

Where Data Meets Decisions:

New Python Notebook Examples that Combine Machine Learning and Mathematical Optimization

Aug 30 – 11AM EDT | WEBINAR

Agenda

WELCOME

GUROBI'S EXAMPLE LIBRARY

More about our educational python notebooks

ABOUT OPTIMIZATION

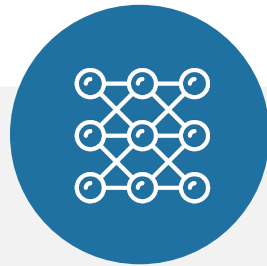
Why do data scientists care about optimization and how can they combine predictive and prescriptive analytics

THE NEW NOTEBOOKS

1. Music Recommendation Systems
2. Creating the Optimal Fantasy Lineup
3. Avocado Price Optimization

Who is this webinar for?:

Combining ML + Optimization



PRACTITIONERS

Data Science



ACADEMICS

Students or
Faculty: OR, DS, or
Analytics



PRACTITIONERS

Operations
Research



Education: Learners & Instructors

Examples to help introduce optimization to those familiar with predictive analytics who might benefit from combining data science and optimization

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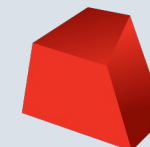
New Python Notebook Examples that Combine Machine Learning and Mathematical Optimization



