



DSO-599 SPORTS PERFORMANCE ANALYTICS
Fall 2021 1.5 Units

Instructor: Lorena Martin, PhD
Class Time: **Monday** 12:30PM – 3:20PM (JKP-210)
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COURSE DESCRIPTION

This course is designed to examine how sports performance measurements, data collection, statistical models are implemented, interpreted, and presented in the pro sports industry. The course provides examples of different analytical models implemented in each of the following sports: basketball, football, baseball, soccer, and tennis. This course begins with a review of the fundamentals of sports performance measurements and the concept of training load. Physical performance measurements such as jumping ability, running speed, agility, strength, as well as the impact of psychological variables will be examined. The course reviews principles of the sports science data protocol implemented in pro sports team. Wearable technology marketed to professional athletes along with validity and reliability testing will be discussed. Examination of the statistical analyses applied to sports performance including drafting players, injury prevention and cost reduction will also be discussed. Throughout the course we will conduct exploratory data analysis, correlations, ANOVA, regression models, as well as non-parametric statistical models commonly implemented in pro sports. The course will culminate by learning how to develop reports using R markdown and tailoring it to different audiences such as coaches and front office executives. This course will provide real-world implications for athletes, coaches, front office executives, and professionals working in the sports industry.

COURSE OBJECTIVES

Upon successful completion of this course, students will be able to (see Appendix I):

1. Apply data science principles to sports performance, referred to as sports analytics.
2. Apply measurement and statistical modeling to professional athletes in sports.
3. Examine professional athletes' performance and implication of injuries on financial costs to industry.
4. Present data to different pro sports industry audiences: players, coaches, and front office management.
5. Comprehend the processes that take place from the inception of a research question, identification of key performance indicators, data collection, statistical analyses, and data visualization, also termed the sports science data protocol.

SUGGESTED BOOKS

Martin, L. (2016). *Sports Performance Measurement and Analytics: The Science of Assessing Performance, Predicting Future Outcomes, Interpreting Statistical Models, and Evaluating the Market Value of Athletes*. Old Tappan, N.J.: Pearson/FT Press [ISBN-13 978-0-13-419330-4].

Morrow Jr J, Jackson A, Disch J, Mood D. (2010). *Measurement and Evaluation in Human Performance* 4th Edition. Human Kinetics. [ISBN-10: 0736090398]. Chapters 1, 2, 9 and 11. Chapter 1: Concepts in Tests and Measurements, pages 3-16. Chapter 2: Using Technology in Measurement and Evaluation, pages 17-34. Chapter 9: Physical Fitness and Activity Assessment in Adults, pages 187-244. Chapter 11: Assessment of Sport Skills and Motor Abilities, pages 279-313.

Shea SM, Baker CE (2013). *Basketball Analytics: Objective and Efficient Strategies for Understanding How Teams Win*. Advanced Metrics, LLC. [ISBN-10:1492923176]. Chapter 10. A commentary on the Unpredictability of Outcomes, pages 111-116.

Anderson C. (2013). *The Numbers Game: Why Everything You Know About Soccer Is Wrong*. Penguin Books. [ISBN-0143124560]. Chapters 1 and 2. Chapter 1: Riding Your Luck, pages 22-65. Chapter 2: The Goal: Soccer's Rare Beauty, pages 66-92.

Marchi M. (2013). *Analyzing Baseball Data with R*. Chapman & Hall/CRC The R Series. [ASIN:B00MEYLZ4K]. Chapters 1 and 4. Chapter 1: The Baseball Datasets, pages 1-25. Chapter 4: The Relation Between Runs and Wins, pages 87-99.

No Prerequisites Needed

Structure

Each topic in the course is motivated by a data problem. Some of the data sets we will use are:

- Wearable Technology Output
- External Load (GPS, Accelerometer, Magnetometer, and Gyroscope) Data
- Internal Load (Physiological and Psychological) Data
- Collection of Behavioral (Sleep, Nutrition, etc.) Data
- Tennis (ATP/WTa) Tour Data
- Football (NFL/XFL) Data
- Soccer (UEFA/MLS) Data
- Basketball (NBA) Data
- Baseball (MLB) DATA

Topics:

