

Indian School of Business

Business Forecasting

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| Academic Year & Term: 2011 – 12: Term: 7 | |
| Instructor: Galit Shmueli Affiliation: ISB Email: galit.shmueli@gmail.com | Office Hours: Right after class (with appointment) |
| Academic Associate: Pranay Jinna Email: | |

Course Objective and Key Takeaways from the course

Students taking this course will be familiar with and have hands-on experience with popular forecasting techniques and approaches used in business, as well as best practices for building forecasting methods and evaluating their performance.

You are not required to have any extraordinary technical ability in Statistics or other methodological areas to benefit from the course, but you are expected to have familiarity with regression models (from the Statistics course). The material is developed and presented in an intuitive manner with the objective of making you smart consumers of forecasting technologies and approaches. Real data will be used to motivate the topic being covered.

Upon successful completion of the course, you should possess valuable practical analytical skills that will equip you with a competitive edge in almost any contemporary workplace. In particular, the knowledge acquired in this course will benefit those who plan careers in analytics, marketing, strategic consulting, financial services, and more. More formally, the course will provide participants with the following skills and knowledge:

- Understand the importance of forecasting for planning and decision making
- Have knowledge of main fields where forecasting is used
- Be familiar with the difference between descriptive and forecasting goals
- Know how to visualize time series data for discovering their nature and data issues
- Understand how different models and methods can be used for forecasting time series
- Be familiar with popular methods and be able to choose adequate methods for different types of data
- Be familiar with the concept of autocorrelation and uses of autoregressive models
- Know how to evaluate the performance of a forecasting method, and to compare methods
- Be familiar with the concept of ensembles and the advantages of combined forecasts
- Understand the notion of predictability and methods to evaluate it
- Be aware of issues that arise in practice when trying to implement forecasts into decision making, and of strategies to approach them
- Understand issues that relate to automating forecasting methods

Learning Goals

In addition to the course objectives listed above, students should expect to develop the following by the end of the course:

1. Effective Oral Communication

Each student shall be able to communicate verbally in an organized, clear, and persuasive manner, and be a responsive listener.

Assessment: Project Presentations

2. Critical and Integrative Thinking

Each student shall be able to identify key issues in a business setting, develop a perspective that is supported with relevant information and integrative thinking, to draw and assess conclusions.

Assessment: Individual Assignments (plus ungraded: in-class and online discussions)

3. Interpersonal Awareness and Working in Teams

Each student shall demonstrate an ability to work effectively in a team, exhibiting behavior that reflects an understanding of the importance of individual roles and tasks, and the ability to manage conflict and compromise, so that team goals are achieved.

Assessment: Team Project Report and Team Presentations

Course Description

Forecasting describes the act of generating predictions of future values or events. Quantitative forecasting, which focuses on data for generating numerical forecasts, is an important component of decision making in a wide range of areas and across many business functions, including economic forecasting, workload projections, sales forecasts and transportation demand. This course focuses on forecasting time series, where past and present values are used to forecast future values of a series of interest. The course covers issues relating to different steps of the forecasting process, from goal definition, through data visualization, modeling, and performance evaluation to model deployment.

We will work with real world business data, as opposed to artificial examples. The most popular and useful forecasting methods will be introduced, with an emphasis on when each method is useful, its strengths and weaknesses. Forecasting will be approached from a practical and logical approach rather than focusing on mastering the theoretical underpinnings of the techniques.

The course will be driven by a business forecasting project that will encapsulate the different steps of practical forecasting.

An important feature of this course is the use of Excel, an environment familiar to MBA students. All required forecasting methods and algorithms (plus illustrative data sets) are provided in an Excel add-in, XLMiner. In addition, we will introduce Spotfire, an industry leading interactive data-visualization software, as a powerful tool for time series visualization and characterization.

Required Textbook

Practical Time Series Forecasting: A Hands-On Guide by Galit Shmueli, 2nd Edition, CreateSpace 2011 (available soon).

The book datasets are available at <http://galitshmueli.com/practical-time-series-forecasting>.

Further handouts will be available through the LMS.

Recommended Textbooks

Online textbook *Forecasting: Principles and Practice* (<http://robjhyndman.com/fpp/>) by Hyndman & Athanasopoulos (some chapters are still under construction)

Time Series Analysis and Forecasting by Montgomery, Jennings and Kulahci, Wiley 2008. Especially chapters 1-4.

Software requirements for the course

We will make extensive use of Microsoft Excel and a data mining software called XLMiner, which is an Excel add-in.

We will also use the interactive visualization tool TIBCO Spotfire. Please download your free copy from http://registration.spotfire.com/eval/default_edu.asp (make sure to use your isb.edu email address). For further details see the Learning Management System.

Session-Wise Topics/Readings

| <i>Session (Date)</i> | <i>Reading</i> | <i>Topics</i> | <i>Deliverable</i> |
|---------------------------|----------------|---|--|
| #1 Jan 10 | Chp 1-2 | Course Overview Time series vs. cross-sectional data The forecasting process Goal definition, data collection Time series components and characterization Forecasts and forecast errors Visualizing time series Why visualize? Why interactively? Visualizing a series and forecast errors Introduction to Spotfire software | |
| #2 Jan 12 | Chp 3 | Predictive performance Measuring predictive accuracy Data partitioning and over-fitting Naïve Forecasts Discussion of Team Project | Email team members to AA |
| #3 Jan 14 | Chp 5 | Regression-based forecasting Linear regression refresher Regression for forecasting vs. inference Linear, exponential, polynomial trends Additive and multiplicative seasonality De-trending and seasonal adjustment Using the model for generating forecasts | Assignment 1 (Chap 2, Prob #5-6; Chap 3, Prob #1-2) |
| #4 Jan 17 | Chp 5 | Regression-based forecasting – cont. Measuring predictive accuracy Global vs. local patterns Including external information Irregular patterns Autocorrelation and AR models Evaluating predictability and random walks Two-layer models General overview of ARIMA models | Teams present a chart for their project data |

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| #5 Jan 24 | Chp 6 | Smoothing Methods Moving Average (centered/trailing) De-trending and seasonal-adjustment: differencing, seasonal indexes Simple Exponential Smoothing | Assignment 2 (Chap 5, Prob #1 and #4) |
| #6 Jan 27 | Chp 6 | Smoothing Methods – cont. Advanced Exponential Smoothing Smoothing constants Regression vs. Smoothing | |
| #7 Jan 31 | Chp 9 (9.1) Chp 2 (2.5) | Case: Forecasting Transportation Demand Data Pre-processing Missing values, unequally spaced series, choice of time span | Assignment 3 (Chap 6, Prob #8; Chap 9, Case #9.1: submit answers and charts for the six “Tips and Suggested Steps”) |
| #8 Feb 2 | Chp 7 (7.1- 7.3) | Ensembles Forecasting binary events Including external predictors Logistic regression | |
| #9 Feb 7 | Chp 7 (7.4) Chp 8 | Forecasting binary events Including external predictors Neural networks Forecasting in Practice | |
| #10 Feb 9 | | Team Presentations | Project report |

Evaluation Components

| Deliverable | Weight | Coding Scheme (see appendix) |
|------------------------------|--------|---------------------------------|
| Three individual assignments | 60% | 2 |
| Final Team Project Report | 30% | 3 |
| Final Team Presentation | 10% | 3 |

Individual Assignment Schedule

| Name of the Component | Date of Submission/Deadline | Take-home or in-class | Group Assignment (Y/N) | Instructions to students on word limit/format of submission etc | Coding Scheme |
|-----------------------|-----------------------------|-----------------------|------------------------|---|---------------|
| Assignment #1 | Session #3 | Take-home | N | Hardcopy | 2 |
| Assignment #2 | Session #5 | Take-home | N | Hardcopy | 2 |
| Assignment #3 | Session #7 | Take-home | N | Hardcopy | 2 |

About Individual Assignments:

Because the most effective way to learn this material is by “doing,” the course will have three individual assignments. Please budget approximately five hours per assignment. Our expectation is that as a result of these assignments, you will observe a marked improvement in your conceptual understanding of forecasting.

Assignments are to be submitted via hardcopy at the beginning of the class meeting they are due. Late assignments are accepted, but subject to a penalty that deducts 2 points (on a total of 20 points) per day they are late. For example, if an assignment due on Wednesday is not submitted via hard copy at the beginning of the class, but sent via email after the class, there will be a 2 point penalty. If, on the other hand, it is sent on Thursday at 8pm, there will be a four point penalty and so on.

No extra credit work is offered under any circumstances. You are always welcome to submit assignments prior to the due date in case you have an exigency on that particular date.

Team Project

Based on their collective experience and course knowledge, each team will work on a project related to transportation demand. The purpose is to make hands-on use of the material learned in class to solve a real-world problem.

Students should form groups of 4-5 members. Our prior experience indicates that the more diverse the group the more interesting the project and the analysis.

Team Project Schedule

| Name of the Component | Date of Submission/Deadline | Take-home or in-class | Group Assignment (Y/N) | Instructions to students on word limit/format of submission etc | Coding Scheme |
|----------------------------|-----------------------------|-----------------------|------------------------|---|---------------|
| Send names of team members | Before Session #2 | Take-home | Y | | |
| Project Presentation | Session #10 | In-Class | Y | Hardcopy | 3 |
| Project Report | Midnight of Session #10 | Take-Home | Y | Submit PDF by email | 3 |

Project Goal

All teams will tackle the same transportation demand case (given in Chapter 4 of the textbook). The purpose is to build solid and reasonable forecasting methods, to evaluate them, and finally to generate forecasts of future values. Through this process, students will have first-hand experience with challenges and steps that are taken in forecasting in practice.

What is the grading criterion?

The project is evaluated in terms of soundness of the approach, from data organization and characterization, through choice of potential forecasting methods, their evaluation, and generation of forecasts. It is not only the predictive accuracy, but also the approach that matter.

What are the guidelines for the project report?

The report should be no longer than five pages in length (please use at most 12pt font size, 1.5-spacing, and 1 inch margins on all sides of the page) and should include an executive summary that is accessible to any manager (not necessarily familiar with quantitative forecasting). The report should have the following sections:

1. Executive summary that includes conclusions and recommendations
2. Problem description
3. Brief description of the data, its key characteristics, and graph(s). More details can be provided in an Appendix
4. Technical summary that includes the components under *Assignment* in the textbook case page

You can provide additional technical details of the model and the data in an Appendix.

Group Information

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| Group Size | 4-5 |
| Group Composition | Student-chosen (encouraged to be diverse) |
| Can groups be formed across different sections? | no |

Attendance & Punctuality

Learning is an interactive process. ISB students are admitted partly based on the experiences they bring to the learning community and what they can add to class discussions. Therefore attendance is an important aspect of studying here. You have to be present in all the classes. Absence is only appropriate in cases of extreme personal illness, injury, or close family bereavement. Voluntary activities such as job interviews, business school competitions, travel plans, joyous family occasions, etc. are never valid reasons for missing any class. The faculty with the assistance of the Academic Associate will keep track of your attendance and decide on the nature and extent of penalty for any absence from the class. Penalty may include reduction in grade.

Late arrival is disruptive to the learning environment; so you have to be in class before the scheduled time. Most courses meet twice a week during the day. Normally there are no classes scheduled on Friday or in the evenings, but there are exceptions. Class and Exam schedules are posted on the PGP intranet site. Any change in the class schedule is notified in advance.

Class participation, both in an out of the classroom, is strongly encouraged. It forms an important part of the course pedagogy. Participation is a direct function of your outside experiences and the level of mastery of the material. You are expected to enhance the overall learning environment of the class by coming prepared, asking questions and bringing issues to life based on your experience.

You can further contribute by engaging in the **Online Discussion Forum**.

