

Mathematics for Machine Learning (AI 512)

A. Chattopadhyay (Oct - Dec 2021)

Module 3 (Random Walks and Markov Chains)

- Random Walks, Markov Chains - properties, stationary, convergence
- Applications - Page Ranking, MCMC Sampling

Module 4 (Latent Variable Models)

- K-Means, Expectation Maximization (EM-Algorithm)
- Gaussian Mixture Model (GMM)

MATHEMATICS FOR MACHINE LEARNING (AI 512)

Parts covered by V. Ramasubramanian (Nov – Dec 2020)

A QUICK README – to the table/references in the NEXT slide...

All material referred in these slides are in Google Drive, accessible via the following link:

<https://drive.google.com/drive/folders/1BvBKHOEiGmglHvRgliCHDGaAUAL-jEBK?usp=sharing>

These are as below and referenced by numbering as below

[1] 2020 Class Notes – **SUB-FOLDER: CLASS-NOTES**

- [1.1] #1-MML-1.pdf
- [1.2] #1-1-Random-Walk-Animation-Clips.ppsx
- [1.3] #2-MML-2.pdf
- [1.4] #3-MML-3.pdf
- [1.5] #4-MML-4.pdf
- [1.6] #5-MML-Page-Rank.pdf
- [1.7] #6-MML-Sampling-1-CDF.pdf
- [1.8] #7-MML-Sampling-2-MCMC.pdf
- [1.9] #8-MML-K-Means.pdf
- [1.10] #8-1-K-Means-Related-Pics.pdf
- [1.11] #8-2-K-Means-Visualizations-Links.pdf
- [1.12] #9-MML-EM-Generic.pdf
- [1.13] #10-MML-EM-GMM.pdf

[2] TUTORIALS – **SUB-FOLDER: Tutorials [2 pdfs]**

- [3.1] Google-Paper-1998.pdf
- [3.2] Google-Pagerank-AMSI-Report-2013.pdf

Companion Material Shared by Prof. Ram

REFERENCES (Contd...)

- [3] John E. Hopcroft and Ravindran Kannan., “Foundations of Data Science”, pages 1-403, Version 4/9/2013, © 2011
[Books / Hopcroft-Kannan-2013-Foundations-of-Data-Science.pdf](#)
- [4] Kevin Murphy, “Machine Learning – A Probabilistic Perspective”, The MIT Press 2012.
[Books / Murphy-2012-Machine-Learning-A-Probabilistic-Perspective.pdf](#)
- [5] Jim Lambers, Power Iterations, 2009-10, Report
[Papers-Reports-Slideset / Power-Method-Jim-Lambers.pdf\]](#)
- [6] Purnamrita Sarkar, Random Walks on Graphs: An overview
[\[Papers-Reports-Slideset / Power-Iterations-Perron-Frobenius.pdf\]](#)
- [7] Gaussian Mixtures and the EM Algorithm, Robert Collins,
[\[Papers-Reports-Slideset / EM-Robert-Collins-Slide-Set.pdf\]](#)
- [8] A gentle tutorial on EM algorithm and its application to....Gaussian mixture ... models....
[\[Papers-Reports-Slideset / Jeff-Bilmes-1998-EM-Tutorial.pdf\]](#)

GUIDE TO REFERENCE MATERIAL – [#] refers to References in Previous 2 Slides

MODULE	TOPICS	Reference Material
Module 3 (Random Walks and Markov Chains)	Random Walks, Markov Chains – properties, stationarity, convergence	<ul style="list-style-type: none"> ▪ [1.1] , [1.2], [1.3], [1.4], [1.5] ▪ Hopcroft and Kannan's book Ch.5, Sec. 5, 5.1, pages 147-152 [3] ▪ Power-Method, Page 1 [5] Jim-Lambers.pdf ▪ Power-Iterations-Perron-Frobenius.pdf, Pages 25, 26, 45-55 [6]
	Applications – Page Ranking	<ul style="list-style-type: none"> ▪ [1.6] ▪ Hopcroft and Kannan's book Ch.5, Sec. 5, 5.5, pages 167, 170-171 (Personalized page rank and Algorithm for computing personalized page rank) [3] ▪ Power-Iterations-Perron-Frobenius.pdf, Pages 56-59 [6]
	MCMC Sampling	<ul style="list-style-type: none"> ▪ [1.7], [1.8] ▪ Hopcroft and Kannan's book Ch.5, Sec.5.6, Page 171-172, Sec. 5.6.1, Page 174-175 [3] ▪ Kevin Murphy's book, Ch. 23, Sec. 23.1, 23.2, 23.2.1, Pages 815-816 [4] ▪ Kavin Murphy's book, Ch. 24, Pages 837, Sec. 24.3, Pages 848-849 [OPTIONAL] [4]
Module 4 (Latent Variable Models)	K-means algorithm (Soft-clustering, Hard-clustering)	<ul style="list-style-type: none"> ▪ [1.9], [1.10], [1.11] ▪ Kevin Murphy's book, Sec. 11.4.2.5, Pages 352-354 [4] ▪ EM-Robert-Collins-Slide-Set.pdf, Pages 41-43 [7]
	Expectation Maximization (EM Algorithm)	<ul style="list-style-type: none"> ▪ [1.12] ▪ Jeff-Bilmes-1998-EM-Tutorial.pdf, Sec.1, 2, Pages 1-3 [8] ▪ Kevin Murphy's book, Ch. 11, Sec. 11.1, 11.2, 11.2.1, Sec. 11.4, 11.4.1. [4] ▪ EM-Robert-Collins-Slide-Set, Pages 13-28 [7]
	EM for Gaussian Mixture Models (GMM)	<ul style="list-style-type: none"> ▪ [1.13] ▪ Jeff-Bilmes-1998-EM-Tutorial.pdf, Sec.3, Pages 3-7 [8] ▪ Kevin Murphy's book, Sec. 11.4.2 [4] ▪ EM-Robert-Collins-Slide-Set, Pages 1-12, 29-40 [7]