Ardrand: The feasibility of the Arduino as a random number generator

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Randomness

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- External sources needed

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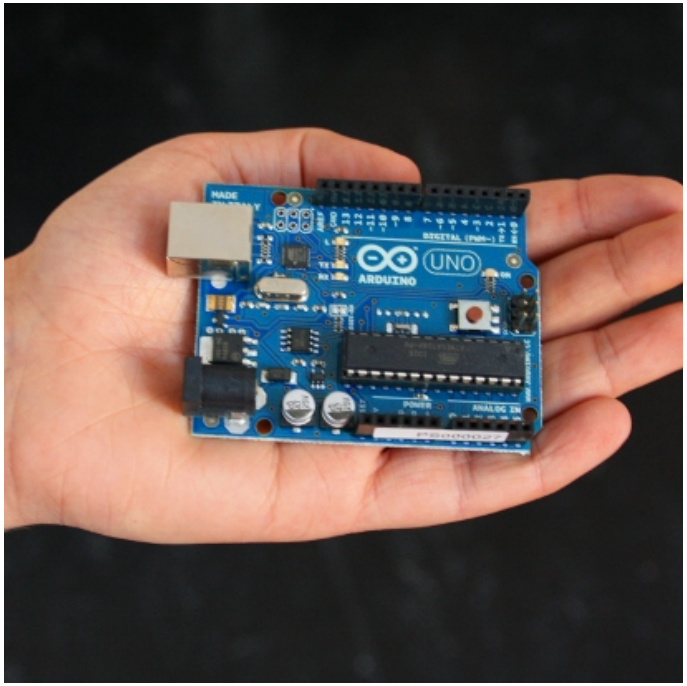
Today: Arduino



Arduino

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If it is important for a sequence of [random] values generated to differ [...] initialize the random number generator with a fairly random input, such as analogRead() on an unconnected pin.

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Picture?

Does the environment matter?

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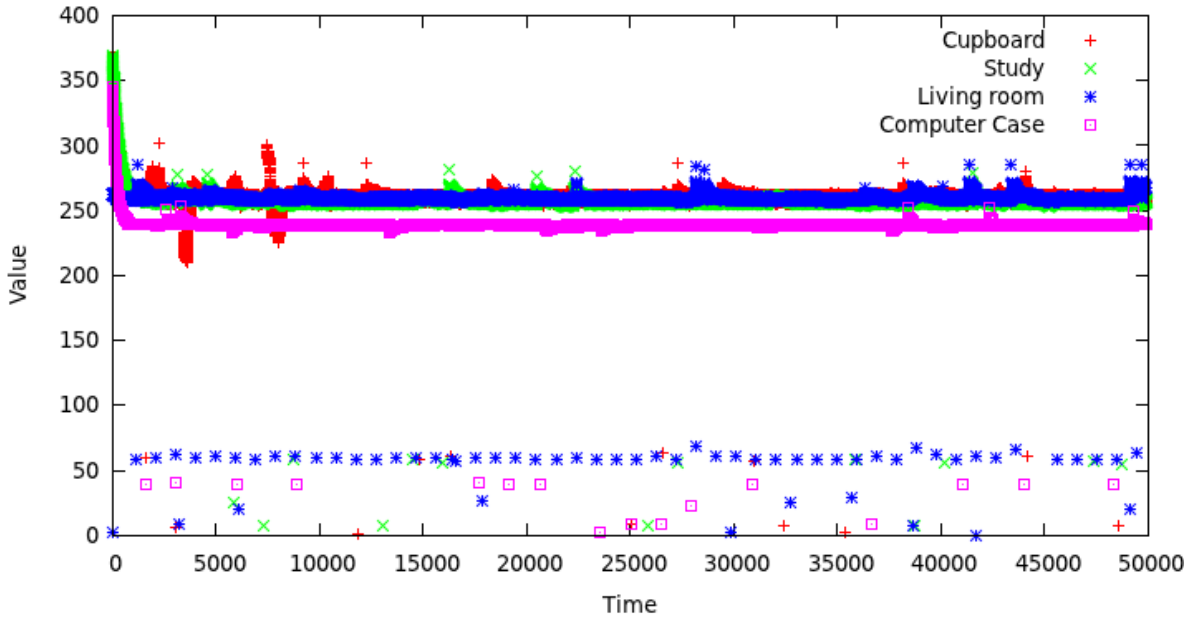

Yes!

