MA 266 Project 3

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SET-UP We will be using the pplane8 tool to figure out the prey-predator model of a aphids (x) and ladybugs (y) The model equation is

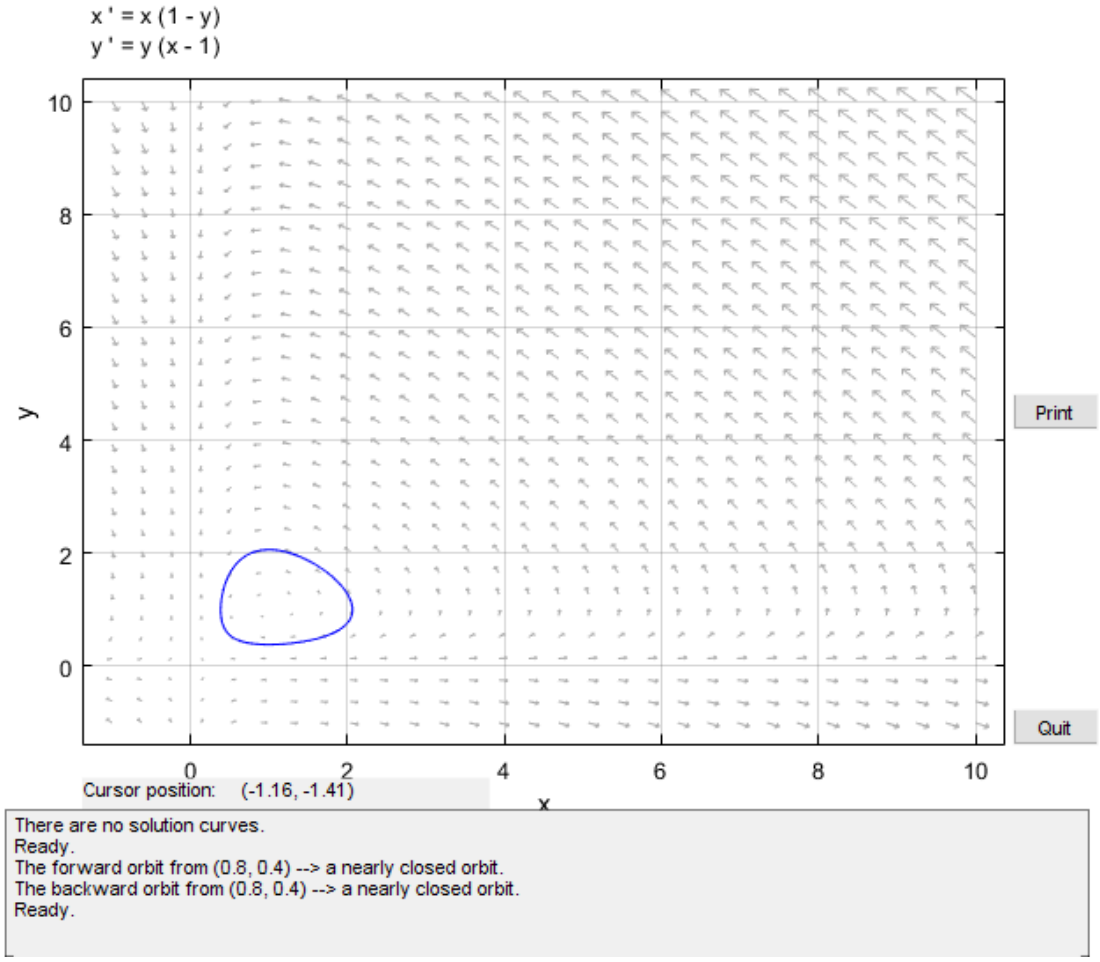
$$dx/dt = x(1-y)$$

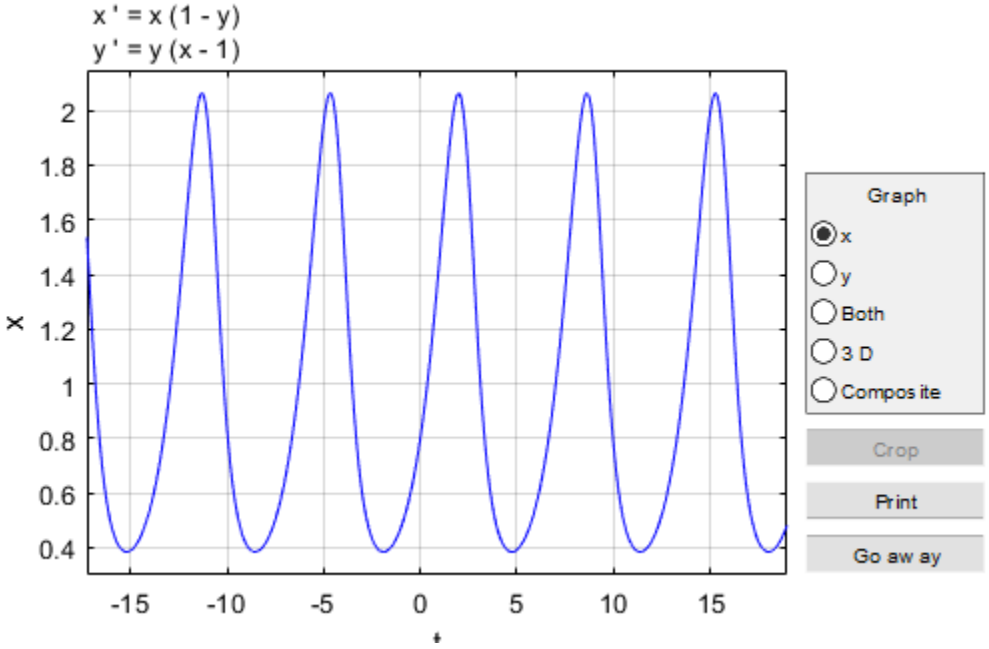
$$dy/dt = y(x-1)$$

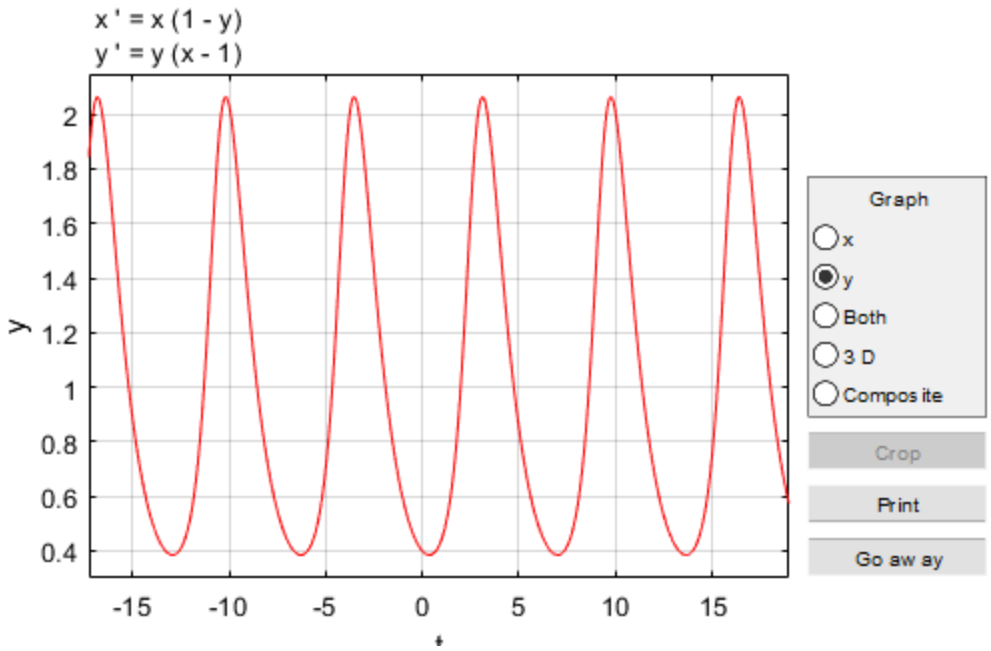
$$x(0) = 800000, y(0) = 400000$$

QUESTION 1: Use pplane8 to plot the trajectory through $(0.8, 0.4)$. As t increases, describe what happens to each population. Is the aphid population ever smaller than 300,000? Are the aphids ever eradicated? Does the ladybug population ever exceed 2 million?

```
openfig('pplane8_figure1.fig');
openfig('pplane8_x_vs_t.fig');
openfig('pplane8_y_vs_t.fig');
```


x ' = x (1 - y)
y ' = y (x - 1)
y
x
Print
Quit
Cursor position: (-1.16, -1.41)
There are no solution curves.
Ready.
The forward orbit from (0.8, 0.4) --> a nearly closed orbit.
The backward orbit from (0.8, 0.4) --> a nearly closed orbit.
Ready.


