* TITLE
  + Predicting Pit Stop Decisions in Formula1 Utilizing Bayes Equilibrium
  + Bayesian Analysis for Predicting Decision Making for Pit Stops in Formula One
* STUDENT(S)
  + Andrew Estes
* COMMITTEE
  + Chair/Advisor: Dr. Beregovska
  + Second: Dr. Alberts
  + Third: TDB
* DESCRIPTION
  + Formula1, also known as Formula One and F1, cars are the fastest road-course racing cars in the world. There are ten teams, each with two drivers, competing for two concurrent awards – best driver and best constructor (or team). The determination of these awards is made by the culmination of points earned during the course of the season. Points are awarded to the top 10 finishers of each race in a Fibbonaci Sequence-esque manner.
  + Several studies, as well as driver anectdotes, place over 80% of the standings based upon the construct of the car. That means the crucial edge when determining success lay in optimizing the last 20% - a combination of driver skill and strategy.
  + A Formula1 strategist is a data scientist at heart – running simulations and making adjustments on the fly to determine a pit stop strategy. The two considerations on pit stops include first the decision when to pit and second, what tyre compound to use. We are going to focus on the decision to pit, or not, and try to predict when a certain team or driver will make a pit stop.
  + When the thesis is ready to submit, the presentation will likely be provided in a PowerPoint format via Quarto. At the moment I cannot foresee any reason that a Shiny application would be a better visualization tool. Since the thesis uses both R and Python, a technical document rendering program like Quarto would be good to show various bits of code and perhaps some significant graphics.
  + The most ambitious idea would to run concurrently the prediction tool we are creating alongside a race to see how accurate we are.
* DATA/OTHER SOURCES
  + Supporting Docs
    - Bruce Bueno de Mesquita - The Predictioneer’s Game - <https://www.amazon.com/Predictioneers-Game-Brazen-Self-Interest-Future/dp/081297977X>
    - Bruce Bueno de Mesquita - A New Model for Predicting Policy Choices - <https://www.jstor.org/stable/26275398>
    - Norman Schofield - Instability of Simple Dynamic Games - <https://www.jstor.org/stable/2297259>
    - Avinash Dixit and Barry Nalebuff - Thinking Strategically, the Competitive Edge in Business, Politics, and Everyday Life - <https://terpconnect.umd.edu/~pswistak/GVPT%20100/Dixit%20and%20Nalebuff.pdf>
    - Erik Jan van Kesteren and Tom Bergkamp - Bayesian Analysis of Formula One Race Results: Disentangling Driver Skill and Constructor Advantage - <https://arxiv.org/pdf/2203.08489.pdf>
    - Harry Glahn - Statistical Weather Forecasting - <https://www.ecmwf.int/sites/default/files/elibrary/1982/9605-statistical-weather-forecasting.pdf>
  + Data
    - Reddit and Other forums for “expert” input
    - Fast F1 - <https://theoehrly.github.io/Fast-F1/examples/index.html>
    - Ergast API - <http://ergast.com/mrd/>
    - Race Strategies - <https://www.formula1.com/en/latest/article.strategy-guide-what-are-the-possible-race-strategies-for-the-2022-belgian.3rU2eOmR5tEMNrpukMd5Ar.html>
    - Supporting Projects
    - Accessing and Exploring - <https://pandeyparul.medium.com/accessing-formula-1-races-historical-data-using-python-b7c80e544f50>
    - Telemetry - <https://medium.com/towards-formula-1-analysis/how-to-analyze-formula-1-telemetry-in-2022-a-python-tutorial-309ced4b8992>
    - Reinforcement Learning for Optimal Box and Tyre Strategy - <https://towardsdatascience.com/reinforcement-learning-for-formula-1-race-strategy-7f29c966472a>
    - To Box or Not To Box - <https://medium.com/towards-formula-1-analysis/formula-1-data-analysis-tutorial-2021-russian-gp-to-box-or-not-to-box-da6399bd4a39>
    - Race Winner Predictor - <https://towardsdatascience.com/formula-1-race-predictor-5d4bfae887da>
    - Pit Stop Strategy Analysis - <https://statathlon.com/analysis-of-the-pit-stop-strategy-in-f1/>
    - 2016 Australian Grand Prix Box and Tyre Strategy - <https://www.racefans.net/2016/03/20/2016-australian-grand-prix-tyre-strategies-and-pit-stops-2/>
    - 2017 Australian Grand Prix Tyre Degradation - <https://www.f1technical.net/forum/viewtopic.php?t=26536>
    - Max vs LeClerc, Traffic, Strategy, and Degradation - <https://tracinginsights.substack.com/p/max-easily-won-the-race-but-what>
    - Bayesian Approach to Baseball - <https://www.sports-management-degrees.com/baseball/>
    - Building a Race Simulator - <https://f1metrics.wordpress.com/2014/10/03/building-a-race-simulator/>
    - Various F1 Analysis by driver, by race, by historical driver, etc - <https://www.formulae.one/home>
    - Various F1 Analysis by driver, by race, by historical driver, etc - <https://tracinginsights.substack.com/>
    - NFL Big Data Bowl, perhaps additional analysis ideas - <https://operations.nfl.com/gameday/analytics/big-data-bowl/>
    - Adjusting long-range dependence and fractional multinomial distribution
    - <https://www.researchgate.net/publication/363652349_A_finite-state_stationary_process_with_long-range_dependence_and_fractional_multinomial_distribution>
  + Where to Publish
    - <https://www.sfu.ca/~tswartz/papers/publish.pdf>
* SECURITY/ETHICS
  + Minority Report is a 2002 movie where a special police unit can arrest murderers prior to the murder happening. This system works fine until a member of the special unit finds himself as the murderer. If he commits the murder, then the system is fine, but if he doesn’t, what does that say about the rest of the incarcerated people?
  + This thesis topic is also about predicting human decisions and behavior. Not to the extent of murder but if we create a fairly accurate model, then further research could fall down the Minority Report rabbit hole.
  + One add-on to this project would be using it to determine if a NFL team will go for it on 4th down or not. There are already numerous models determining win-probability differentials but coaches are not fully rational (a 51% chance to increase winning may not lead to going for it on 4th down). In the NFL, if we can predict a coach will go for it on 4th and 2 but not 4th and 3, that changes the mindset and goal for the defense.
  + However, at a certain point, people might break from the pattern just to throw some irrationality into the mix. That could lead to model problems.
  + Data can be used to extrapolate other parts of someone’s personality. This is already commonplace with the various psychological tests, but adding additional software analysis could reduce the ability for nuanced opinions.