Obtained numbers

- Odd locations

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- Odd locations
  - Freezer

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  - Freezer
  - Fridge

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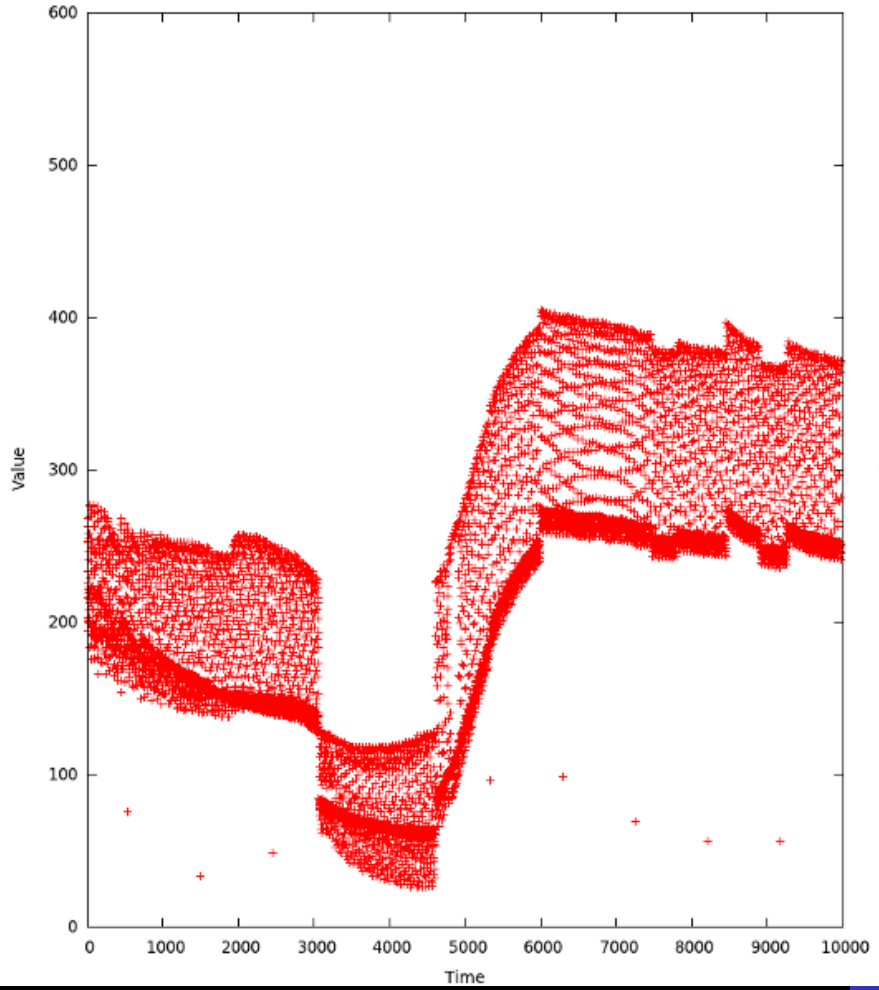
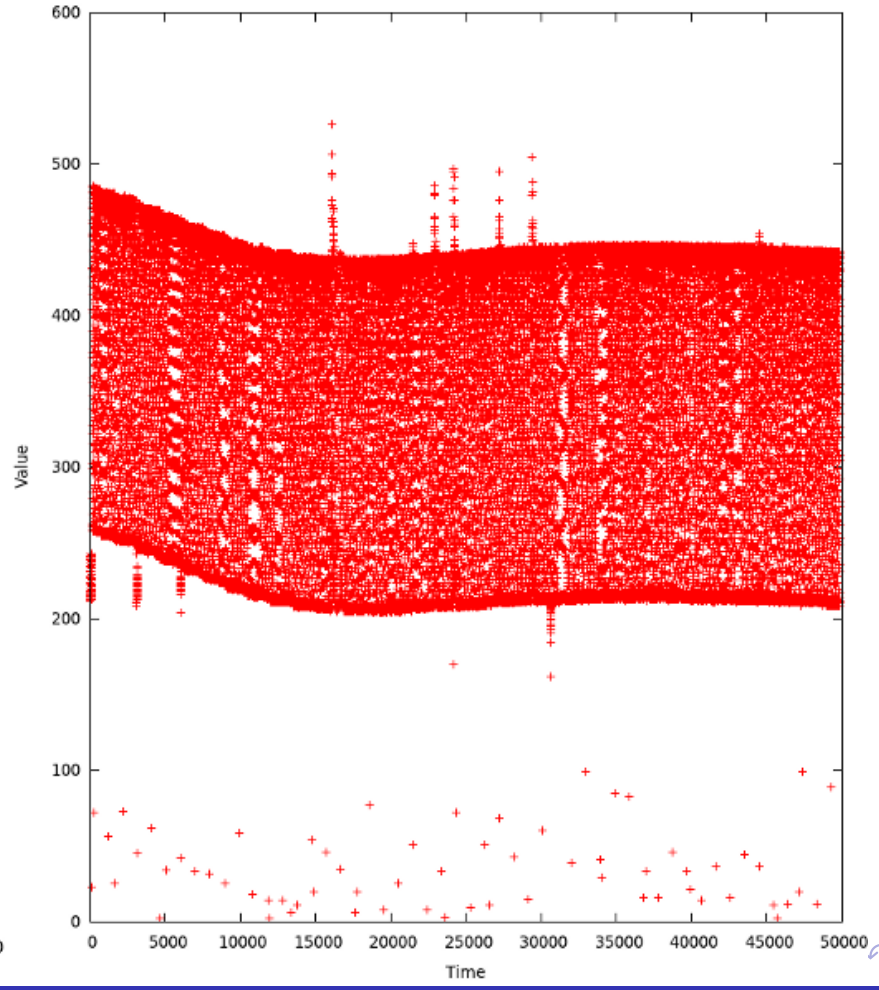
Temperature is important





Meanrand

Idea

Keep track of the mean of the values read, generate a 0 if below and a 1 otherwise.

- Observed bitrate: 25-85 bps

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See what happens if we mix `Mean-RAND` and `Updown-RAND`.
Generate one bit from either and XOR them together.

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Return the least significant (rightmost) bit for each value from `analogRead`

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Let $b = b_9, \ldots, b_1, b_0$ be a 10-bit integer generated by `analogRead`. Return b_0.

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Return the XOR of the two least significant (rightmost) bits for each value from `analogRead`

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The von Neumann box

Used to remove bias from a generator

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Applied in all our algorithms.

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Let n_0 denote the number of 0's and n_1 the number of 1's. We then find

$$X_1 = \frac{(n_0 - n_1)^2}{2}$$

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Based on the idea of five-card hands in poker. In a random sequence we would expect each hand to show up about the same amount of time.

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Math

Let m be the size of the poker hand and $k = \lfloor \frac{n}{m} \rfloor$, where n is the length of the sequence. Find

$$X_3 = \frac{2^m}{k} \left(\sum_{i=1}^{2^m} n_i^2 \right) - k$$

Runs

Runs examples

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Let G_i and B_i be the number of gaps and blocks of length i and e_i denote the expected number of blocks of length i. Find

$$X_4 = \sum_{i=1}^{k} \frac{(B_i - e_i)^2}{e_i} + \sum_{i=1}^{k} \frac{(G_i - e_i)^2}{e_i}$$

Results

Algorithm	Monobit	Poker	Runs	Long runs	Bandwidth
`Leastsign`	ACC	ACC	(REJ)	ACC	290.55 bps
`Twoleastsign`	ACC	ACC	ACC	ACC	172.0 bps
`Mean`	ACC	REJ	REJ	REJ	25.32 bps

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- `Twoleastsign` passes NIST tests as well when it passes our tests

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