

Probabilistic Models & Stochastic Differential Equations

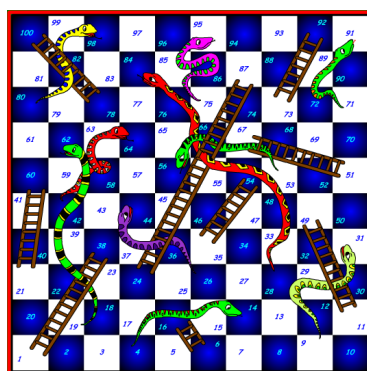
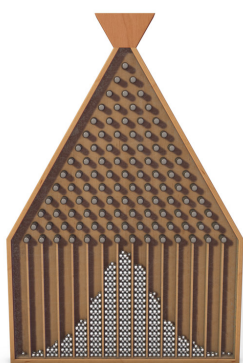
Randomness is amenable to a mathematical description when viewed as a probabilistic phenomenon. This course is an introduction to the mathematical and computational tools developed for the understanding of systems that include the feature of randomness. These methods incorporate ideas of probability theory into simple mathematical models of discrete or continuous processes. Many of these models form the basis of those used in the sciences, finance and engineering. The goal is to obtain an understanding of the statistics of model outcomes, or the properties of the random processes.

This course will begin with introductory reviews of the theory of probability and the calculus of mathematical models. The aim is to develop tools for a quantitative understanding of the most basic stochastic systems: Markov models, Brownian motion and stochastic differential equations. The analysis of these models combines ideas of elementary probability, advanced calculus (differential equations and Fourier series) and numerical computing — participants should have previous experience in some, but not necessarily all of these areas. Matlab will be the default computing environment for the class, and most of the numerical work will involve modification of downloaded scripts.

Minimum course prerequisites: Integral calculus (Math 152), linear algebra (Math 232/240) and Stat 270. Programming experience (script editing & debugging).

Text: *Stochastic Tools in Mathematics and Science*, Chorin & Hald, Springer (2009).

Further information & updates: www.math.sfu.ca/~muraki



expected rolls to finish (start = 30.066)									
0	1	20.55	4.5917	5.357	17.076	9.0957	10.612	12.214	16.857
100	99	98	97	96	95	94	93	92	91
19.669	18.806	18.137	30.198	15.478	15.012	14.383	13.628	14.12	12.899
81	82	83	84	85	86	87	88	89	90
20.55	21.473	0	17.439	17.323	17.076	16.843	12.214	14.449	16.857
80	79	78	77	76	75	74	73	72	71
21.782	26.322	19.662	26.999	17.799	17.32	16.591	16.598	16.667	16.76
61	62	63	64	65	66	67	68	69	70
22.648	23.535	24.491	24.073	25.592	24.687	25.171	25.592	25.934	16.591
60	59	58	57	56	55	54	53	52	51
27.359	26.999	26.687	30.602	24.434	24.649	24.783	24.839	24.817	24.928
41	42	43	44	45	46	47	48	49	50
27.789	28.312	28.958	28.684	29.017	25.171	28.988	29.188	29.334	28.785
40	39	38	37	36	35	34	33	32	31
22.648	28.507	28.646	14.383	30.813	30.602	30.4	30.198	29.48	29.414
21	22	23	24	25	26	27	28	29	30
26.933	26.322	25.573	27.438	27.237	27.025	29.595	28.198	28.511	24.817
20	19	18	17	16	15	14	13	12	11
28.958	29.93	29.767	29.595	28.912	27.237	28.992	29.078	28.785	28.564
1	2	3	4	5	6	7	8	9	10

Two examples of discrete randomness. The pegs of a Galton board deflect balls to the left and right with equal probabilities. The distribution of lateral deflection has a Gaussian profile (left). For the children's game of snakes and ladders (centre), as played with a single six-sided die, the table (right) shows the expected number of rolls remaining to complete the journey to square 100.