University at Buffalo
Office of Academic Services
The Graduate School

Course Subject Code: MGF
Course Number: 694
Type of Instruction: Lecture
Course Title: Financial Modeling using R
Class Number: 1
Semester: Fall 2020

Course Information
- Instructor: Paul Yan
- Contact information :
  - Office: 359 Jacobs Management Center (Monday afternoon only)
  - Emails: yyan6@buffalo.edu and pyan@geneseo.edu
  - Phones: 716 645 3277 (Monday afternoon), 716 888 2604 (other weekdays)
- Date(s)/Time(s): Mondays: 5:00pm – 7:50pm @ Jacobs 214
- Office hours: Mondays: 2:00pm – 4:00pm. @ Jacobs 359 or by appointment
- Delivery mode: traditional lecture. Each class will be consist of two parts: lecture (including discussion of homework & potential topics for term projects) and hands-on (in-class exercises).
- Number of credits: 3

Course Description
- Unlike many Financial Modeling courses that using Excel, this course uses R as the computational tool. R is free and powerful software. In terms of data, students learn how to download and process public data associated with economics, finance and accounting. Over the past several years, many business schools have established many business analytics programs. The trend is obvious: students at business school should master at least one computer language. From this course, students learn how to apply R to various finance theories.
- Course prerequisites: Minimum two finance courses, such as Corporate Finance and Portfolio Analysis

Course Materials
- For Fall 2020, I will supply all chapters in a PDF format [new edition of the book]
- Reference: Financial Modeling using R by Yuxing Yan, ISBN: 9-78-1-94696454, Lagaia Books, 2018, Amazon link: http://datayyy.com/webs/amazonR2018.html
- Websites:
  - http://datayyy.com/fmr/
  - http://datayyy.com/webs/R.shtml
  - https://ublearns.buffalo.edu/

- o https://www.r-project.org/,

- References:
  - o An Introduction to R http://cran.wustl.edu/doc/manuals/r-release/R-intro.pdf
  - o R Language Definition http://cran.wustl.edu/doc/manuals/r-release/R-lang.pdf
- One-line R code   source("http://datayyy.com/abc.R")

   # I will explain this line during the first lecture.

Software
- R, open source statistical and computational software . Students are expected to spend at least 1 hour per day on R outside the classroom.

QR Code (Later, I will show how to generate a QR code for a given webpage)

UB learns	My book on Amazon	Course webpage

Student Learning Outcome
- Learn/review basic financial concepts such as Ratio Analysis, Portfolio Theory, CAPM, Fama-French-Carhart Factor Model, Monte Carlo simulation, Options Theory, VaR (Value at Risk) and Market microstructure
- Learn and apply R to finance
- Focus on publicly available financial data such as Yahoo Finance, Google Finance, Prof. French's Data Library and Federal Reserve Economic Data Library (FRED).
- Learn how to use CRSP, Compustat and/or TAQ (Trade and Quote) databases.
- Learn how to make a good presentation

Course Requirements
- Regular attendance since hands-on is critical
- Class participation (10% of the final grade)
- About 6-7 Home work
- Mid-term and final exams
- Term project (a group project) and term project presentation

Grading Policy

Homework	30%
Midterm	20%
Final exam	25%
Group project	10%
Group presentation	5%
Class participation	10%

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                          Total                    100%
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From a percentage grade to a letter grade

Percentage grade	Letter grade
$grade \geq 90\%$	A
$85\% \leq grade < 90\%$	A-
$80\% \leq grade < 85\%$	B+
$75\% \leq grade < 80\%$	B
$70\% \leq grade < 75\%$	B-
$60\% \leq grade < 70\%$	C
$grade < 60\%$	F

Graduate Grade Options:

Grade	Quality Points
A	4.0
A-	3.67
B+	3.33
B	3.0
B-	2.67
C+	2.33
C	2.0
C-	1.67
D+	1.33
D	1.0
F	0

Mid-term and Final

All exams (midterm and final) will be conducted in the computer lab. Those are open book exams with three types of questions: related to 1) finance; 2) R or 3) financial data.

Group project

Each group can have up to three members. A topic should be closely associated with this course. The maximum number of pages of your report is 15 with 12-point font. Please discuss with me your topic before you start to work on it. Some basic criterions are listed below.

