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CS1010E Practice Exercise: Temperature Distribution

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Temperature Distribution

A metal plate represented by a n-by-n grid is heated at it's four edges at a constant temperature t. To compute the temperature of each internal grid cell on the metal plate, simply take the average of the neighboring four grid cells located at the top, bottom, left and right. An example is shown below for a n=6 plate that is initially heated at the edges with temperature t=5.

Averaging the internal grid cells above produces the following new values in iteration 1 (note the use of integer division):

5	5		5		5		5		5
5	(5+5+0+0)/4=2	(5+0+0+0)/4=1	(5+0+0+0)/4=1	(5+5+0+0)/4=2	5
5	(5+0+0+0)/4=1	(0+0+0+0)4=0	(0+0+0+0)/4=0	(5+0+0+0)/4=1	5
5	(5+0+0+0)/4=1	(0+0+0+0)4=0	(0+0+0+0)/4=0	(5+0+0+0)/4=1	5
5	(5+5+0+0)/4=2	(5+0+0+0)/4=1	(5+0+0+0)/4=1	(5+5+0+0)/4=2	5
5	5		5		5		5		5

Averaging the internal grid cells above produces the following new values in iteration 2:

Averaging the internal grid cells above produces the following new values in iteration 3:

Averaging the internal grid cells above produces the following new values in iteration 4:

Notice that the plate temperature no longer changes, i.e. the system has reached steady state at iteration 4.

Write a program that reads the plate dimension n and temperature t, and determines the iteration at which steady-state occurs. Assume that $3 \leq n \leq 10$ and $0 < t < 1000$.

Sample Runs

The following are sample runs of the program. User input is <u>underlined</u>. Ensure that the last line of output is followed by a newline character.

- Sample run #1:

```
Enter n: 6
Enter t: 5
Steady state iteration: 4
```

- Sample run #2:

```
Enter n: 6
Enter t: 50
Steady state iteration: 17
```

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