Randomness
“Maybe the greatest novelty here is the ability of the computer not only to follow any complex rule of organization but also to introduce an exactly calculated dose of randomness.”

— E.H. Gombrich

Georg Nees, *Gravel Stones* (1971)
Generative Art
39

cracks and

crackle

30. Enlargement of part of Design 29.
Athanasius Kircher (1602-1680)

Arca Musarithmetic
Sol Lewitt  (1928–2007)

Plate 1. Within a twenty inch square area, using a black, hard crayon, draw ten thousand freehand lines, of any length, at random.

Plate 2. Within a twenty inch square area, using a black, hard crayon, draw ten thousand straight lines, of any length, at random.

Plate 3. Using a black, hard crayon draw a straight line of any length. From any point on that line draw another line perpendicular to the first. From any point on the second line draw another line perpendicular to that line. Repeat this procedure.

Plate 4. Using a black, hard crayon, draw four contiguous ten inch squares, forming one twenty inch square, divided into quarters. Within the first square (upper left) draw one line, one inch long. Within the second square (upper right) draw ten lines, each one inch long. Within the third square (lower left) draw one hundred lines, each one inch long. Within the fourth square (lower right) draw one thousand lines, each one inch long. All lines should be drawn at random, and straight.

Plate 5. Using a black, hard crayon draw a twenty inch square. Divide this square into one inch squares. Within each one inch square, draw nothing or a freehand line or lines.
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Random

noise()
noiseDetail()
noiseSeed()
random()
randomGaussian()
randomSeed()
Random

noise()
noiseDetail()
noiseSeed()
random()
randomGaussian()
randomSeed()
float random( float lo, float hi ) { ... }

Return a random number at least as big as \( lo \) but smaller than \( hi \).

Get a different answer every time!
float random( float lo, float hi ) { ... }

Return a random number at least as big as lo but smaller than hi.

Get a different answer every time!

float random( float hi )
{
    return random( 0, hi );
}
Random integers

\[ \text{int( random( N ) )} \]

Choose a random integer from the set 0, 1, ...
Random integers

\[ \text{int( random( N ) )} \]

Choose a random integer from the set 0, 1, ..., \( N-1 \)

(The \text{int()} function always rounds down)
Flipping a coin

Write a function that simulates flipping a fair coin.
Flipping a biased coin

What if we wanted to get heads 75% of the time and tails 25% of the time?
Plate 6. Using a black, hard crayon draw a twenty inch square. Divide this square into one inch squares. Within each one inch square, draw nothing, or draw a diagonal straight line from corner to corner, or two crossing straight lines diagonally from corner to corner.
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10 PRINT CHR$(205.5+RND(1)); : GOTO 10
10 PRINT CHR$(205.5+RND(1)); : GOTO 10
Is this sequence of digits random?

94370277053921717629317675238467481846766940513200056812
Most random number generators are like the digits of π: completely deterministic, but hard to predict.

These are called Pseudorandom Number Generators (PRNGs).
void randomSeed( int seed )
{
    ... 
}

Reset the internal state of Processing’s PRNG based on the passed-in seed. A given seed will always produce the same sequence of answers to a given sequence of calls to random().
Pseudorandom number generators are a double-edged sword.
The good: we can always “replay” a sequence of pseudorandom numbers.
The bad: pseudorandom numbers are not actually random.
Keno
In April 1994, Daniel Corriveau won $620,000 CAD playing keno. He picked 19 of the 20 winning numbers three times in a row. Corriveau claims he used a computer to discern a pattern in the sequence of numbers, based on chaos theory. However, it was later found that the sequence was easy to predict because the casino was using an inadequate electronic pseudorandom number generator. In fact, the keno machine was reset every morning with the same seed number, resulting in the same sequence of numbers being generated. Corriveau received his winnings after investigators cleared him of any wrongdoing.
Partial solutions:

1. Set an initial seed based on the current time.

3. Generate random numbers continuously, not just when needed.
Russians Engineer a Brilliant Slot Machine Cheat—and Casinos Have No Fix

Ronald Dale Harris is a computer programmer who worked for the Nevada Gaming Control Board in the early 1990s and was responsible for finding flaws and gaffes in software that runs computerized casino games. Harris took advantage of his expertise, reputation and access to source code to illegally modify certain slot machines to pay out large sums of money when a specific sequence and number of coins were inserted.

https://en.wikipedia.org/wiki/Ronald_Dale_Harris
Modern cryptographic protocols often require frequent generation of random quantities. Cryptographic attacks that subvert, or exploit weaknesses in, this process are known as random number generator attacks.

https://en.wikipedia.org/wiki/Random_number_generator_attack
Enigma Machine
Transport Layer Security (TLS/SSL)
Early versions of Netscape’s Secure Socket Layer (SSL) encryption protocol used pseudo-random quantities derived from a PRNG seeded with three variable values: the time of day, the process ID, and the parent process ID.
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# Archived NIST Technical Series Publication

The attached publication has been archived (withdrawn), and is provided solely for historical purposes. It may have been superseded by another publication (indicated below).

## Archived Publication

<table>
<thead>
<tr>
<th>Series/Number:</th>
<th>Special Publication 800-90A</th>
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<tbody>
<tr>
<td>Title:</td>
<td>Recommendation for Random Number Generation Using Deterministic Random Bit Generators</td>
</tr>
<tr>
<td>Publication Date(s):</td>
<td>January 2012</td>
</tr>
<tr>
<td>Withdrawal Date:</td>
<td>June 2015</td>
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<tr>
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<td>NIST Released Special Publication (SP) 800-90A Revision 1, Recommendation for Random Number Generation Using Deterministic Random Bit Generators June 25, 2015</td>
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NIST announces the completion of Revision 1 of NIST Special Publication (SP) 800-90A, Recommendation for Random Number Generation Using Deterministic Random Bit Generators. This Recommendation specifies...
How the NSA (may have) put a backdoor in RSA’s cryptography: A technical primer

Here are the basics on backdoors in security systems.

NICK SULLIVAN - 1/5/2014, 7:00 PM

Author Nick Sullivan worked for six years at Apple on many of its most important cryptography efforts before recently joining CloudFlare, where he is a systems engineer. He has a degree in mathematics from the University of Waterloo and a Masters in computer science with a concentration in cryptography from the University of Calgary. This post was originally written for the CloudFlare blog and has been lightly edited to

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In 2013, Reuters reported that documents released by Edward Snowden indicated that the NSA had paid RSA Security $10 million to make Dual_EC_DRBG the default in their encryption software, and raised further concerns that the algorithm might contain a backdoor for the NSA.
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Goals

• Understand how to use random() to generate unpredictable behaviour in Processing sketches.

• Understand how to use randomSeed() to control the generation of pseudorandom numbers.

• Understand the difference between random numbers and pseudorandom numbers.