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GUROBI
OPTIMIZATION

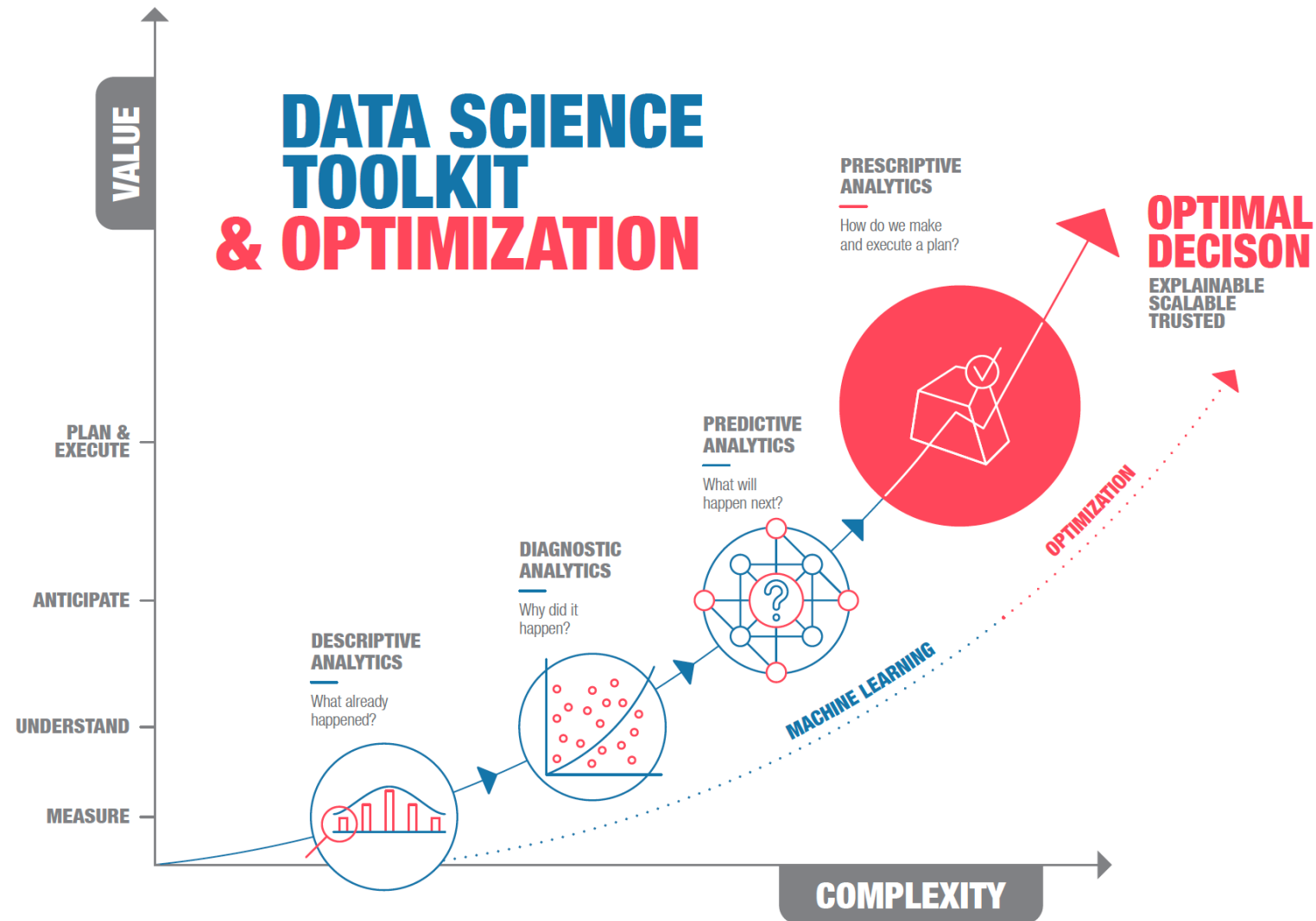
Gurobi's Example Notebook Library

- Introductory to advanced examples
- Key features of Gurobi and the Python API
- Show the power of combining predictive analytics with prescriptive
- Provides a great way to experiment and learn with mathematical optimization
- Covers numerous industries

- 
- Telecommunications
 - Logistics
 - Financial Services
 - Energy and Utilities
 - Healthcare
 - Food and Agriculture
 - Research, Analytics, and Optimization
 - Manufacturing
 - Metals and Mining
 - Oil and Gas
 - Transportation
 - Services
 - Government
 - Professional Services
 - Airlines

What is Meant by Data Meets Decision?

Predictive models only give you part of the solution



What is Mathematical Optimization?

A lightning-fast introduction

- Prescriptive analytics or decision intelligence
- Works best for problems where...
 - Decisions are to be made and the number of possibilities is huge
 - Some decisions may not be allowed
 - Some decisions are quantifiably better than others
- Scalable from improvements in algorithms and hardware
- Versatile way of modeling – not case specific!
- Guarantees the solution is **feasible** and **optimal**!
- Building blocks
 - Decision variables: Continuous, integer, binary
 - Constraints
 - Objective function

Each notebook will go through
defining these building blocks

Three New Notebooks

Music Recommendation System

Collaborative filtering + Integer program

Fantasy Basketball Lineup

Regression + Integer program

Avocado Price Optimization with Elastic Demand

Regression + Quadratic program

I. Music Recommendation System

Recommend products to users

NETFLIX



amazon

YouTube

facebook



Harry Potter



The Triplets of Belleville



Shrek



The Dark Knight Rises



Memento



?

Predict preference



Optimize recommendation

Typical output: A preference score distribution for unknown products

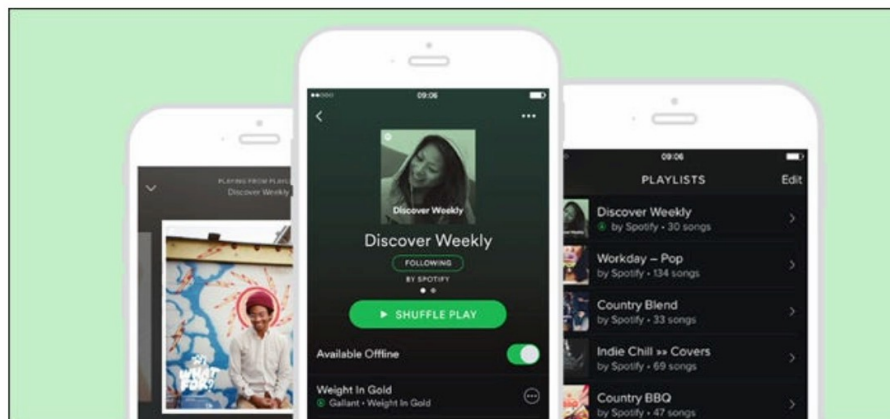
What if want the recommended products to satisfy certain constraints?

Integer Programming

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A Music Recommendation System With Mathematical Optimization

A good song never gets old, except when it does. Music streaming services like Spotify periodically provide their millions of users with curated music recommendations to keep them wanting to come back for more. It is important that these recommendations truly resonate with their users, while also introducing them to novelty that keeps their curiosity alive.



