

## PART B - DESIGNING A TREATMENT PLAN WITH TWO DRUGS

One approach to addressing the problem of acquired drug resistance is to use cocktails – administration of multiple drugs that act independently to attack the virus population.

In this problem, we use two independently-acting drugs to treat the virus. We will use this model to decide the best way of administering the two drugs. Specifically, we examine the effect of a lag time between administering the first and second drugs on patient outcomes.

Use the following parameters to initialize a `TreatedPatient`:

- `viruses`, a list of 100 `ResistantVirus` instances.
- `maxPop`, maximum sustainable virus population = 1000

Each `ResistantVirus` instance in the `viruses` list should be initialized with the following parameters:

- `maxBirthProb`, maximum reproduction probability for a virus particle = 0.1
- `cClearProb`, maximum clearance probability for a virus particle = 0.05
- `resistances`, the virus's genetic resistance to drugs in the experiment: `{'guttagonol': False, 'grimpex': False}`
- `mutProb`, probability of a mutation in a virus particle's offspring = 0.005

Run the simulation for 150 time steps before administering guttagonol to the patient. Then run the simulation for 300, 150, 75, and 0 time steps before administering a second drug, grimpex, to the patient. Finally, run the simulation for an additional 150 time steps.

For each of these 4 conditions, repeat the experiment for enough trials to get a reasonable condition, while recording the final virus populations. Use `pylab.hist()` function to plot a histogram of the final total virus populations under each condition.

[Hint: time it takes to run simulation](#)


Fill in the function `simulationTwoDrugsDelayedTreatment(numTrials)` to perform this simulation. Feel free to break down the problem into smaller subparts and define helper functions for each.

Create 4 histograms (for 300, 150, 75, and 0 time steps) and then answer the following set of questions.

### PROBLEM 1 - PERCENTAGE CURED (10/10 points)

If you consider final virus particle counts of 0-50 to be cured (or in remission), approximately what percentage of patients were cured (or in remission) at the end of the simulation?

1. delay of 2nd drug = 300

- ☒ 0 - 15% 
- ☐ 16 - 30%

- ☐ 31 - 60%
- ☐ 61 - 85%
- ☐ 86 - 100%

2. delay of 2nd drug = 150

- ☒ 0 - 30% ✓
- ☐ 31 - 60%
- ☐ 61 - 85%
- ☐ 86 - 100%

3. delay of 2nd drug = 75

- ☐ 0 - 30%
- ☒ 31 - 65% ✓
- ☐ 66 - 100%

4. delay of 2nd drug = 0

- ☐ 0 - 30%
- ☐ 31 - 65%
- ☒ 66 - 100% ✓

Check

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## PROBLEM 2 - RELATIONSHIPS (5/5 points)

What is the relationship between when drugs are applied and patients being cured?

- ☒ Applying the 2nd drug earlier means the patient is more likely to be cured. ✓
- ☐ Applying the 2nd drug later means the patient is more likely to be cured.
- ☐ Applying the 2nd drug too late means the patient will never be cured.
- ☐ None of the above.

Final Check

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## PROBLEM 3 - CHANGING MUTPROB (5/5 points)

Increasing mutProb will increase the number of cured patients.

- ☐ True
- ☒ False ✓


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## PROBLEM 4 - RELATIONSHIPS (5/5 points)

The relationship between number of cured patients and when the delay occurs is linear.

- ☐ True
- ☒ False 


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## PROBLEM 5 - VARIANCE (5/5 points)

Of the four delay values tested, which has the lowest variance?

- ☐ delay of 2nd drug = 300
- ☐ delay of 2nd drug = 150
- ☐ delay of 2nd drug = 75
- ☒ delay of 2nd drug = 0 

Final Check

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