Statistical Physics 2019/20
MATH327
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Computer project generic feedback & any requests

Monday 11 May

Computer project Part B feedback

Little trouble with Exercise 4, Exercise 5 more challenging

One challenge was how to check results (e.g., dependence of α on θ)
without exact knowledge based on the central limit theorem

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Useful check: We know ordinary diffusion ($\ell_\theta \propto N^{1/2}$ with $\alpha = 1/2$)
only possible if single-step standard deviation σ exists

We know σ does not exist for the Cauchy–Lorentz distribution

$\Longrightarrow$ should be no chance of $\alpha = 1/2$ for **any** θ

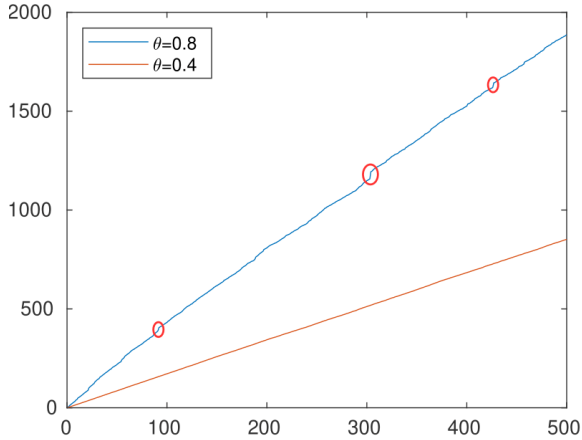
θ dependence more generally

$\alpha = 1$ independent of θ

But random fluctuations increase with θ
(big steps from fat tails less suppressed)

$\longrightarrow$ More chance of α farther from 1

$\alpha_{0.8} \approx 0.9526$ vs. $\alpha_{0.4} \approx 0.9987$



Issue easier to see with 500 independent (rather than correlated) walks. . .

θ dependence more generally

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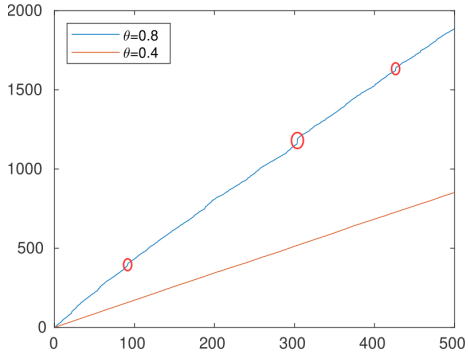
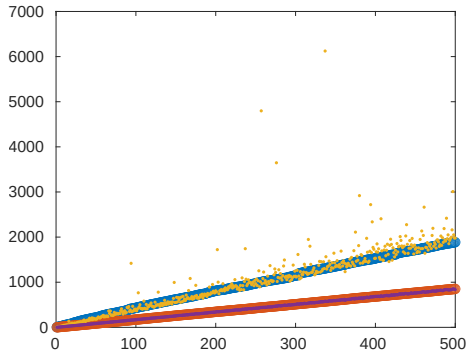


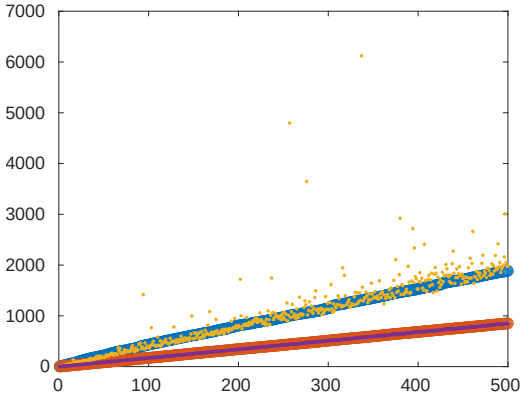
$\alpha_{0.8} \approx 1.0064$ vs. $\alpha_{0.4} \approx 1.0001$

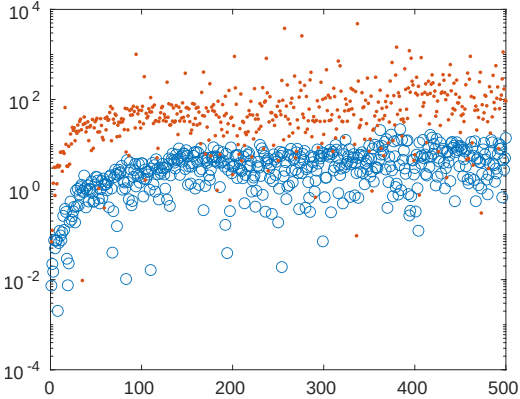


More random samples $\longrightarrow$ more big steps,

though for $\theta < 1$ statistics will (eventually) win

θ dependence more generally





Fit residuals roughly double for $\theta = 0.4$ (same as for ordinary diffusion)

vs. much larger $\sim 5\times$ increase for $\theta = 0.8$

Request: Extra practice problems

EXTRA 1: Entropies and probabilities from rolling dice

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More possibilities in David Tong's problem sheets, including the following:

EXTRA 2: Fugacity and particle number fluctuations in the grand-canonical ensemble

EXTRA 3: Internal energy and average occupation numbers for non-interacting fermions in the grand-canonical ensemble

EXTRA 4: The q-state Potts model as a generalization of the Ising model

Can also provide digital copy of Schroeder's textbook, with many exercises