- Data Science Tools: R and Rstudio
- Principles of the measurement model for sports
- Exploratory data analysis
- Multivariate analyses
- Sports Science Data Collection in Pro Sports
- Presentation of Graphics to three audiences: Players, Coaches, Front office management

GRADING

Assessment

- Homework – assignments are designed to encourage you to do that. For each homework assignment, you will need to revise the week's work, as well as synthesize some new information.
- Midterm – will consist of material from assigned readings, R code, and statistical analyses.
- Team Project and Presentation
For your final project, you'll be expected to find your own dataset by either obtaining sports data from repositories such as Github, Kaggle or web scraping from sites with publicly available sports data. A written report and presentation will be due. The report as well as the presentation should include a title page, abstract, introduction, methods, results, discussion, and references section as well as relevant data visualizations such as tables and figures. It is a group project (groups of 3-5).
- Final Exam - will consist of material from assigned readings, R code, and statistical analyses.

<u>Assignments</u>	<u>Points</u>	<u>% of Overall Grade</u>
Class Participation	10	10%
Homework	15	15%
Team Project and Presentation	20	20%
Mid-Term Exam	25	25%
Final Exam	30	30%
TOTAL	100	100%

CLASS PARTICIPATION

In-class participation is also a critical part of this course's learning experience. In-class participation grading will be based on students' demonstrated willingness to participate and the quality of the comments expressed, rather than quantity. While some students are far more comfortable than others with class participation, all students should make an effort to contribute meaningfully.

HOMEWORK

Assignments will consist of the lecture topics. Each homework assignment will consist of R coding, choosing a particular sport and respective dataset, statistical analysis and data visualization.

TEAM PROJECT

The objective of the project is to apply statistical models and measurement in order to assess sports performance. Teams will meet outside of class and provide a Team Project Proposal that will identify the sections responsible by each team member. Peer review for the team project will be collected at the end of the team presentation (see Appendix II).

- Sport has to be chosen by each team
- Role of team members (is your team a group of coaches, training staff, or front office)?
- What KPIs will be collected
- What models will be used to analyze the data?
- Who are you presenting to (Coach, Player, or Front Office Management)?
- Peer assessment will be included as a phase of the team project.

EXAMS

Midterm and Final Exams will be in class. Exams will consist of material from assigned readings, R code, and statistical analyses. Notes condensed to one page will be allowed to use to check statistical formulas.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, (www.usc.edu/scampus or <http://scampus.usc.edu>) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>. Failure to adhere to the academic conduct standards set forth by these guidelines and our programs will not be tolerated by the USC Marshall community and can lead to dismissal.

Synchronous Sessions

In order to earn full participation points, students must actively participate in all synchronous sessions via computer or laptop, with a webcam and headset/speakers. You are expected to be in a location with a reliable internet connection and without distractions. You need to be able to fully engage at all times. Students are expected to be visually present and to ask thought-provoking questions, offer relevant comments, and answer questions from faculty in a clear and concise manner. If the class meets at a time outside of 7:00am to 10:00pm in time zone, please consider registering for a section that meets then. If you are unable to do this, please contact your professor immediately. As outlined in the student handbook, there are specific expectations of a student attending class online. When attending, present and act appropriate as if you were in a physical classroom.

Please do:

- Attend class from a quiet area, free of distractions.
- Dress respectfully. Video conference business meetings are and will be the norm, so practice your professional telepresence.
- If you use a virtual background, please keep it respectfully professional
- Display both your first and last name during video conferencing and Synchronous class meetings.
- Respectfully minimize distractions by muting and or turning video off when moving around
- Engage in appropriate tone and language with instructors or classmates
- Disagree respectfully
- Respectfully pay attention to classmates

Please do not:

- Engage in a simultaneous activity (e.g., using a telephone, reading a book, knitting)
- Interact with persons who are not part of the class
- Leave frequently or not be on camera for extended periods of time
- Have other persons or pets in view of the camera
- Behave in an overtly inattentive manner (looking distracted, not participating)

Asynchronous Activities – Discussion Boards and emails

Our discussion boards are ways for you to share your ideas and learning with your colleagues in this class. We do this as colleagues in learning, and the Discussion Board is meant to be a safe and respectful environment for us to conduct these discussions.

