1 Identifying Commons

In your group, brainstorm a list of as many resources as you can that would be considered a commons. Then discuss to what extent each resource on your list is relevant to sustainability.

2 Tragedy of the Commons

Suppose there are two farmers (the "players") sharing an orchard (the commons). Each farmer can choose to plant a new fruit tree, which will deplete resources of the commons, but will also produce a fruit yield for the farmer.

The yield of a single fruit tree depends on how many total trees are planted. If more trees are planted, there are fewer resources available to a single tree, so the yield of a single tree will decrease as more trees are planted.

For our example, suppose the yield of a single tree is $16 - \frac{T}{2}$ when there are T trees planted. Then the total yield of all trees combined would be $T \cdot (16 - \frac{T}{2})$. The graph of the total fruit yield for different numbers of trees is given below.

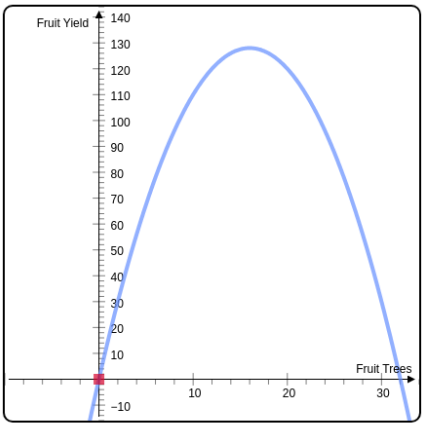

Figure: A line graph with Fruit Yield on the vertical axis and number of Fruit Trees on the horizontal axis. The line graph passes through the points $(0, 0)$ and $(32, 0)$, and has a maximum at $(16, 128)$.

1. Using the graph and the sliding point [1] , what is the total number of trees that should be planted that would result in the maximum yield of fruit? This is called the **social optimum**. ☐ ↵
2. What is the maximum fruit yield at this social optimum? ☐ ↵

Now let's determine the outcome when the orchard is managed by two farmers making decisions individually. The table below gives the payoff matrix for the game when both farmers have one tree on the orchard, where the entries are the fruit yield for each farmer. Use it to determine if the farmers will both add a tree. If they will both add a tree, select the "Add a Tree For Both" button, which will update the payoff matrix to the new scenario where both farmers now have one more tree. Continue this until you think both farmers will not add a tree, and then answer the questions. You can use the "Remove a Tree For Both" button to return to the scenario where both farmers have one less tree at any time.

💡 Curious how the payoff matrix is updated? Here are the models explained. (click to open)

Both Farmers Have 1 Tree(s)

Commons	B does not add a tree	B adds a tree
A does not add a tree	$(15, 15)$	$(14.5, 29)$
A adds a tree	$(29, 14.5)$	$(28, 28)$

Add a Tree For Both | Remove a Tree For Both

1. What number of trees will be planted total, as predicted by game theory? ☐ ↵
2. What is the fruit yield for this number of trees? ☐ ↵
3. Discuss the relationship between the social optimum outcome and the actual outcome under this model.

New Variation

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1. Choose new variations of the problem with the "New Variation" button. Complete at least 3 different versions, and write down a summary of the relationship between the social optimum outcome and the actual outcome predicted by game theory when managing a commons.

3 Managing the Commons

In your group, brainstorm some ideas for how you think the tragedy of the commons might be avoided.

- How might the commons itself impact your solution?
- How might the scale of the individuals involved impact your solution?

Then read through and discuss the brief summaries of some solutions that have been proposed and used in different contexts.

Remark 3.1 Managing the Commons. The following are examples of approaches to avoiding the tragedy of the commons.

- **Privatization**. Make the commons no longer a shared resource. Divide the commons into parts, and give individuals ownership over those parts.
- **Regulation**. Establish individual limits (legally or socially) on the use of the commons based on the social optimum use.
- **Cap and Trade**. Establish an upper limit on the overall use of the commons based on the social optimum use. Individuals can buy and trade permits for the use of the commons up to a specified level. The number of permits issued is limited to ensure the upper limit is not exceeded.
- **Revenue-Neutral Use Tax**. Individual users of the commons pay a tax proportional to how much they use the commons. The tax is collected and then re-distributed evenly to all individuals using the commons.