Department of Computer Science
Qualifying Examination Requirement for PhD students
(applicable to the 2019/20 intake and thereafter)

Aims and Requirements

- The aims of the PhD Qualifying Examination are to test students' knowledge of major subject areas of their research disciplines and assess their readiness to conduct research in their specific discipline.

- The Qualifying Examination consists of written examination only.

- The Qualifying Examination is mandatory for all full-time and part-time PhD students, including those under joint PhD programmes.

- A maximum of two attempts will be allowed within the specified periods as follows:

  (a) For PhD students
  Full-time: within 10-24 months from start of study
  Part-time: within 20-48 months from start of study

  (b) For students under Mainland Collaboration Schemes and joint PhD programme with overseas universities
  Within 10-36 months upon official registration as a student at CityU, or to the end of normal study period, whichever is earlier.

- Students who fail to pass the examination by the deadline will result in termination of study.

Details of the Qualifying Examination

- The Qualifying Examination will be held in mid/late June 2022. Details including the date and time, and the exam mode will be announced in due course.

- This is a closed-book exam. The exam duration is two hours. The paper consists of four questions, covering the four major subject areas, namely Computer System Networking and Security, Artificial Intelligence and Data Engineering, Multimedia Computing, and Algorithms and Software Engineering. Students can attempt any two questions in the paper, with each question carrying 50 marks.

- The total marks of the Qualifying Examination are 100 marks. Students are required to obtain at least 54.5 marks in order to pass.

Updated on 9 March 2022

Learning Materials covering the Four Subject Group Areas

Computer System Networking and Security (CSN)

The question will include multiple sub-questions, with scope broadly covering all the teaching and learning materials for *CS 5222 Computer Networks and Internet* (see chapters below).

- Overview of computer networks
- Application layer
- Transport layer (end-to-end segment delivery)
- Network layer (data and control planes)
- Link layer
- Wireless and mobile networks

The reference book is the following:
- Kurose and Ross, Computer Networking- A Top-down Approach, (7th Edition), 2016/17

Artificial Intelligence and Data Engineering (AID)

All the teaching and learning materials for *CS6491 Topics in Optimization and its Applications in Computer Science*

Multimedia Computing (MNC)

Teaching and learning materials for *CS5487 Machine Learning: Principles and Practice* and *CS5489 Machine Learning: Algorithms and Applications*. Details on the syllabus and recommended reading lists are attached.

Notes: This question consists of two parts, with part (a) being more theory oriented and part (b) more application oriented. Students who attempt this question can choose to answer either part (a) or part (b).

Algorithms and Software Engineering (ASE)

Textbook
T. H. Cormen, C. E. Leiserson, R. L. Rivest, **Introduction to Algorithms**, The MIT Press

Notes: The questions will cover both data structure and algorithm design. For the data structure part, we will cover estimating running time of an algorithm in terms of Big O notation for both iterative and recursive methods and basic data structures such as stack, queue, heap, AVL tree, and disjoint sets. Students are expected to use basic approaches such as greedy, divide-and-conquer, and dynamic programming to solve *newly encountered* problems. Course materials in Lectures 1 to 4 in *CS6382 Algorithm Analysis and Game Theory* will also be covered.

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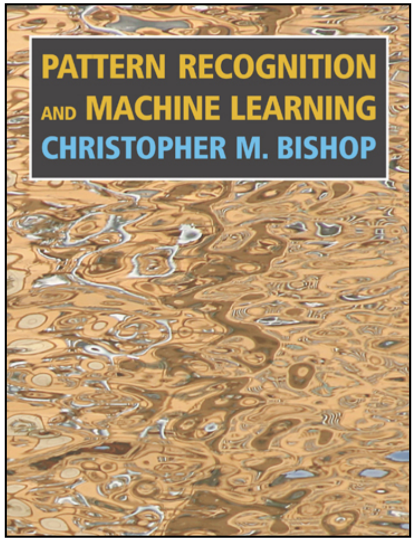
CS5487 Schedule (2019)