x ' = x (1 - y)
y ' = y (x - 1)
x
t
Graph
x
y
Both
3 D
Compos ite
Crop
Print
Go aw ay



ANSWER: The plot of the trajectory at point $(0.8, 0.4)$ is a closed oval As t increases each population increases as well; however the more larger the population of aphids are the smaller the ladybugs and vice versa.

The population of aphids never go below 300000 and they are never eradicated. There is a time when ladybugs exceed 2|M|.

QUESTION 2: A fellow farmer suggests that she use pesticide to kill the aphids. She is reluctant because it also kills the helpful ladybugs and she prefers to have some ladybugs remaining to eat other destructive insects. If she were to use a pesticide, the growth rates would then become

$$dx/dt = x(1-y) - sx(*)$$

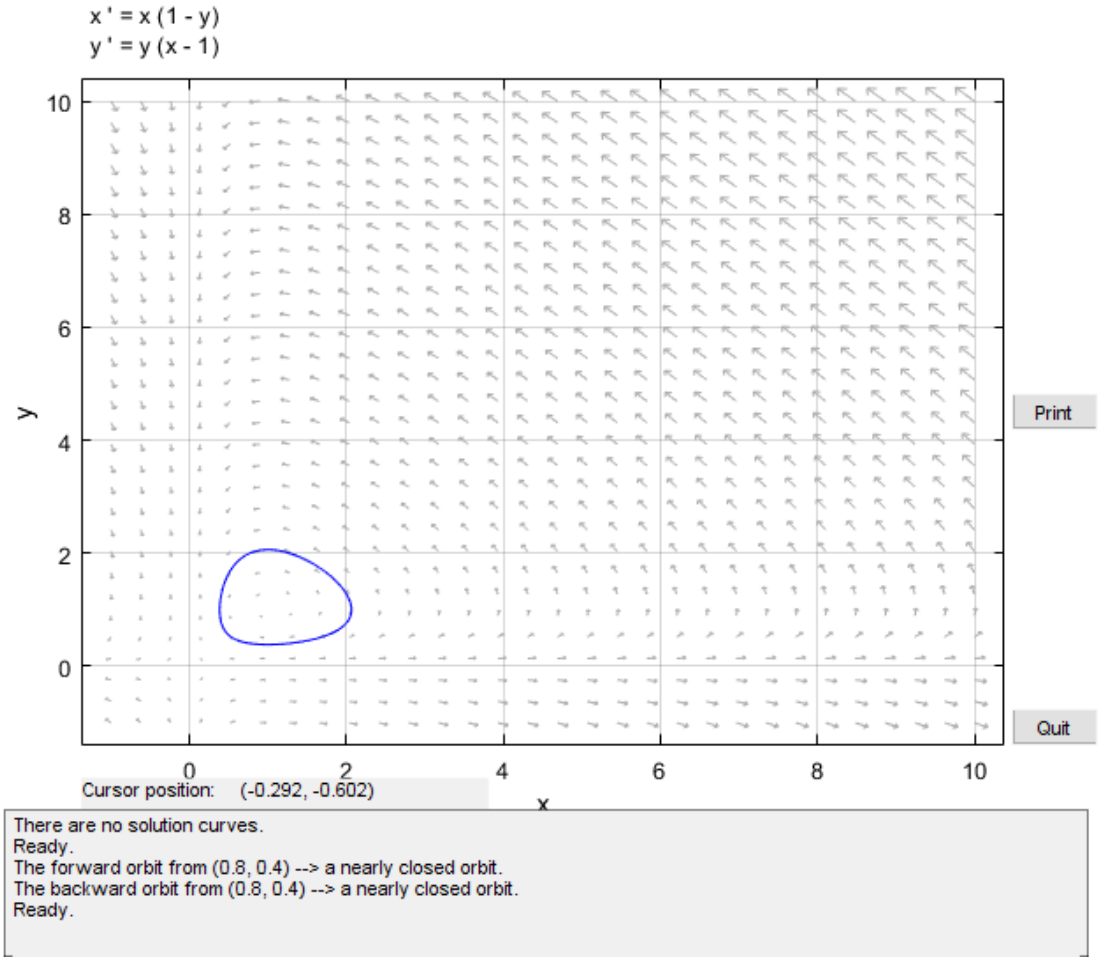
$$dy/dt = y(x-1) - sy(*)$$

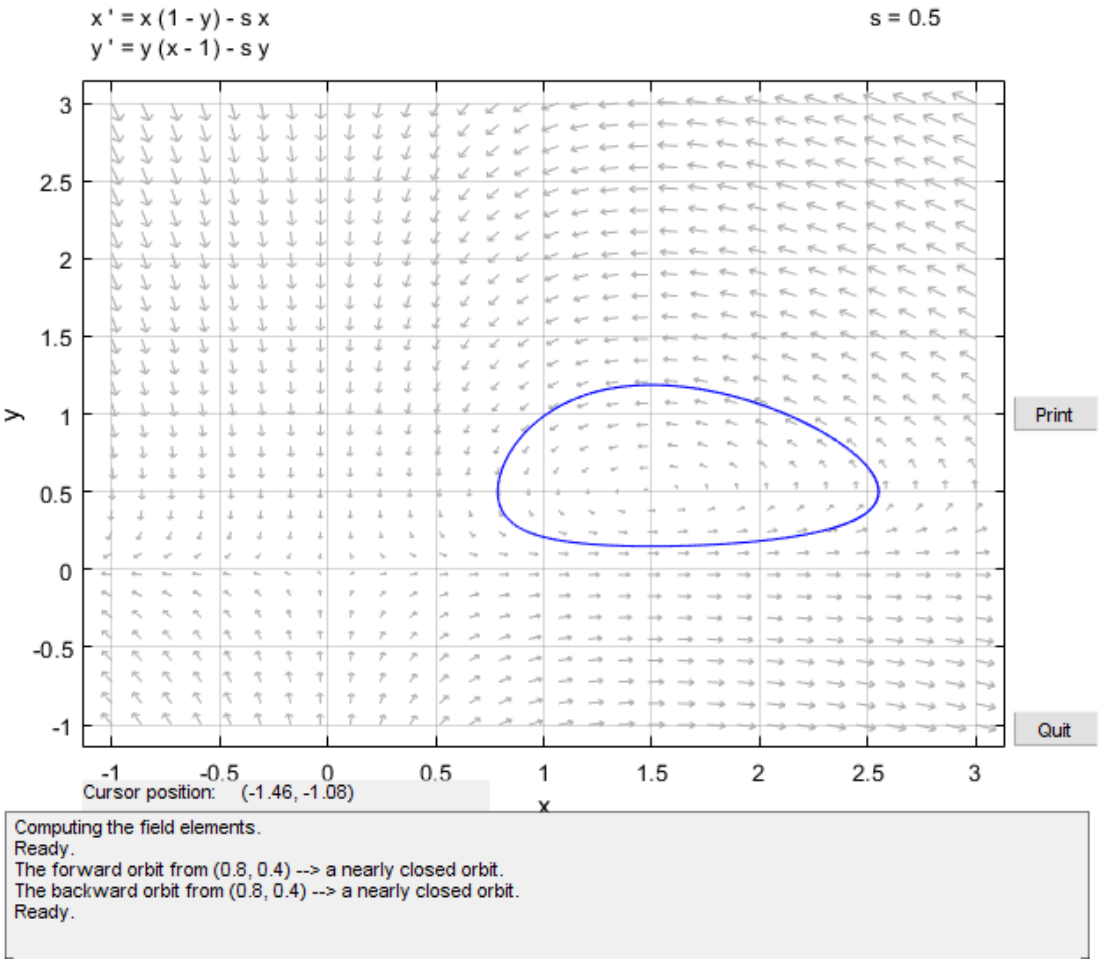
where $s >= 0$ is a measure of the "strength" of the pesticide – the larger the s, the stronger the pesticide. Currently there are only two commercially available strengths: $s = 0.5$ and $s = 0.75$ Plot the trajectories for the new system of equations (*) with these values of s. Will the aphids ever be totally eliminated?