Real world topics are especially encouraged. Three parts are essential:

    1) theory and background of the topic,

    2) R programs with a short explanation of the codes,

    3) final data set (plus the codes to process the data, the source of raw data)

Note: please do not send me your raw data.

The second type of projects is to study one of R packages. Three parts are critical:

1) why this specific package is useful in finance
2) a summary of all or most important functions offered by the package
3) examples to use them

Note: see a list of potential topics, at the end of the syllabus, for the group projects.

Academic Integrity

- Academic integrity is a fundamental university value. Through the honest completion of academic work, students sustain the integrity of the university and of themselves while facilitating the university's imperative for the transmission of knowledge and culture based upon the generation of new and innovative ideas.
- Graduate Academic Integrity policy (http://grad.buffalo.edu/study/progress/policylibrary.a-to-z.html#academicintegrity).

Accessibility Resources

- If you have any disability which requires reasonable accommodations to enable you to participate in this course, please contact the Office of Accessibility Resources in 60 Capen Hall, 645-2608 and also the instructor of this course during the first week of class. The office will provide you with information and review appropriate arrangements for reasonable accommodations, which can be found on the web at: http://www.buffalo.edu/studentlife/who-we-are/departments/accessibility.html.

Attendance Policy

- Regular attendance is expected sine this is a hands-one course.
- Attendance issues related to religious observances (http://grad.buffalo.edu/study/progress/policylibrary.a-to-z.html#classattendance).
- Email me beforehand for your athletic commitments, family/work obligations/emergencies.
- For cancellations/delays due to weather or other unforeseen events , see the following the web page at http://emergency.buffalo.edu/.

Academic calendar

https://registrar.buffalo.edu/calendars/academic/2020-21.php

Weekly Course Schedule (tentative and subject to change)

#	Date	Topics	Description (F for Finance)	Data case
1	8/31	Syllabus discussion, introduction to R Open data	A short survey, self-intro, syllabus, course structure, mid-term/final Chapter 1: R Installation, basics and value assignments assignment, basic math functions: mean(), min(),max(), median(), sd(), as a scientific calculator Chapter 17: Open data for finance/economics/accounting	
2	**9/7**		**Labor Day (no Class)**	
3	9/14	Writing simple R functions	Chapter 2: Simple function, input data from external files Writing one-line functions, multi-lines, add help double_f(), pv_f(), fv_f(), IRR(), pv_annuity(), fv_annuity(), pv(perpetuity), pv(perpetuity_due), how to call your functions? use R as a financial calculator, input data from a text file, simple programs to get data, French's data library Chapter 18: Review of basic finance concepts, several decision rules Time-value, NPV, IRR, Payback rules	Data case #1
4	9/21	Data, loops Fin Statement Analysis	Chapter 3: Simple data manipulation Chapter 4: R loops, if else, if else if Chapter 19: Modern financial statement analysis ratio analysis, probability ratio: operating margin, net profit margin, ROA, ROE, current ratio, book debt- equity ratio, SEC filings (from 2009 to today)	Data Case #2
5	9/28	Data output, linear regression, CAPM	Chapter 5: Output data to an external file Chapter 6: Linear Regression Chapter 20: CAPM (Capital Asset Pricing Model) β estimation, rolling/portfolio β, hedging portfolio market risk	Data Case #3
6	10/5	data.frame Subset Multi-factor linear model	Chapter 7: Data frame and list Chapter 8: subset, combine data sets, and merge Chapter 21: Multi-factor models (ff3, ffc4, ff5) Fama-French Model etc. Sharpe, Treynor and Sortino Ratios, Jensen's α, ff3factor, ff4, weekday/January effect. sharpe.R, Treynor.R	Data Case #4
7	10/12	CAPM R-loops	Chapter 9: date variable, simple plots and graphs Chapter 10: Matrix manipulation Chapter 22: Option theory, Black-Scholes-Merton model trading strategies with options, implied volatility, put- call parity, hedging strategy, pnorm() , bs_f.R, implied_vol.R, greeks.R	Data Case #5
8	10/19	Multi-factor models Ratios	Chapter 12: Introduction to R packages Chapter 13: Reading Excel data, SAS data, binary data and zip files Chapter 14: Various distributions and hypothesis tests	Data Case #6
9	**10/26**		**Midterm**	

