts off defecting and then plays each subsequent round with whatever move has been used most frequently by its opponent. Defects if the opponent has cooperated and defected with equal frequency.**
-
- **I. Hard Tit-for-Tat**
- **Starts off cooperating and then cooperates unless the opponent has defected at least once in the last two rounds.**

What Strategy Evolved to Dominate?

Our "Winner": H. "Hard Majority"

- **Starts off defecting and then plays each subsequent round with whatever move has been used most frequently by its opponent. Defects if the opponent has cooperated and defected with equal frequency.**

We saw "population effects"

- **A small population, very noisy and random**

A Strategy that often evolves to dominate:

  - » **C. Tit-for-Tat**
  - » **Starts off cooperating and then plays whatever move the opponent played in the previous round.**
  - » **It forgives a defection after "punishing it right away"**

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Lab #2 Wrap Up

- What we learned by active learning
- How cooperation can evolve
  - Mixed strategies,
  - Multiple random interactions
  - Evolution: survival of the fittest
- Can be simulated in software too
  - http://www.christopherxjjensen.com/research/projects/online-cooperative-resource/easy-iterated-prisoners-dilemma/
  - Erik's software
    - » Evo_NIPD.py
      - Look at code to learn more Python and how to program evolution
    - » Evo_NIPD_skeleton.py (challenging!)
- Need a journal entry for today…

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Tuesday Journal Entry

Use these questions to guide today's journal entry

- **Be brief**
- **Sketch or bullets**

- **A journal is a diary**
- **Make an entry for each day (Monday, Tuesday, Weds, Thursday)**

- **Comments on evolution after having simulated it with NIPD**
  - **What are important properties of evolution?**
  - **Do you see evolution as more complex than Monday when we showed Linux example?**

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