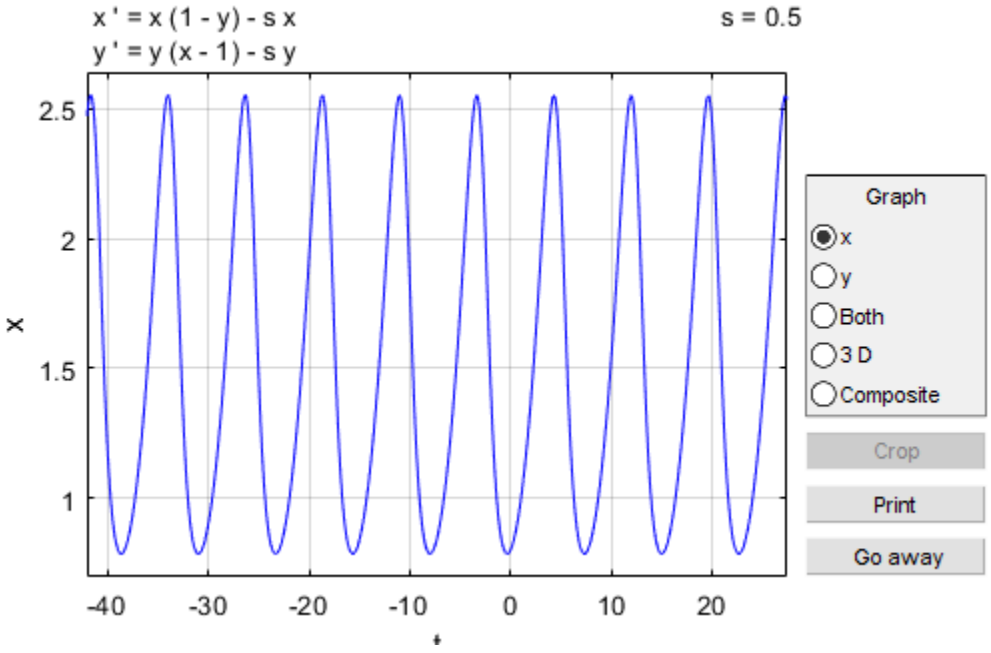
ANSWER:

