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 Jan Roubos (Sponsor) 20★  
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--- Day 11: Dumbo Octopus ---

You enter a large cavern full of rare bioluminescent **dumbo octopuses**! They seem to not like the Christmas lights on your submarine, so you turn them off for now.

There are 100 octopuses arranged neatly in a 10 by 10 grid. Each octopus slowly gains energy over time and flashes brightly for a moment when its energy is full. Although your lights are off, maybe you could navigate through the cave without disturbing the octopuses if you could predict when the flashes of light will happen.

Each octopus has an energy level - your submarine can remotely measure the energy level of each octopus (your puzzle input). For example:

```
5483143223
2745854711
5264556173
6141336146
6357385478
4167524645
2176841721
6882881134
4846848554
5283751526
```

The energy level of each octopus is a value between `0` and `9`. Here, the top-left octopus has an energy level of `5`, the bottom-right one has an energy level of `6`, and so on.

You can model the energy levels and flashes of light in steps. During a single step, the following occurs:

- First, the energy level of each octopus increases by `1`.
- Then, any octopus with an energy level greater than `9` flashes. This increases the energy level of all adjacent octopuses by `1`, including octopuses that are diagonally adjacent. If this causes an octopus to have an energy level greater than `9`, it also flashes. This process continues as long as new octopuses keep having their energy level increased beyond `9`. (An octopus can only flash at most once per step.)
- Finally, any octopus that flashed during this step has its energy level set to `0`, as it used all of its energy to flash.

Adjacent flashes can cause an octopus to flash on a step even if it begins that step with very little energy. Consider the middle octopus with `1` energy in this situation:

```
Before any steps:
11111
19991
19191
19991
11111

After step 1:
34543
40004
50005
40004
34543

After step 2:
45654
51115
61116
51115
45654
```

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An octopus is highlighted when it flashed during the given step.

Here is how the larger example above progresses:

Before any steps:

5483143223  
2745854711  
5264556173  
6141336146  
6357385478  
4167524645  
2176841721  
6882881134  
4846848554  
5283751526

After step 1:

6594254334  
3856965822  
6375667284  
7252447257  
7468496589  
5278635756  
3287952832  
7993992245  
5957959665  
6394862637

After step 2:

8807476555  
5089087054  
8597889608  
8485769600  
8700908800  
6600088989  
6800005943  
0000007456  
9000000876  
8700006848

After step 3:

0050900866  
8500800575  
9900000039  
9700000041  
9935080063  
7712300000  
7911250009  
2211130000  
0421125000  
0021119000

After step 4:

2263031977  
0923031697  
0032221150  
0041111163  
0076191174  
0053411122  
0042361120  
5532241122  
1532247211  
1132230211

After step 5:

4484144000  
2044144000  
2253333493  
1152333274  
1187303285  
1164633233  
1153472231  
6643352233  
2643358377

```
2643358322
2243341322
```

```
After step 6:
5595255111
3155255222
3364444605
2263444496
2298414396
2275744344
2264583342
7754463344
3754469433
3354452433
```

```
After step 7:
6707366222
4377366333
4475555827
3496655709
3500625609
3509955566
3486694453
8865585555
4865580644
4465574644
```

```
After step 8:
7818477333
5488477444
5697666949
4608766830
4734946730
4740097688
6900007564
0000009666
8000004755
6800007755
```

```
After step 9:
```

After step 10, there have been a total of `204` flashes. Fast forwarding,  
the same configuration every 10 steps:

```
6900000080
5840000082
5858000093
6962400000
8021250009
2221130009
6111130007
```

After step 20:

3936556452  
5686556806  
4496555690  
4448655580  
4456865570  
5680086577  
7000009896  
0000000344  
6000000364  
4600009543

After step 30:

0643334118  
4253334611  
3374333458  
2225333337  
2229333338  
2276733333  
2754574565  
5544458511  
9444447111  
7944446119

After step 40:

6211111981  
0421111119  
0042111115  
0003111115  
0003111116  
0065611111  
0532351111  
3322234597  
2222222976  
222222762

After step 50:

9655556447  
4865556805  
4486555690  
4458655580  
4574865570  
5700086566  
6000009887  
8000000533  
6800000633  
5680000538

After step 60:

2533334200  
2743334640  
2264333458  
2225333337  
2225333338  
2287833333  
3854573455  
1854458611  
1175447111  
1115446111

After step 70:

8211111164  
0421111166  
0042111114  
0004211115  
0000211116  
0065611111  
0532351111  
7322235117  
5722223475

```
5722223475
4572222754
```

After step 80:

```
1755555697
5965555609
4486555680
4458655580
4570865570
5700086566
7000008666
0000000990
0000000800
0000000000
```

After step 90:

At step 100, there have been a total of **1656** flashes.

Starting energy levels of the dumbo octopuses in your cavern, starting at a brightness of zero, will flash after the following number of steps:

```
2222433338
2287833333
2854573333
4854458333
3387777777
```

Your puzzle answer was **1691**.

Two ---

```
3333333333
```

It seems like the individual flashes aren't bright enough to navigate.

However, you might have a better option: the flashes seem to be

syncing!

```
0749766918
0053976933
0004297822
0004229892
0053222877
0532222966
9322228966
7922286866
6789998766
```

In the example above, the first time all octopuses flash simultaneously is

```
step 195!
```

```
After step 193:
5877777777
8877777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777
7777777777
```

```
After step 194:
6988888888
9988888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
8888888888
```

```
After step 195:
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
0000000000
```

If you can calculate the exact moments when the octopuses will all flash simultaneously, you should be able to navigate through the cavern. What is the first step during which all octopuses flash?

Your puzzle answer was 216.

Both parts of this puzzle are complete! They provide two gold stars: \*\*

At this point, you should [return to your Advent calendar](#) and try another puzzle.

If you still want to see it, you can [get your puzzle input](#).

You can also [\[Share\]](#) this puzzle.