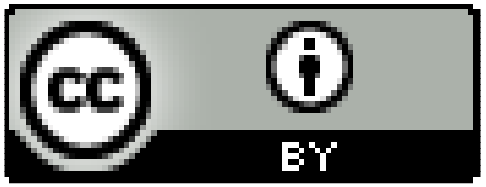
Program Design

Invasion Percolation: Randomness



5	3	7	2	6	1	1	3	4
8	5	6	5	7	2	3	6	2
2	5	8	7	5	5	6	5	9
5	2	6	4	9	3	9	6	5
4	6	8	8	5	9	7	3	9
7	6	4	5	1	2	6	8	5
5	4	2	5	8	5	5	5	8
5	7	5	1	5	3	8	5	5
4	5	1	9	7	8	6	5	1

Need a 2D grid of random values

5	3	7	2	6	1	1	3	4
8	5	6	5	7	2	3	6	2
2	5	8	7	5	5	6	5	9
5	2	6	4	9	3	9	6	5
4	6	8	8	5	9	7	3	9
7	6	4	5	1	2	6	8	5
5	4	2	5	8	5	5	5	8
5	7	5	1	5	3	8	5	5
4	5	1	9	7	8	6	5	1

Need a 2D grid of random values

Uniformly distributed in some range 1..Z

5	3	7	2	6	1	1	3	4
8	5	6	5	7	2	3	6	2
2	5	8	7	5	5	6	5	9
5	2	6	4	9	3	9	6	5
4	6	8	8	5	9	7	3	9
7	6	4	5	1	2	6	8	5
5	4	2	5	8	5	5	5	8
5	7	5	1	5	3	8	5	5
4	5	1	9	7	8	6	5	1

Need a 2D grid of random values

Uniformly distributed in some range 1..Z

Need to check the science on that...

```
assert N > 0, "Grid size must be positive"
assert N%2 == 1, "Grid size must be odd"
grid = []
for x in range(N):
  grid.append([])
  for y in range(N):
    grid[-1].append(1)
```

```
from random import seed, randint
assert N > 0, "Grid size must be positive"
assert N%2 == 1, "Grid size must be odd"
assert Z > 0, "Range must be positive“
seed(S)
grid = []
for x in range(N):
  grid.append([])
  for y in range(N):
    grid[-1].append(randint(1, Z))
```

```
from random import seed, randint
assert N > 0, "Grid size must be positive"
assert N%2 == 1, "Grid size must be odd"
assert Z > 0, "Range must be positive“
seed(S)
grid = []
for x in range(N):
  grid.append([])
  for y in range(N):
    grid[-1].append(randint(1, Z))
```

```
>>> from random import seed, randint
>>> seed(4713983)
>>> for i in range(5):
...   print randint(1, 10),
...
7 2 6 6 5
```

```
>>> from random import seed, randint
>>> seed(4713983)
>>> for i in range(5):
...     print randint(1, 10),
...
7 2 6 6 5
```

Standard Python random number library

```
>>> from random import seed, randint
>>> seed(4713983)
>>> for i in range(5):
...     print randint(1, 10),
...
7 2 6 6 5
```

Initialize the sequence of "random" numbers

```
>>> from random import seed, randint
>>> seed(4713983)
>>> for i in range(5):
...     print randint(1, 10),
...
7 2 6 6 5
```

Produce the next "random" number in the sequence

Here's a simple "random" number generator:

```
>>> base = 17  # a prime
>>> value = 4  # anything in 0..base-1
>>> for i in range(20):
...   value = (3 * value + 5) % base
...   print value,
...
```

0 5 3 14 13 10 1 8 12 7 9 15 16 2 11 4 0 5 3 14

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>>> base = 17  # a prime
>>> value = 4  # anything in 0..base-1
>>> for i in range(20):
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...     print value,
...
```

0 5 3 14 13 10 1 8 12 7 9 15 16 2 11 4 0 5 3 14

base controls how long before values repeat

```
>>> base = 17  # a prime
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>>> for i in range(20):
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...     print value,
...
```

0 5 3 14 13 10 1 8 12 7 9 15 16 2 11 4 0 5 3 14

base controls how long before values repeat

Once they do, values appear in exactly the same order as before

```
>>> base = 17  # a prime
>>> value = 4  # anything in 0..base-1
>>> for i in range(20):
...     value = (3 * value + 5) % base
...     print value,
...
```

0 5 3 14 13 10 1 8 12 7 9 15 16 2 11 4 0 5 3 14

The *seed* controls where the sequence starts

```
>>> base = 17  # a prime
>>> value = 9  # anything in 0..base-1
>>> for i in range(20):
...     value = (3 * value + 5) % base
...     print value,
...
```

15 16 2 11 4 0 5 3 14 13 10 1 8 12 7 9 15 16 2 11

The *seed* controls where the sequence starts

Changing the seed slides values left or right

```
>>> base = 17  # a prime
>>> value = 9  # anything in 0..base-1
>>> for i in range(20):
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...
```

15 16 2 11 4 0 5 3 14 13 10 1 8 12 7 9 15 16 2 11

The *seed* controls where the sequence starts

Changing the seed slides values left or right

(We'll use this fact when testing our program)

This is a lousy “random” number generator

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Did you notice that 6 never appeared?

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Did you notice that 6 never appeared?

That would probably distort our results...

What happens when 6 *does* appear?

```
>>> base = 17
>>> value = 6
>>> for i in range(20):
...     value = (3 * value + 5) % base
...     print value,
...
6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6
```

What happens when 6 *does* appear?

```
>>> base = 17
>>> value = 6
>>> for i in range(20):
...     value = (3 * value + 5) % base
...     print value,
...
```

6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6

How can we prove this won't ever happen?

What happens when 6 *does* appear?

```
>>> base = 17
>>> value = 6
>>> for i in range(20):
...     value = (3 * value + 5) % base
...     print value,
...
```

6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6

How can we prove this won't ever happen?

Or that something subtler won't go wrong?

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Never try to do it yourself

Always use a good library

...like Python's

Any one who considers arithmetical methods of producing random digits is, of course, in a state of sin. For, as has been pointed out several times, there is no such thing as a random number. There are only methods to produce random numbers, and a strict arithmetic procedure of course is not such a method.

– John von Neumann

created by

Greg Wilson

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