

V&V

Exercises

1. Verify the value the random number generator.

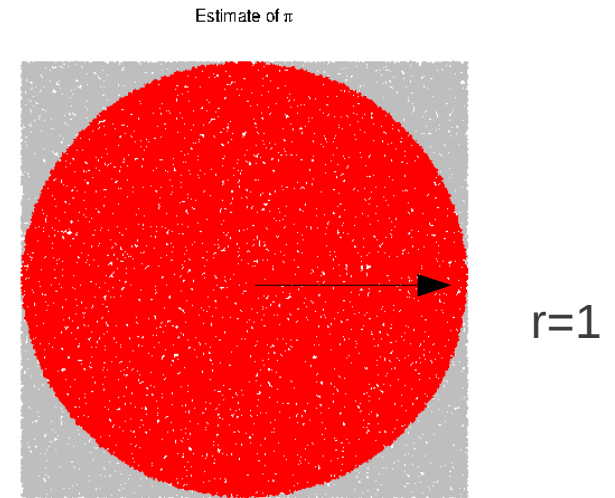
Use the fact that $A = \pi r^2$

Random number generator

Area fraction compared to a 2x2 square.

Hint:

```
x <- runif(N,min=-1,max=1)
y <- runif(N,min=-1,max=1)
r <- x^2 + y^2
inside <- (r <= 1)
piest <- 4*sum(inside)/N
```



$$A_1 = \pi r^2 \quad A_2 = 2 \times 2$$

$$\pi/4 = A_1/A_2$$

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'Model verification'

2. Model skill.

Hypothetical prediction:

Model 'A', 'B', 'C' and a given 'truth'.

Use data provided ([forecast.rda](#)).

- Estimate their skill (correlation, RMSE).
- Which one is best?

N.B. each models have generated several parallel forecasts (ensemble forecast). The difference between each account for unknowns (a stochastic part), but together, they can describe a distribution and most likely outcome.



Statistics

3. Trend test.

Use data provided (`trend.rda`)

- Is the trend statistically significant at the 5%-level?
- Is the marginal distribution of the last 1/3 of the series different to that of the first 1/3?
- Is the data normally distributed?

Physics

4. Validate the forced oscillator

(http://en.wikipedia.org/wiki/Harmonic_oscillator)

Use the function `F0scillator` from `replicationDemos` ([link](#))

Range of different inputs with different frequencies.

Diagnose the amplitude of the response - resonance.

$$x(t) = \frac{F_0}{mZ_m\omega} \sin(\omega t + \phi) \quad Z_m = \sqrt{(2\omega_0\zeta)^2 + \frac{1}{\omega^2} (\omega_0^2 - \omega^2)^2} \quad \phi = \arctan\left(\frac{2\omega\omega_0\zeta}{\omega^2 - \omega_0^2}\right)$$

$$\frac{d^2x}{dt^2} + 2\zeta\omega_0 \frac{dx}{dt} + \omega_0^2 x = \frac{1}{m} F_0 \sin(\omega t),$$

Computer coding

5. Write a small R-package

With functions, data, and documentation.

Make a contingency table and compute hit-rate for a rare event (Finley's (1884) tornado forecast), taking both 'observation' and forecast to be random numbers + a sinusoid. Compare with forecasts of constant non-occurrence.

e.g.

```
> x ← rnorm(N) + sin(omega*t)
> event ← (x > 1.95) # try different thresholds
```

Exercises

1. Verify the value of π
2. Estimate model skill
3. Verify trend in data.
4. Validate the forced oscillator
5. Write a simple R-package to examine Finley's (1884) tornado forecast.

Next lecture