Online Course Management

We will use the LMS extensively for material distribution as well as for online discussions.

- Handouts, assignments, datasets and other materials will be posted only on the LMS
- Discussion board will be used to post Q&A for each assignment

Appendix I

Coding scheme for ALL course work

| Code number | Individual | Group |
|-------------|---|---|
| 1 | Anything and everything is fine. The student can talk to anyone and use ANY resources in completing the assignment or project. However, need to have proper citations for all borrowed work (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/ other secondary/ primary sources), including case/problem set solutions. | Anything and everything is fine. The group can talk to anyone and use ANY resources in completing the assignment or project. However, need to have proper citations for all borrowed work (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/ other secondary/ primary sources), including case/problem set solutions. |
| 2 | The student is limited to discussing only concepts and ideas with other people. The student is NOT allowed to discuss the specifics of the case or assignment with anyone else and has to complete all work on his/her own. The student can use ANY reference material with proper citation (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/other secondary/ primary sources), including case/problem set solutions. | The group is limited to discussing only concepts and ideas with other people. The group is NOT allowed to discuss the specifics of the case or assignment with anyone else and has to complete all work on their own. The group can use ANY reference material with proper citation (company website/ databases/ industry reports/ Google/ journals/article/ open courseware /other secondary/ primary sources), including case/problem set solutions. |
| 3 | The student is limited to discussing only concepts and ideas with other people. The student is NOT allowed to discuss the specifics of the case or assignment with anyone else and has to complete all work on his/her own. The student can use SOME reference material (except case/problem set solutions) with proper citation (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/other secondary/ primary sources) as specified by the course instructor. | The group is limited to discussing only concepts and ideas with other people. The group is NOT allowed to discuss the specifics of the case or assignment with anyone else and has to complete all work on their own. The group can use SOME reference material (except case/problem set solutions) with proper citation (company website/ databases/ industry reports/ Google/ journals/articles/open courseware/ other secondary/ primary sources) as specified by the course instructor. |
| 4 | The student is limited to discussing only concepts and ideas with other people. The student is NOT allowed to discuss the specifics of the case or assignment with anyone else. The student cannot use ANY reference material. This applies to all reference material (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware /other secondary/primary sources, case/problem set solutions). | The group is limited to discussing only concepts and ideas with other people. The group is NOT allowed to discuss the specifics of the case or assignment with anyone else. The group cannot use ANY reference material. This applies to all reference material (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware /other secondary/primary sources, case/problem set solutions). |
| 5 | The student is NOT allowed to discuss anything with anyone. The student can use ANY reference material with proper citation (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/other secondary/ primary sources), including case/problem set solutions. | The group is NOT allowed to discuss anything with anyone. The group can use ANY reference material with proper citation (company website/ databases/ industry reports/ Google/ journals/article/ open courseware /other secondary/ primary sources), including case/problem set solutions. |
| 6 | The student is NOT allowed to discuss anything with anyone. The student can use SOME | The group is NOT allowed to discuss anything with anyone. The group can use SOME reference material |

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| | reference material (except case/problem set solutions) with proper citation (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware/other secondary/ primary sources) as specified by the course instructor. | (except case/problem set solutions) with proper citation (company website/ databases/ industry reports/ Google/ journals/articles/open courseware/ other secondary/ primary sources) as specified by the course instructor. |
| 7 | The student can ONLY use the information given in the case or assignment. The student is NOT allowed to discuss anything with anyone or to refer to any other material. This applies to all reference material (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware /other secondary/primary sources, case/problem set solutions). | The group can ONLY use the information given in the case or assignment. The group is NOT allowed to discuss anything with anyone or to refer to any other material. This applies to all reference material (company website/ databases/ industry reports/ Google/ journals/ articles/open courseware /other secondary/primary sources, case/problem set solutions). |

As a general rule:

- Students can discuss cases and assignments with the course instructor and the Academic Associate for the course.

Required and recommended textbooks for the course and the course pack can be used to answer any individual or group assignment.