Some Netiquette Rules:

- Engage in appropriate tone and language with instructors or classmates
- Disagree respectfully
- Do not use all CAPITAL LETTERS in emails or discussion board postings. This is considered "shouting" and is seen as impolite or aggressive.
- Do not use more than one punctuation mark, this is also considered aggressive!!!!
- Begin communications with a professional salutation (Examples: Dr. Name; Ms. Name; Hello Professor Name; Good afternoon Mr. Name). Starting without a salutation or a simple "Hey" is not appropriate.
- When sending an email, please include a detailed subject line. Additionally, make sure you reference the course number (Ex. BUAD101 in the message and sign the mail with your name.
- Use proper grammar, spelling, punctuation, and capitalization. Text messaging language is not acceptable. You are practicing for your role as a business leader.
- Re-Read, think, and edit your message before you click "Send/Submit/Post.". as a check, consider whether you would be comfortable with your email or post or text being widely distributed on the Internet.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1-800-273-8255 suicidepreventionlifeline.org

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call studenthealth.usc.edu/sexual-assault

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298 equity.usc.edu, or titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also

prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

USC Support and Advocacy - (213) 821-4710 uscsa.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101 diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, *HSC:* (323) 442-1000 – 24/7 on call dps.usc.edu, or emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, *HSC:* (323) 442-1200 – 24/7 on call dps.usc.edu
Non-emergency assistance or information.

Office of Disability Services and Programs - (213) 740-0776 ability@usc.edu.

USC is committed to making reasonable accommodations to assist individuals with disabilities in reaching their academic potential. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs. If you have a disability which may impact your performance, attendance, or grades in this course and require accommodations, you must first register with the Office of Disability Services and Programs <https://dsp.usc.edu/>. DSP provides certification for students with disabilities and helps arrange the relevant accommodations. Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me as early in the semester as possible. DSP is located in GFS (Grace Ford Salvatori Hall) 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday.

COURSE OUTLINE AND ASSIGNMENTS

	Topics/ Daily Activities	Readings	Deliverables
<i>Week 1</i>	Topics: Introduction Sports Organization and Data Science Roles in Sports Teams Overview of Athlete Management Systems implemented pro sports teams and organizations. Training Load External-Internal Load	Readings: Introduction Overview of the Class R Basics Different types of Key Performance Indicators Assignment: Identify Topic for Team Project	
<i>Week 2</i>	Topics: External Load KPIs - GPS, Accelerometer, Gyroscope, Magnetometer Establish Validity Internal Load KPIs - Physiological and Psychological Factors Intra/Inter-rater Reliability	Readings: McDuff, D. R., & Garvin, M. (2016). Working with sports organizations and teams. <i>International review of psychiatry</i> , 28(6), 595-605. Wagstaff, C. R. D., Gilmore, S., & Thelwell, R. C. (2015). Sport medicine and sport science practitioners' experiences of organizational change. <i>Scandinavian Journal of Medicine & Science in Sports</i> , 25(5), 685-698. Akenhead, R., & Nassis, G. P. (2016). Training load and player monitoring in high-level football: current practice and perceptions. <i>International journal of sports physiology and performance</i> , 11(5), 587-593. Assignment: Identify a wearable technology that quantifies external load.	
<i>Week 3</i>	Topics: Behavioral Variables (sleep and nutrition) Identification of KPIs Translation to sports performance	Readings: Barr, M., Beaver, T., Turczyn, D., & Cornish, S. (2019). Validity and Reliability of 15 Hz Global Positioning System Units for Assessing the Activity Profiles of University Football Players. <i>The Journal of Strength & Conditioning Research</i> , 33(5), 1371-1379. Halson, S. L. (2014). Sleep in elite athletes and nutritional interventions to enhance sleep. <i>Sports Medicine</i> , 44(1), 13-23.	HW1: DUE Examine data from chosen wearable Descriptives and Correlations