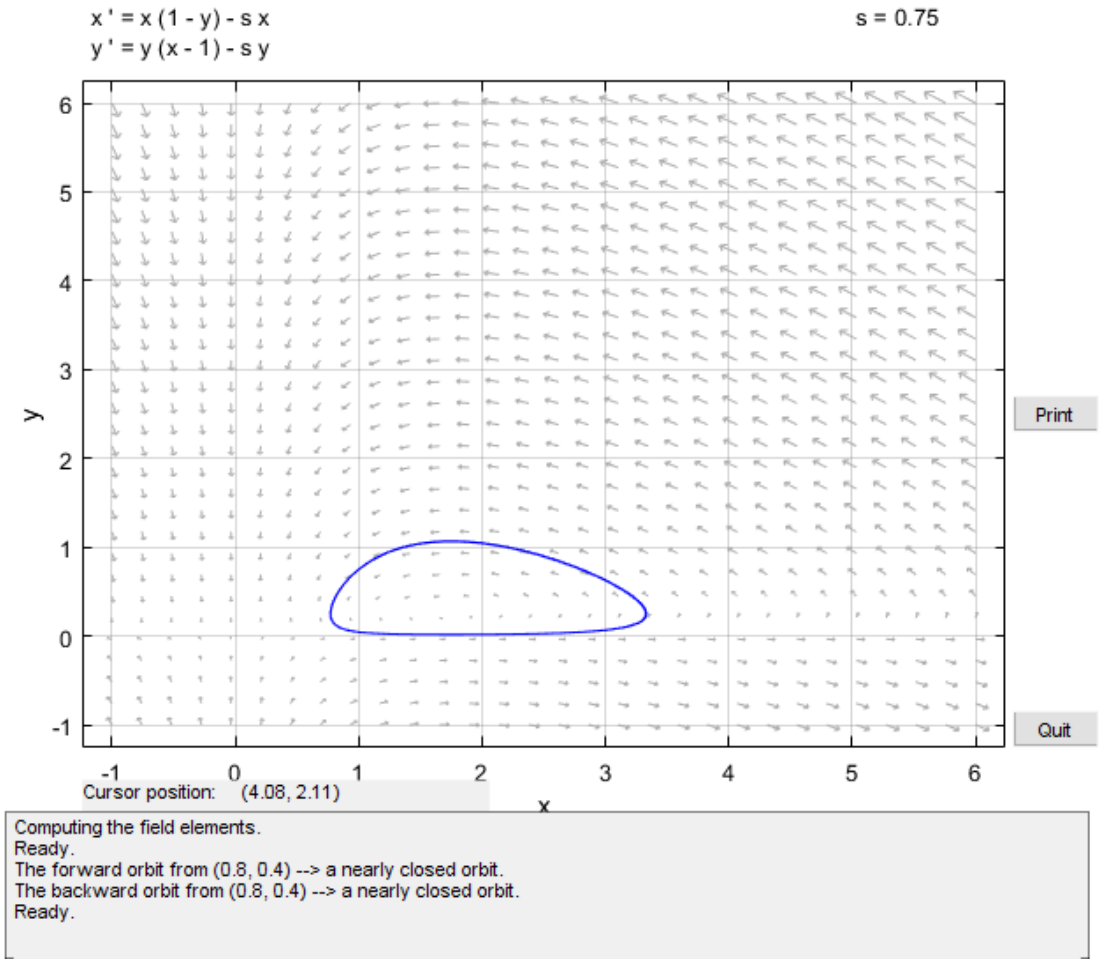
- When $s = 0.5$: Aphids cannot be eradicated.
- When $s = 0.75$: Aphids cannot be eradicated.

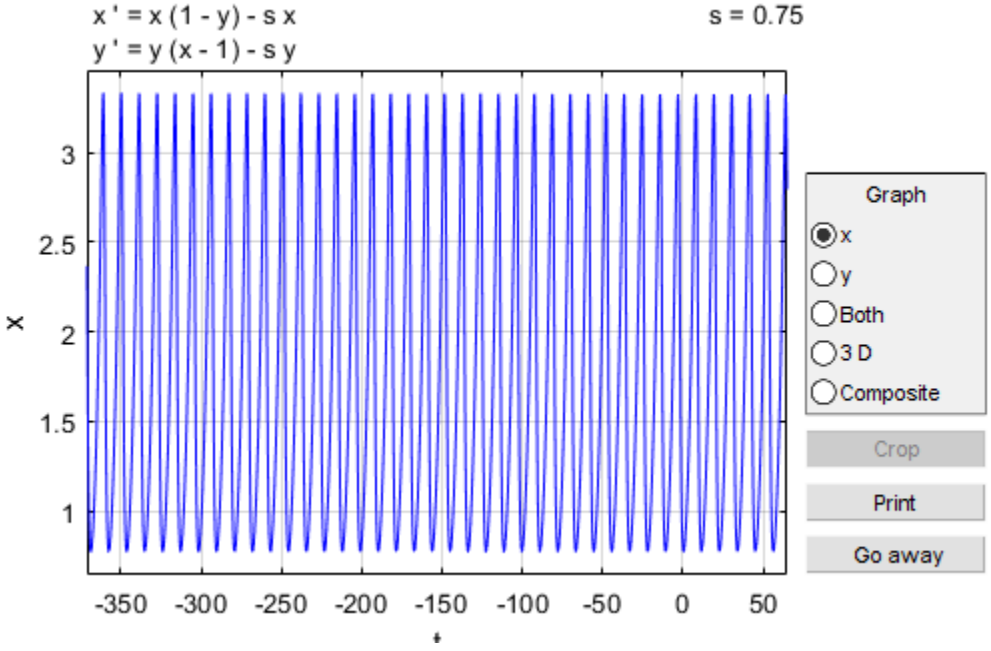
```
openfig('pplane8_figure2.fig');
openfig('s_0.5.fig');

openfig('pplane8_figure4.fig');
openfig('s_0.75.fig');
```


