ENGG7302
Advanced Computational Techniques in Engineering
Tutorial SP4

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The questions in this tutorial are based on Exercise questions from the Grinstead and Snell (Chapter 11) reference text for this part of the course.

Question 1

Complete the following exercises starting from page 413 of Grinstead and Snell:

- (2)
- (3)
- (4)
- (5)
- (11)

Question 2

Consider the Markov chains with transition matrices as given in Exercise 1 ((a)-(e)), page 442 of Grinstead and Snell. In each case:

(i) Which states are *accessible* from each other?

(ii) Which states *communicate* with each other?

(iii) Which states form a *communicating class*?

(iv) Which chains are *irreducible*?

(v) Whether states (and chains) are periodic (and if so what is the period) or not?

(vi) Which chains are *ergodic*?

(vii) Which states are *transient* or recurrent?

(viii) Which states are absorbing?

Question 3

For Exercise 3, page 442 of Grinstead and Snell, identify the conditions under which

- P is absorbing
- P is ergodic

Question 4

Use Matlab to answer Exercise 5, page 443 of Grinstead and Snell.

Question 5

Read Example 11.22, page 440 of Grinstead and Snell. Use Matlab to compute the equilibrium distribution vector for this example and verify the answer given in the example.

Question 6 (MCMC)

Matlab includes an implementation of the Metropolis-Hastings algorithm via the Statistics toolbox. Open Matlab and read the relevant sections of the Help for "Markov Chain Samplers" and then the function `mhsample`.

(a) The mhsample function makes use of the "anonymous function handles" feature of Matlab to enable functions to be passed as input arguments. If you need help understanding this, refer to the Matlab Help on "function_handle (@)" and "Anonymous functions".

(b) Use the `mhsample` function to draw a sample of data points from the distribution defined as:

```
sigma = [0.1 0; 0 0.1];
pdf = @(x) mvnpdf(x,[-2 -2])+mvnpdf(x,[2 2])
+ mvnpdf(x,[-2,2],sigma)+mvnpdf(x,[2,-2],sigma);
```

Plot the path/points sampled by the Markov chain in the data space. Experiment with:

- The number of steps/samples you run the chain for.
- Different proposal distributions (and parameters for those distribution).
- Can you observe the effects of poor mixing and burn-in?