Continued

Week	Date	Topic	Chapters
10	11/2	T-test, F-test, Autocorrelation, Causality	Chapter 16: Durbin-Watson, Normality,Granger causality tests T-test for significance, equality of means, F-test for difference of volatility, Granger causality test, Durbin-Watson autocorrelation test, t.test(), var.test(), dwtest(), Wilcoxon.test(), granger_test() Chapter 23: Binomial Tree Method for option Chapter 30: Term project (please choose one topic)
11	11/9	Monte Carlo Simulation	Chapter 24: Applications of Monte Carlo Simulation to finance assumptions, normality test, estimate variance-covariance matrix, conversion variances between different frequencies, path dependent options, sensitivity analysis, scenario analysis, random number from normal, uniform distribution , price European and Asian options
12	11/16	VaR Portfolio theory(1) CRSP for teaching using R	Chapter 25: VaR (Value-at-Risk) standard normal distribution, thick tail distribution VaR_01.R, VaR_02.R, several R packages Chapter 26: Portfolio Theory (Part I) var, std, correlation, return matrix, portfolio return, portfolio vol of 2-stock (n-stock),var-cov matrix, portfolio optimization, several R package, fPortfolio Extra: Introduction to CRSP What is CRSP? CRSP monthly, daily time series data, event data (more topics for term projects), stockMonthly, indexMonthly, indexDaily, stockD1925 to stockD2014, various R program to retrieve/process data efficiently
13	11/23	Portfolio theory(2)	Chapter 27: Portfolio Theory (Part II): Black-Litterman, Broadt et al. Extra : Introduction to Compustat annual data plus a few other data sets
14	11/30	Spread estimation Task view for finance	Chapter 28: Bid-ask spread and TAQ (Trade and Quote) Chapter 29: Two-dozen R packages related to finance **group presentation?**
15	**12/7**	**Presentation**	**Rest of groups**
	Extra	Text Analysis	Number of lines, number of words, word frequency, search keywords, distance between words etc.
	Extra	TAQ for teaching using R	TAQ (Trade and Quote) are high frequency database by NYSE MTAQ (up to second) DTAQ (up to millisecond) R data sets: TAQct, TAQcq, DTAQ22ct, DTAQ22cq TORQct, TORQcq, TORQcd, TORQsod R: loadTAQ, filterCT, filterCQ, spread, relativeSpread,leeRead
	Extra	Credit risk	F: Credit rating, credit score, probability of default, Z-score for predicting Bankruptcy, Moody's, S&P, Fitch, Best crediting

			systems, credit transition matrix, R: prob_default.R, Z_score.R, KMV.R
	Extra	Spread estimation from low-frequency	F: spread estimation from low frequency data, Roll (1984), Corwin and Schultz (2012) high-low spread R: Roll.R, Corwin_Schultz.R
	Extra	Liquidity measure	F: Amihud (2002) illiquidity measure, Pastor and Stambaugh (2002) liquidity measure. R: Amihud.R, PS.R
	12/9	**Final**	Final-exam (7:15PM - 10:15PM Jacobs 214)

Add UB learn here

Appendix A: A list of potential topics for term projects[1]