x ' = x (1 - y)
y ' = y (x - 1)
10
8
6
4
2
0
y
0
2
4
6
8
10
x
Print
Quit
Cursor position: (-0.292, -0.602)
There are no solution curves.
Ready.
The forward orbit from (0.8, 0.4) --> a nearly closed orbit.
The backward orbit from (0.8, 0.4) --> a nearly closed orbit.
Ready.


x ' = x (1 - y) - s x
y ' = y (x - 1) - s y
s = 0.5
Print
Quit
Cursor position: (-1.46, -1.08)
Computing the field elements.
Ready.
The forward orbit from (0.8, 0.4) --> a nearly closed orbit.
The backward orbit from (0.8, 0.4) --> a nearly closed orbit.
Ready.


x ' = x (1 - y) - s x
y ' = y (x - 1) - s y
s = 0.5
Graph
x
y
Both
3 D
Composite
Crop
Print
Go away


x ' = x (1 - y) - s x
y ' = y (x - 1) - s y
s = 0.75
Print
Quit
Cursor position: (4.08, 2.11)
Computing the field elements.
Ready.
The forward orbit from (0.8, 0.4) --> a nearly closed orbit.
The backward orbit from (0.8, 0.4) --> a nearly closed orbit.
Ready.

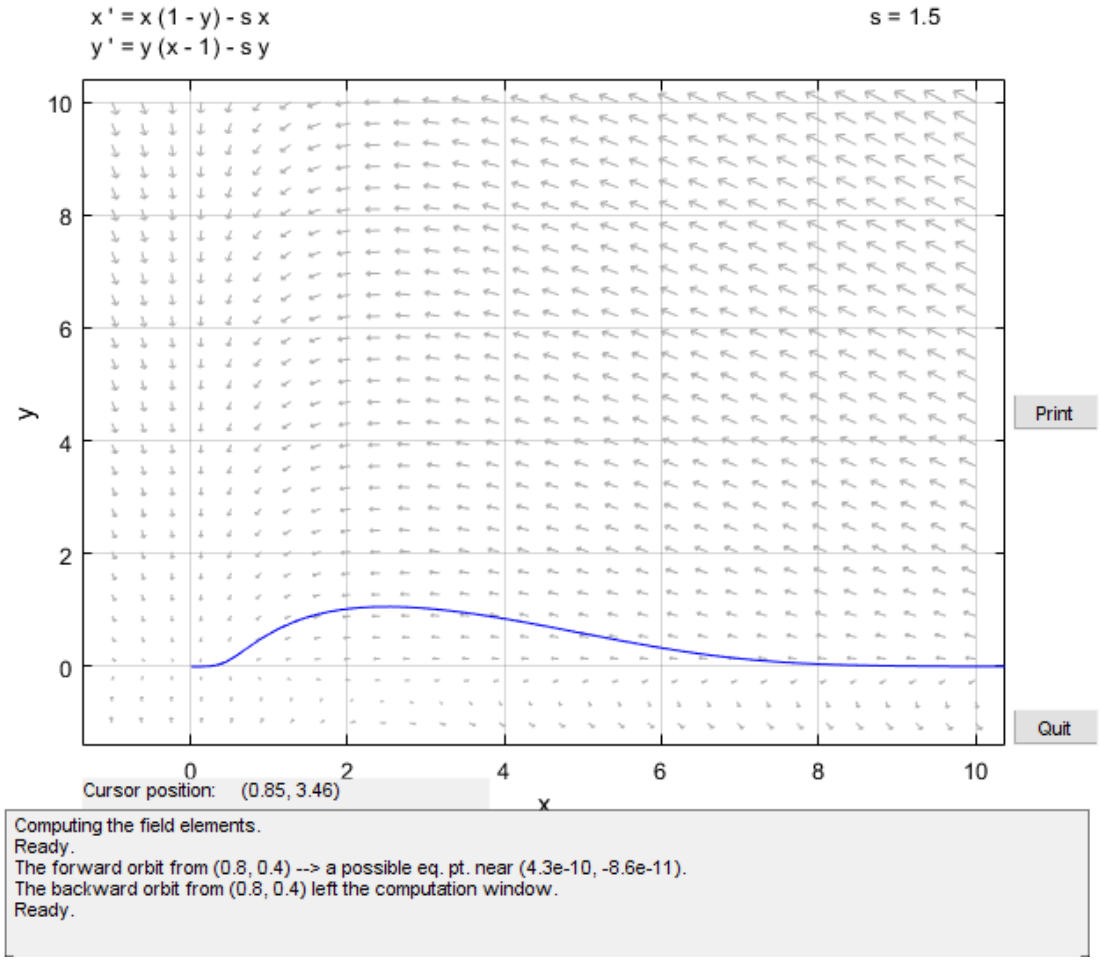