		Huyghe, T., Scanlan, A., Dalbo, V., & Calleja-González, J. (2018). The Negative Influence of Air Travel on Health and Performance in the NBA: A Narrative Review. <i>Sports</i>, 6(3), 89. Assignment: Choose an external load variable to run Intraclass correlation coefficients. Choose an internal load variable to collect data on for instance, sleep and nutrition for the week for a class partner or volunteer and establish Intra and Inter rater reliability.	
Week 4	Topics: Data Collection in Pro Sports Midterm	Readings: Sports Science Data Protocol Assignment: Regression Analyses Choose topic from class: Tennis WTA and ATP data or Football NFL or XFL data. Identify a sports science initiative that has been implemented in sports and critique what went right or wrong.	HW2: DUE External Load KPI Validation ICC and Internal load KPI and Intra and Inter Rater Reliability
Week 5	Topics: Football Analytics Tennis Analytics	Readings: Chapter 5 – Touchdown Analytics Chapter 9 – Game, Set, Match Analytics Assignment: ANOVA and Multivariate analyses. Choose from: UEFA and MLS or NBA.	HW3: DUE Regression Analyses from WTA and ATP or Football NFL or XFL
Week 6	Topics: Basketball Analytics Soccer Analytics	Readings: Chapter 6 – Slam Dunk Analytics Chapter 8 – Golden Goal Analytics Assignment: Finalize Team Project	HW4: DUE Multivariate Analyses from MLB or NBA
Week 7	Topics: Baseball Analytics Data Visualization to three key audiences Project Presentations	Readings: Chapter 7 – Home Run Analytics Kirmizibayrak, C., Honorio, J., Jiang, X., Mark, R., & Hahn, J. K. (2011). Digital Analysis and Visualization of Swimming Motion. <i>International Journal of Virtual Reality</i>, 10(3).	Team Project Due
Week 8	Final Exam		

Appendix I. MARSHALL GRADUATE PROGRAMS LEARNING GOALS

How DSO-599 Contributes to Marshall Graduate Program Learning Goals

Marshall Graduate Program Learning Goals	DSO-599 Objectives that support this goal	Assessment Method*
<i>Learning Goal #1: Develop Personal Strengths.</i> Our graduates will develop a global and entrepreneurial mindset, lead with integrity, purpose and ethical perspective, and draw value from diversity and inclusion.		
1.1 Possess personal integrity and a commitment to an organization's purpose and core values.	1,5	Team Project
1.2 Expand awareness with a global and entrepreneurial mindset, drawing value from diversity and inclusion.	1,5	Team Project
1.3 Exhibit awareness of ethical dimensions and professional standards in decision making.	1,5	Team Project
<i>Learning Goal #2: Gain Knowledge and Skills.</i> Our graduates will develop a deep understanding of the key functions of business enterprises and will be able to identify and take advantage of opportunities in a complex, uncertain and dynamic business environment using critical and analytical thinking skills.		
2.1 Gain knowledge of the key functions of business enterprises.	2,3,4	Lectures/HW
2.2 Acquire advanced skills to understand and analyze significant business opportunities, which can be complex, uncertain and dynamic.	2,3,4	Lectures/HW/ and Individual Project
2.3 Use critical and analytical thinking to identify viable options that can create short-term and long-term value for organizations and their stakeholders.	2,3,4	Lectures/HW/ and Individual Project
<i>Learning Goal #3: Motivate and Build High Performing Teams.</i> Our graduates will achieve results by fostering collaboration, communication and adaptability on individual, team, and organization levels.		
3.1 Motivate and work with colleagues, partners, and other stakeholders to achieve organizational purposes.	1,2,3,4,5	Team Project Presentation
3.2 Help build and sustain high-performing teams by infusing teams with a variety of perspectives, talents, and skills and aligning individual success with team success and with overall organizational success.	1,2,3,4,5	Team Project Presentation
3.3 Foster collaboration, communication and adaptability in helping organizations excel in a changing business landscape.	1,2,3,4,5	Team Project Presentation

Appendix II

SAMPLE PEER EVALUATION FORM

Please identify your team and team members for the ____ Project(s) that you worked on. Then rate all your team members, *including yourself*, based on the **contributions** of each team member for the selected assignment according to the criteria listed below. On a scale of 0 – 2 with 0 indicating does not meet expectations, 1 meets expectations and 2 exceeds expectations, rate each person on each of the five criteria. Lastly, add up the points for each person with the maximum number of points for each person being 10. In the box below, describe the exact contributions of each team member, including yourself.

Team Members/ Assessment Criteria of Team Contributions	Team Member 1	Team Member 2	Team Member 3	Yourself
1. Role Performance				
2. Assists Team Members				
3. Listening and Discussing				
4. Research and Information Sharing				
5. Time Management				
Total				

Contribution details: