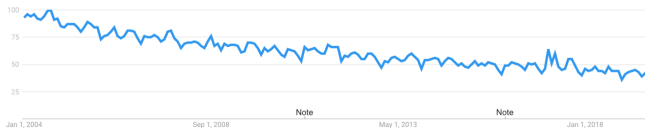


STAT 153 - Introduction to Time Series with Jared Fisher



My email jared.fisher@berkeley.edu *

* for private concerns, otherwise please use Piazza

Office Hours in Evans 387
Tuesday/Thursday 1:30pm - 3:00pm
or by appointment

Lectures in Hearst Mining 390
Tuesday/Thursday 3:40pm - 4:59pm

GSI's and Friday Lab Sections

GSI Alan Aw, email: alanaw1@berkeley.edu

Friday Sections: 9-11am in 334 Evans, 12pm-2pm in 344 Evans

Office hours: TBA

GSI Andrew Do, email: do@berkeley.edu

Friday Sections: 11am-1pm in 334 Evans, 2-4pm in 344 Evans

Office hours: TBA

Labs start Friday with an optional review of concepts needed for this course.

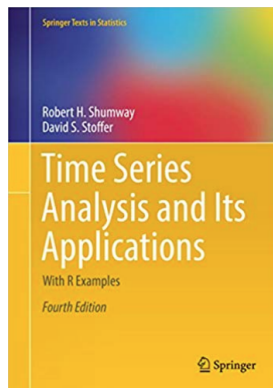
Course Description

- ▶ An introduction to time series analysis in the time domain (mostly) and frequency domain (some).
- ▶ Time series data are data points from a single source at different points in time.
- ▶ Independence is unlikely, so we look at ways to deal with how the data interact with time.

Course Prerequisites

- ▶ STAT 101, 134 or consent of instructor. 133 or 135 recommended.
- ▶ In other words, you'll need a basic understanding of statistics, probability, and programming in R.
- ▶ Also quite helpful, but not required, to be familiar with regression
- ▶ I do not enforce these prerequisites as we have students from a variety of majors and backgrounds. However, as you are graded in this class, it is in your best interest to feel truly comfortable with that material.
- ▶ If you'd rather use a different programming language, such as Python, you are welcome to, but the staff cannot necessarily answer questions, and in-class examples will be in R.

Time Series Analysis and its Applications by Shumway and Stoffer, *fourth edition*. It is available for free via the library website.



Needed. bCourses will be the hub for class material, grades, and announcements. All lecture frames/notes, sample R code, homework, etc. will be posted there.

- ▶ Optional
- ▶ <http://piazza.com/berkeley/spring2020/stat153> .
- ▶ Questions about the administration and material of the course should be asked on Piazza.
- ▶ The GSIs and I cannot monitor Piazza 24/7, so please help your fellow classmates.
- ▶ Do not post your entire homework solutions on Piazza and try to be specific in your questions.
- ▶ Again, personal/private/individual questions should be sent directly to me at my email address, while questions about the class should be on Piazza. If you have a question about something, you're probably not the only one!

Grading

- ▶ Homework: 30%
- ▶ Midterm 1: 15%, date: Thursday, February 27, in class.
- ▶ Midterm 2: 15%, date: Thursday, April 9, in class.
- ▶ Project: 10%, due date: Friday, April 24
- ▶ Final Exam: 30%, assigned time: Friday May 15, 7-10pm, location TBA

- ▶ Gradescope - allows us to provide fast and accurate feedback on your work.
- ▶ As soon as grades are posted, you will be notified immediately so that you can log in and see your feedback.

Assignments - Homework

- ▶ Due on Thursdays by midnight (but checked Fridays at 8:59am... before your lab sessions) most weeks.
- ▶ No late homework will be accepted, but the lowest 2 homework grades are dropped.
- ▶ You are welcome and encouraged to work in small groups on the assignments. However, as listed in the academic honesty section, you are expected to write up your own solutions and/or code, and when you are assisted by a classmate/website/etc., make a simple citation (like a code comment) to denote where the insight came from.
- ▶ Regrade requests must be submitted on Gradescope within two weeks of grades being published.

Assignments - Exams

- ▶ Two midterms
- ▶ One comprehensive final
- ▶ If you cannot attend an exam due to an emergency, certification such as a doctor's note will be required for alternate arrangements.
- ▶ If you do not take the final exam, it is policy that you fail the course. There is insufficient time after the final to accept regrade requests.
- ▶ Regrade requests must be submitted on Gradescope within one week of midterm grades being published. Note that we will (likely) regrade your whole exam for accuracy!

Assignments - Project

- ▶ Due April 24. More details to come.
- ▶ Please get together in groups of 3-5 students. Groups with less than 3 or more than 5 students will not be accepted.
- ▶ There won't be individual grades for the group project, but each group will receive a single grade.

