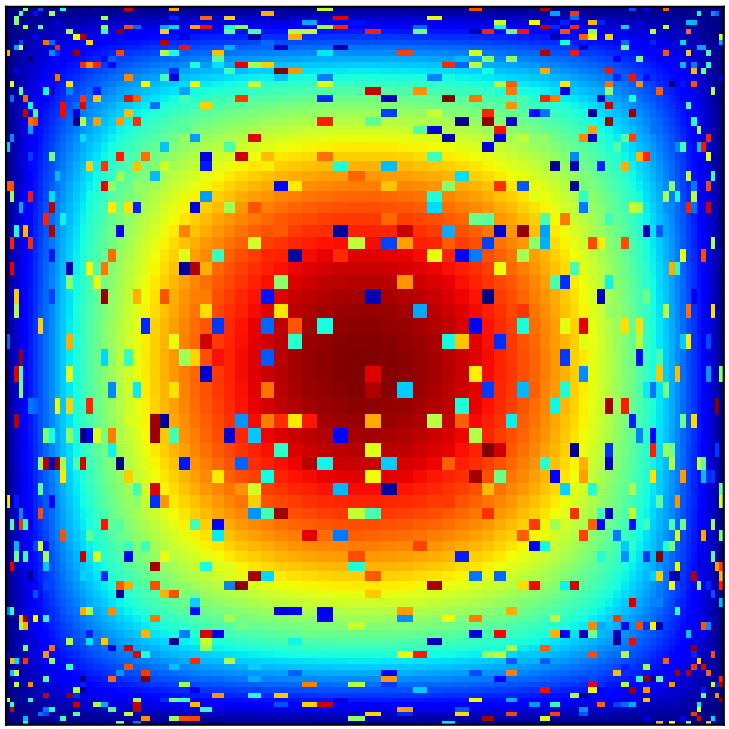
Pseudorandom Identicon Generation

UMB CS 410 SE project outline

Constantin “Ted” Malliaris

September 24, 2026



Pseudorandom Identicon Generation

Constantin “Ted” Malliaris

Pseudorandom Number Generation Examples

Pseudorandom Number Generation Concepts

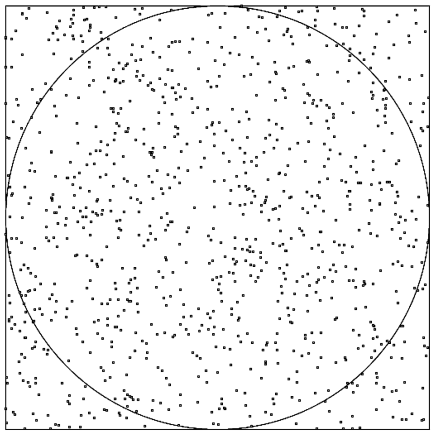
Heatmaps

Combining PRNGs and Heatmaps

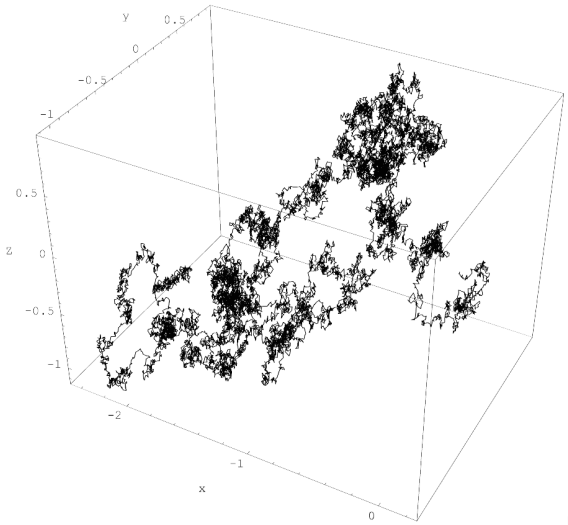
References

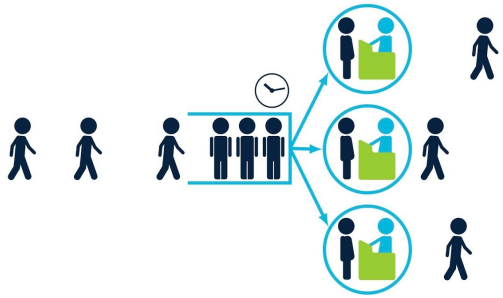
Pseudorandom Number Generation I: Examples

- random numbers needed for:
  - video games, cryptography
  - **NEW** AI/ML: stochastic gradient descent
  - Monte Carlo methods, stochastic simulation
- (*truly*) random vs. *pseudo*-random numbers
  → PRNG: deterministic algorithm that yields "random" string of #'s


[2]


[8]


[12]


[13]

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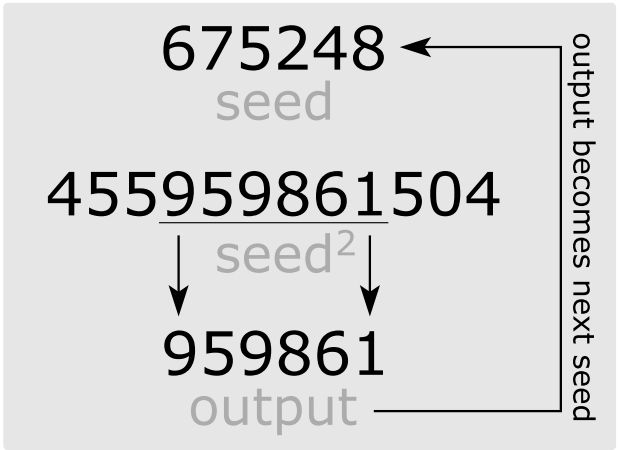
References

Pseudorandom Number Generation II: Concepts

- basic PRNG components:
  - state
  - seed
  - output
- typical PRNG library pseudocode:
  - construct: `rng = Generator(type)`
  - (optionally) seed: `rng.seed(90210)`
  - get $f \in [0, 1)$: `f = rng.get_float()`
  - get $i \in \{0, 1, 2, \ldots, b-1\}$: `i = rng.get_integer(b)`
- middle-square method (von Neumann, $\sim$ 1949)
  - n-digit seed $s \to 2n$-digit $s^2 \to$ extract middle n digits, repeat
  - roles of state/seed/output are blurred!
  - very short period for some seeds!

$$2916 \xrightarrow{5030} 08503056 \xrightarrow{3009} 25300900 \xrightarrow{0540} 09054081 \xrightarrow{2916} 00291600$$

$$3792 \xrightarrow{3792} 14379264$$



[6]

Heatmaps (aka colormaps)

- idea: visualize data by mapping values to colors
- many different choices for this mapping
  - different colors, color models (e.g., RGB, HSL)
  - data can always be transformed, e.g., to $[0, 1)$
  - heatmap can be "linear" or "cyclic"



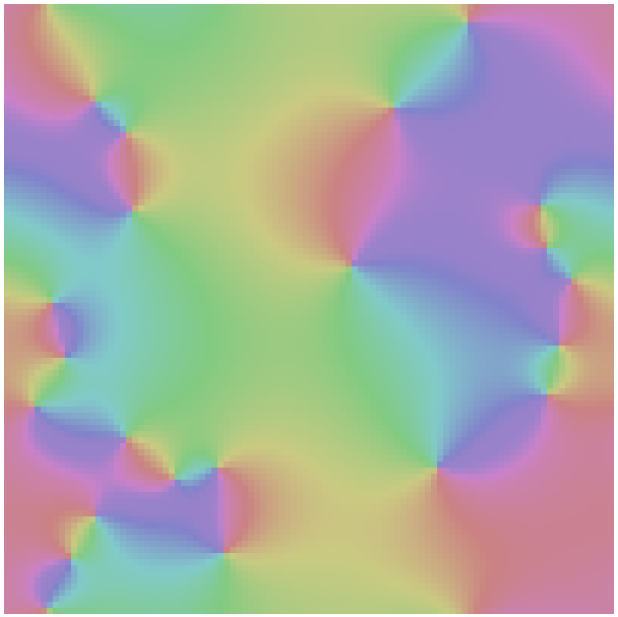
turbo [10]



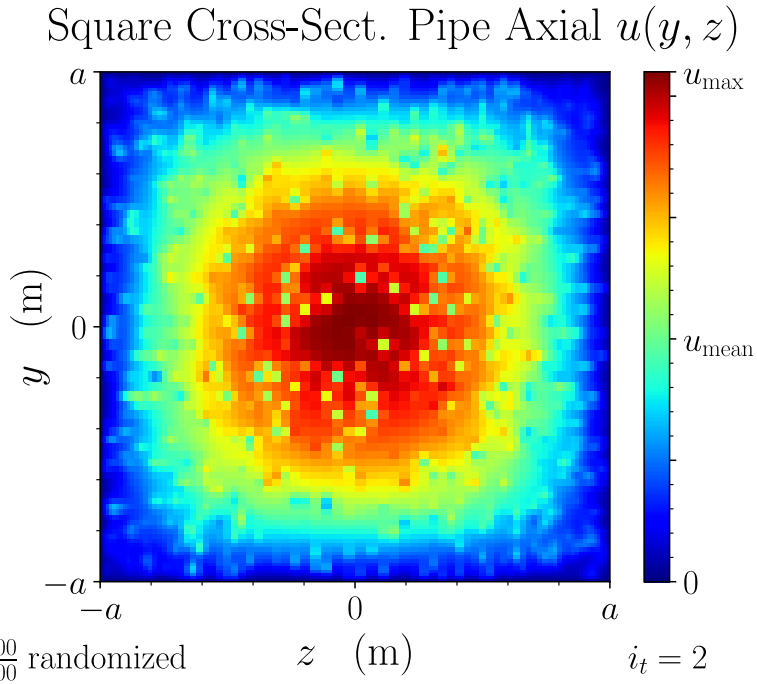
romaO [10]



romaO [10]



$(\mathrm{H}, \mathrm{S}, \mathrm{L}) = (\theta/2\pi, 0.55, 0.5)$



Combining PRNGs and Heatmaps

- one possibility, raster image with pixels:
  - unique seed values in leftmost column
  - corresponding strings of #'s in rows

s_0	v_{01}	v_{02}	$\cdots$
s_1	v_{11}	v_{12}	$\cdots$
s_2	v_{21}	v_{22}	$\cdots$
$\vdots$	$\vdots$	$\vdots$	$\ddots$

- inspiration: GitHub identicons!



[16]

- project will involve (to be refined/finalized):
  - object-oriented Python code with some sensible class hierarchies
  - PRNG functionality via `numpy.random`
  - exploration of different PRNGs (not necessarily good ones!)
  - heatmap functionality via `matplotlib.pyplot.imshow`
  - exploration of different heat-mappings
  - display of identicons under `www.cs.umb.edu/~hdeblois/cs410/f26/`
  - nightly update script that seeds identicon generation, e.g., with Nvidia stock price

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References

References

Three relevant textbooks, in order of increasing difficulty, and links:

1. Kneusel, *Random Numbers and Computers*, Springer, 2018.
2. Johnston, *Random Number Generators — Principles and Practices*, DeG Press, 2018.
3. Gentle, *Random Number Generation and Monte Carlo Methods*, 2nd ed., Springer, 2003.
4. https://en.wikipedia.org/wiki/Identicon
5. https://en.wikipedia.org/wiki/Pseudorandom_number_generator
6. https://en.wikipedia.org/wiki/Middle-square_method
7. https://en.wikipedia.org/wiki/Heat_map
8. https://en.wikipedia.org/wiki/Lavarand
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