x ' = x (1 - y) - s x
y ' = y (x - 1) - s y
s = 0.75
Graph
x
y
Both
3 D
Composite
Crop
Print
Go away

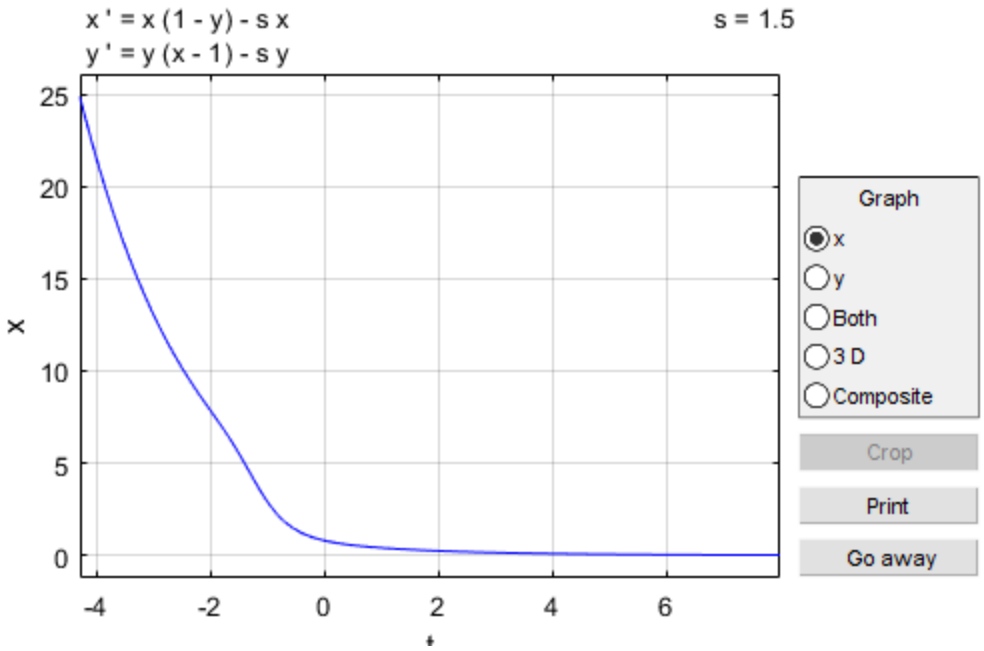
QUESTION 3: If she knows her crops will survive if the aphid population never exceeds 2.6 million, which strength (if any) would you recommend she use: s = 0.0 (no pesticide), $s = 0.5, s = 0.75$?

ANSWER: Examining the figures of the population of aphids by time when using the pesticide of $s = 0.5, 0.75$, I would recommend $s = 0.5$ since the population of aphids do not surpass 2.75 by using that one.

QUESTION 4: By special permission, she could get a pesticide with the maximum strength of $s = 1.5$. Plot this trajectory. What happens to the ladybugs and aphids if she uses this pesticide?

```
openfig('pplane8_figure3.fig');
openfig('s_1.5.fig');
```





ANSWER: The population of aphids asymptote to 0 making it nearly possible to eradicate the ahpids.

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