Spotify's "Discover Weekly" Feature. Image Credits: [How-To-Geek](#)

In this notebook, we will walk-through how to create a music recommendation system using a mixture of predictive and prescriptive analytics. The predictive component foresees what users might be into based on their past music preferences, while the prescriptive component uses these predictions to create an optimally diverse recommendation list.

Goal: Recommend new artists to users such that the artists are likeable and diverse.

The datasets used in this notebook are pre-processed from two Kaggle datasets:

- [Encrypted user data \(Pichl, Zangerle and Specht, 2015\)](#) with playlists created by [Spotify](#) users, and
- [Artist data](#) with musician demographics collected from [Musicbrainz](#) and [Last.fm](#).

Pichl, Martin; Zangerle, Eva; Specht, Günther: "Towards a Context-Aware Music Recommendation Approach: What is Hidden in the Playlist Name?" in 15th IEEE International Conference on Data Mining Workshops (ICDM 2015), pp. 1360-1365, IEEE, Atlantic City, 2015.

II. Creating the Optimal Fantasy Lineup

A quick primer for fantasy sports

- Building “dream teams”
 - Traditional and E-sports
 - Each player’s performance is distilled to “fantasy points”
 - Positional requirements and salary cap
 - Can play for fun or for money
- Fantasy sports is extremely popular
 - 60 million users in the US and Canada in 2017*
 - \$20 billion market value of globally in 2022**
- Creating an optimal lineup is not easy



The 1992 Dream Team

www.usab.com

Predict
fantasy points



Optimize
lineup

*Fantasy Sports and Gaming Association

**www.businesswire.com



+ Code + Text Copy to Drive



Editing



Creating the Best Fantasy Basketball Lineup

Introduction

Fantasy basketball, and fantasy sports in general, is an extremely popular game where participants compete against each other by virtually selecting players from real upcoming games to create a lineup. Typically, the goal is to assemble the best all-star team, meaning participants are allowed to select players from different professional teams that compete in the same league to play in each coach's virtual team.

A basketball team typically consists of five players: a point guard (PG), a shooting guard (SG), a small forward (SF), a power forward (PF), and a center (C). Each player, assigned to these positions, can have different characteristics and objectives in the basketball game. A shooting guard might specialize in scoring, while a point guard's objective might be to run the game-plan and distribute the ball efficiently. To help compare players across different positions we need to find a common metric to assess each player's performance -- and we'll use fantasy points to do this.

In a follow-on example we will extend the optimization model to reflect actual fantasy basketball competitions found on major sites.

Objective and Prerequisites

In this example, we'll take on the role of a basketball coach and learn how to find the optimal lineup of National Basketball Association (NBA) players in the context of fantasy basketball. The goal is to select the five players who are going to perform the best in the NBA games played on December 25, 2017, by simultaneously satisfying player and position eligibility and budget constraints.

III. Avocado Price Optimization

How to set the optimal price of an avocado?

- Avocado sales is a \$2 billion industry in the US
- Let's say you supply avocados to the US
 - How to decide the **price** of an avocado?
 - How much to **supply** to each region?
- Data available from Hass Avocado Board



Image courtesy: DALL·E

Predict
demand



Optimize
price & supply

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How Much Is Too Much? Avocado Pricing and Supply Using Mathematical Optimization

A [Food Network article](#) from March 2017 declared, "Avocado unseats banana as America's top fruit import." This declaration is incomplete and debatable for reasons other than whether avocado is a fruit. Avocados are expensive.

As a supplier, setting an appropriate avocado price requires a delicate trade-off. Set it too high and you lose customers. Set it too low and you won't make a profit. Equipped with good data, the avocado pricing and supply problem is *ripe* with opportunities for demonstrating the power of optimization and data science.

They say when life gives you avocados, make guacamole. Just like the perfect guacamole needs the right blend of onion, lemon and spices, finding an optimal avocado price needs the right blend of descriptive, predictive and prescriptive analytics.



GUROBI: ALWAYS FREE FOR ACADEMICS

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Introducing:



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Thank You

Questions?