Accommodation

Students requesting accommodations due to a disability should contact me (the professor) at the start of the semester (or as soon as they become eligible for accommodations) in order to provide you with ample time to meet the required accommodations.

Scheduling Conflicts

- ▶ Please notify me in writing (I prefer email)
- ▶ by the second week of the term about any known or potential extracurricular conflicts
- ▶ e.g. religious observances, graduate or medical school interviews, or team activities
- ▶ I will try my best to help you with making accommodations, but cannot promise them in all cases.
- ▶ Missing an exam due to a non-emergency conflict that was not addressed with me in advance should result in a zero.

Academic Integrity

- ▶ Being able to find information is perhaps more important than knowing the information
- ▶ Homework: Groups are encouraged, but you must write up your own responses! No blatant copying and cite (simple is fine, MLA not needed) your classmate/wikipedia/etc. when appropriate.
- ▶ Project: use formal citations
- ▶ Exams: should be your work alone, so no citations!
- ▶ Not acceptable: cheating on exams, blatantly copying homework, and not participating in the project with your group. These will result in failing grades on said assignments and will be reported to the appropriate office.

Academic Integrity

In the event that an exam is disturbed via bomb threat, fire alarm, or other severe classroom disruption, I will announce to the class to grab your belongings and exit silently but immediately, leaving your exam behind in the classroom unless instructed otherwise. The decision on how to proceed with the exam will be made at the time of the alarm. Any talk about or looking at exam material before the exam is finished, without instructor permission, will constitute cheating and your exam will be graded as a zero. Use common sense and honesty and we'll all be fine!

Enrollment Issues

- ▶ Once enrolled, please only attend the lab section you are actually enrolled in, to make sure we have enough seats.
- ▶ Before enrollment, you are welcome to attend Friday labs, but only if there is room in the lab for the enrolled students.
- ▶ If you'd like to switch sections, use CalCentral. If there is no room in section you'd like to be in, you can add yourself to the top of waiting list... but this does essentially drop you from the course. For add/drop deadlines, see <https://registrar.berkeley.edu/calendar>.

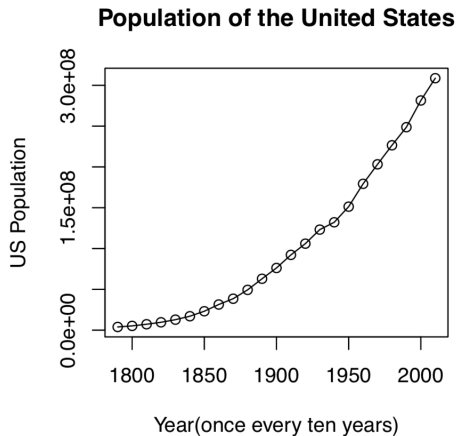
Enrollment Issues

- ▶ I must wait to enroll Concurrent Enrollment (CE) students until after the waiting list gets cleared.
- ▶ CE applications will be accepted on two criteria: 1) in order that applications were received, and 2) if up to date on all assignments.
- ▶ If you are a concurrent enrollment student and a California resident, please let me know.

Any Questions?

5 minute break, then we'll talk about time series!