Warm up		1	Financial statement analysis
		2	An interned connected financial calculator (Yan, 2012)
		3	Correlations among stocks in US, UK, Canada, France, China, Japan and Australia
		4	A Business cycle indicator (Yan and Zhang, 2015)
		5	Use journal ranking data efficiently (SCImago Journal and Country Ranking)
		6	Find an optimal portfolio
		7	How much you need when you retire? Social Security Benefit calculator
		8	Which party, Republican or Democratic, could manage the economy better?
		9	Monte Carlo Simulation (standard normal distribution, one variables) VaR
		10	PCA (Principal Component Analysis)
Data	Public data	11	Generate R data sets for 200 stocks, CPI, GDP, Unemployment rate etc.
		12	Generate R data sets for Fama-French 3-factors, 5 factors etc.
		13	Generate R data sets for all SEC 10Q and 10K index files from SEC (1993-2015)
		14	Generate R data sets for TORQ (Trade, Order, Report and Quote) database
		15	Generate R data sets for TDAQ (millisecond by millisecond transaction data)
		16	Parse 10K data from SEC filings, generate related R data sets
	CRSP/TAQ	17	Generate R data sets for one month's TAQ data (MTAQ)
		18	Generate R data sets for crspInfo, stockMonthly, indexMonthly for CRSP
		19	Generate R data sets for stockDaily, indexDaily for CRSP
		20	Generate R data sets for TDAQ for several months
Using public data		21	Are annual beta mean reversion?
		22	Test the January and weekday effects
		23	Does size effect exist?
		24	Tracking errors
		25	Z-score (bankruptcy prediction, Altman, 1968)
		26	52-week High trading strategy using more than 200 stocks
		27	estimate Roll (1984) spread from daily data (Roll, 1984)
		28	Assessment of multiple choice questions using R
		29	Monte Carlo Simulation (capital budgeting, replicate a Slot Machine)
		30	Monte Carlo Simulation (one variables) VaR, n correlated stocks
Usin		31	Replicate S&P500 EW (equal-weighted) and VW (value-weighted) returns
		32	Is liquidity factor priced? (Amihud, 2002)

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[1] After mid-term, I will explain a few term projects.

	33	What is the color of your firm, blue or red? (Yan, 2014)
	34	Which model is the best, CAPM, FF3, FFC4, or FF5?
	35	Estimate spread, relative spread, expected spread etc. by using TAQ
	36	Process TAQ efficiently, how to process 30 year MTAQ data efficiently ?
	37	Replicate momentum trading strategy (Jegadeesh and Titman, 1993)
	38	Replicate industry momentum trading strategy (Moskowitz and Grinblatt, 1999)
	39	Replicate 52-week high trading strategy (George and Huang, 2004)
	40	Replicate max- trading strategy (Bali, Cakici and Whitelaw, 2011)
	41	Impact of business cycle on the above four trading strategies, (Yan and Zhang , 2015)

References (most of them are for term projects)

Altman, Edward, Altman, E. (1968), Financial ratios, discriminant analysis and the prediction of corporate bankruptcy, *Journal of Finance*, 23(4), pp 598-608.

Amihud, Yakov, 2002, Illiquidity and Stock returns, *Journal of Financial Markets* 5, 31-56.

Bali, Turan G., Nusret Cakici, and Robert F. Whitelaw, 2011, Maxing Out: Stocks as Lotteries and the Cross-Section of Expected Returns, *Journal of Financial Economics* 99 427-446.

George, Thomas J, and Chuan-Yang Huang, 2004, The 52-week High and Momentum Investing, *Journal of Finance* 54, 5, 2145-2176.

Jegadeesh, N., and S. Titman, 1993, Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency, *Journal of Finance* 48, 65-91.

Moskowitz, Tobias, and Mark Grinblatt, 1999, Do industries explain momentum? *Journal of Finance* 54, 2017-2069.

Pastor, L. & Stambaugh, R., 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111, 642-685.

Roll, Richard, 1984, A simple implicit measure of the effective bid-ask spread in an efficient market, *Journal of Finance* 39, 1127-1139.

Yan, Yuxing, 2019, CRSP for Teaching, *Journal of Accounting and finance*, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3303504

Yan, Yuxing, 2018, Financial Modeling using R, *Lagaia Books*, Amazon link at http://datayyy.com/webs/amazonR2018.html

Yan, Yuxing, 2018, A Trend in Business Education, *International Journal of Education and Social Science*, 5(75), http://www.ijessnet.com/uploades/volumes/1575190910.pdf

Yan, Yuxing, 2017, Teaching programming skills to finance students: how to design and teach a great course, *Financial Innovation*, https://link.springer.com/article/10.1186/s40854-017-0081-x

Yan, Yuxing, 2015, Red vs. Blue Stocks: Politics and Profitability of Firms, *Journal of Business and Policy Research* 10 (1), 117-138.

Yan, Yuxing, An internet connected financial calculator, 2012, *Journal of Accounting and Finance* 12(5), 59-70.