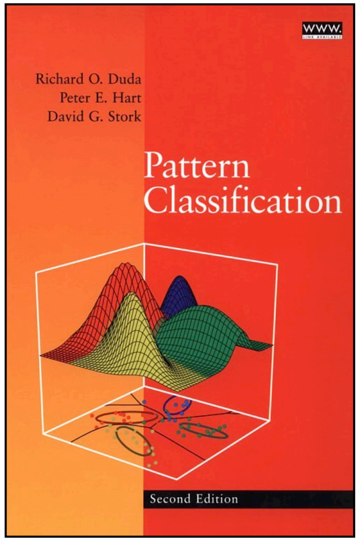
Wk	Lecture	Topics	Reference	Assessment
1	1. Introduction & Review	Probability & Statistics, Linear Algebra	PRML 1.2, 2, Appendix C	
2	2. Parameter Estimation	MLE, bias/variance, LS regression	PRML 2.1-2.4, 3.1; DHS 3.2	
3	3. Bayesian Estimation	MAP, Bayes estimation, Gaussians	PRML 2.3, 3.1, 3.3; DHS 3.3-3.5	PA1 out
4	4. Parametric Clustering	K-means, GMM & EM	PRML 9; DHS 10.1-10.4	
5	5. Non-parametric Clustering	KDE & mean-shift	PRML 2.5; DHS 4.1-4.4; m-s paper	
6	6. Bayesian classifiers	Bayesian Decision Theory, Gaussian classifier, Naïve Bayes	PRML 1.5; DHS 2.1-2.6	PA1 due, PA2 out
7	7. Dimensionality & Linear Dimensionality Reduction	PCA, LSA, pPCA, FA, CCA	PRML 12-12.2, 12.4; DHS 3.7-3.8	
8	*Midterm Quiz*			
9	8. Discriminative Learning – Linear Classifers (I)	least-squares classification, perceptron, logistic regression, empirical risk minimization	PRML 4.1-4.3	PA2 due, Project out
10	Course project discussions	(tutorial/lecture replaced with office hours)		Project proposal due
11	9. Discriminative Learning – Linear Classifers (II)	linear SVM, regularized risk	PRML 7.1; DHS 5.11	
12	10. Kernels	kernel functions, kernel SVM	PRML 6.1-6.2, 6.4, 7.1	
13	11. Non-linear Dim. Reduction	kernel PCA, pre-image problem	PRML 12.3	
14		Course Project Presentations		Project report due

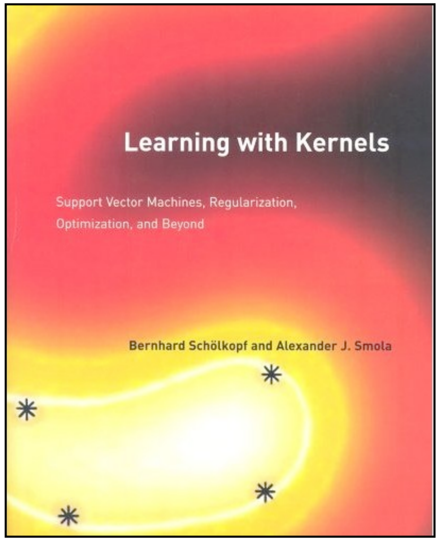
PRML = Bishop, "Pattern Recognition and Machine Learning.
DHS = Duda, Hart, & Stork, "Pattern Classification".

Learning Resources

- Course website on Canvas – CS5487
  – announcements, course packet, discussion board
- Textbooks
  - **Bishop, *Pattern Recognition and Machine Learning*.**
  - Duda, Hart, & Stork, *Pattern Classification*.
  - Schölkopf and Smola, *Learning with kernels: support vector machines, regularization, optimization, and Beyond*.







CS5489 Schedule v3 (2020B)

Wk	Lecture Topic (2020)	References MG (pg)	H (Ch)	B (Ch)	GBC (Ch)	Tutorial	Assessment
1 (13/1)	Lec 1: Introduction / Python					Tut 1	
	<u>Supervised Learning</u>						
2 (20/1)	Lec 2: Probabilistic Models & Bayes Classifiers	70-71	4	4.2		Tut 2	
3 (10/2)	Lec 3: Discriminative Classifiers (LR & SVM)	58-70	5, 6	4.3, 7.1		Tut 3	A1 out
4 (17/2)	Lec 4: Nonlinear Classifiers (KSVM, AdaBoost & RF)	85-106	6, 7	14.2, 14.3		Tut 4	
5 (24/2)	Lec 5: Regression	47-58	8, 9	3.1, 7.1, 6.4		Tut 5	
6 (2/3)	**Midterm (online)**						
	<u>Unsupervised Learning</u>						
7 (9/3)	Lec 6: Dimensionality Reduction	142-170	13, 14	12		Tut 6	A1 due, A2 out
8 (16/3)	Lec 7: Clustering	170-183	10.1-10.4	9.1-9.3		Tut 7	
	<u>Deep learning</u>						
9 (23/3)	Lec 8: Neural networks	106-121		5.1-5.5	6	Tut 8	
10 (30/3)	Lec 9: CNNs			5.5	7, 9	Tut 9	A2 due, Pr. out
11 (6/4)	Lec 10: Deep Learning				8	Tut 10	
12 (20/4)	Lec 11: Deep generative models				14, 20.9, 20.19	Tut 11	
	<u>Other topics</u>						
13 (27/4)	Lec 12: Graphical models (if time)			8		-	
14 (4/5)	Project presentations (online)					Pr. Pres.	Pr. Due

References

- Textbooks
  - **MG**: Muller & Guido, “Introduction to Machine Learning with Python”, O’Reilly, 2017.
  - **H**: Harrington, *“Machine Learning in Action”*, Manning Publications Co., 2012.
  - **B**: C.M. Bishop, *“Pattern Recognition and Machine Learning”*, Springer, 2006.
  - **GBC**: Goodfellow, Bengio, Courville, *“Deep Learning”*, MIT Press 2016.
- Papers:
  - Batch Norm: https://arxiv.org/abs/1502.03167
  - SGD: https://arxiv.org/abs/1802.06175
  - ResNet Ensembles: https://arxiv.org/abs/1605.06431