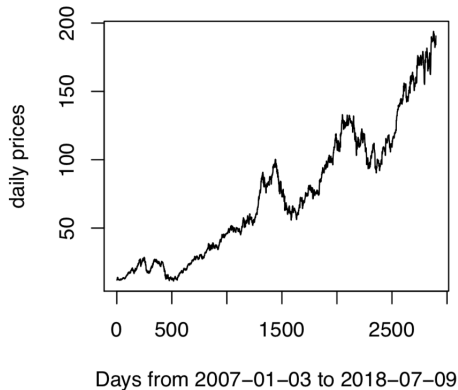
Population Data



Data: US Census Bureau

Financial Data - Apple Stock price

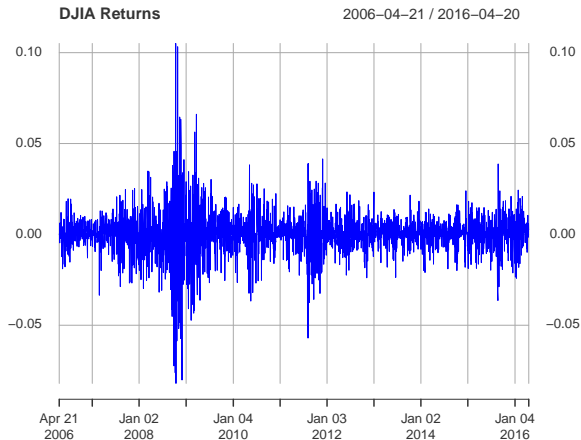
Stock prices of Apple Inc. (AAPL) stock



Financial Data - Dow Jones

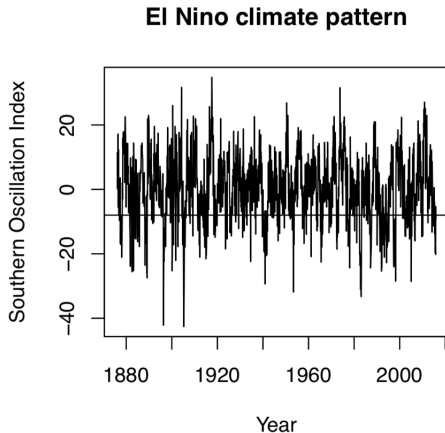


Financial Data - Dow Jones Returns



Example 1.4 - note the daily return $= \frac{P_t - P_{t-1}}{P_{t-1}} \approx \log \left(\frac{P_t}{P_{t-1}} \right)$

Climate Data - El Nino



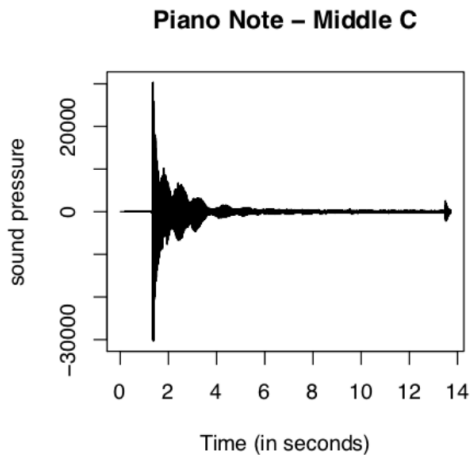
Data: Australian Government Bureau of Meteorology

Audio Data - Piano

Piano Note - Middle C

www.youtube.com/watch?v=FtqgqYRDTDg

Audio Data - Piano



Data: ? (Thanks Dr. Behr!)

Google's Cool Time Series Data

<https://trends.google.com>

<https://books.google.com/ngrams>

Why Time Series?

- ▶ Many statistics classes - assume a simple random sample: N independent, identically distributed observations (iid)

Why Time Series?

- ▶ Many statistics classes - assume a simple random sample: N independent, identically distributed observations (iid)
- ▶ Time series classes - N observations taken sequentially over time, so not independent and/or identically distributed!

Objectives

- ▶ Build models that plausibly describe the time series

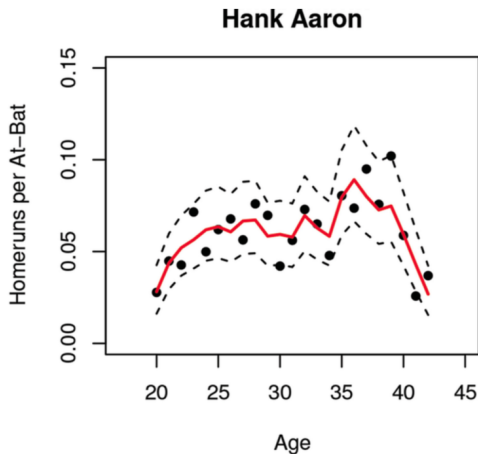
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- ▶ Build models that plausibly describe the time series
- ▶ Learn how to estimate these models

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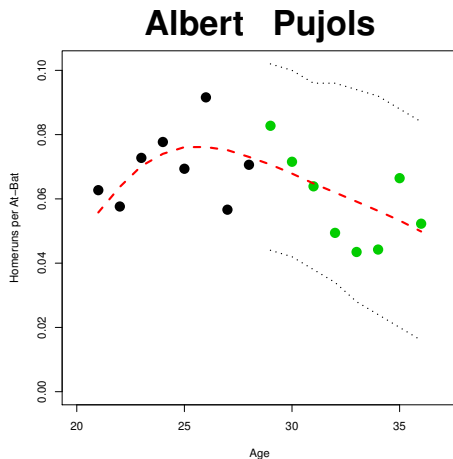
- ▶ Build models that plausibly describe the time series
- ▶ Learn how to estimate these models
- ▶ Learn how to predict/forecast with these models

Example: Baseball



Data: Lahman Database, Figure: Fellingham and Fisher (2018)

Example: Baseball



Data: Lahman Database, Figure: Fellingham and Fisher (2018)

Topics - A Tentative List

- ▶ Basics
 - ▶ Weak and strong stationarity
- ▶ Pursuing stationarity
 - ▶ Trend and seasonality models
 - ▶ Best linear prediction
 - ▶ Discrete Fourier transform and spectral density
 - ▶ Time invariant filters and power transfer function
- ▶ Modeling stationary processes
 - ▶ Moving average (MA), autoregressive (AR), ARMA models
 - ▶ Estimation: method of moments, least squares, maximum likelihood
 - ▶ ARIMA and SARIMA models
 - ▶ Diagnostics and model selection (AIC/BIC, crossvalidation)