We were able to solve our sports scheduling problem with 4 teams, 24 decision variables, and 22 basic constraints, pretty quickly.

However, the problem size increases rapidly.

The same problem with 10 teams, would have 585 decision variables and 175 basic constraints.

For scheduling major league baseball, the problem has 100,000 decision variables and 200,000 constraints.

For small problems, spreadsheet softwares, like LibreOffice, are great.

But for large problems like this, solving them in LibreOffice would be impossible.

So how are integer optimization models like this solved in practice?

Many different tricks are used to solve large integer optimization problems.

One is to reformulate the problem.

The sports scheduling problem with more teams is often solved by changing the formulation.

Instead of the decision variables we discussed in this lecture, the variables are sequences of games.

Additionally, the problem can be split into three smaller problems that can each be self separately and much faster than just solving the whole problem.

Another trick that's often used, is what are called Heuristic methods.

These methods find good, but not necessarily optimal decisions.

A good decision is sometimes accepted since the problem is so much easier to solve using a heuristic method.

In addition to changing the formulation in using heuristics, there are general purpose optimization solvers that can solve large problems.

These include CPLEX, Gurobi, GLPK and Cbc, a COIN-OR project.

Most practitioners who solve large optimization problems use one of these software packages.

And in the past 20 years, the speed of integer optimization solvers has increased by a factor of 250,000, which doesn't even include the increasing speed of computers.

Assuming a modest machine speedup of 1,000, this means that a problem that can be solved in one second today, took seven years to solve 20 years ago.

Because of this increase in speed were able to solve much larger and more complicated optimization problems today, than just a few years ago.

So how about the sports scheduling problem?

When the Sports Scheduling Group was started in 1996, integer optimization software was too slow to be useful.

Now, they can use powerful solvers to generate sports schedules.

Even with these solvers, it can take months to make the major league baseball schedule.

This is due to several reasons, including the enormous list of ever changing constraints that they have to account for, the need to define priorities on the constraints to find a feasible solution, and the fact that it takes several iterations to get a good schedule.

But even with these challenges, analytics offers a significant edge in sports scheduling.

The use of optimization allows for the addition of new constraints or schedule changes.

A new schedule can easily be generated based on an updated requirement or request.

Now, all professional sports and most college sports, construct their schedules using optimization.

In this lecture, we've seen one powerful use of integer optimization, but this method has a huge number of applications, which you'll see more of in the second lecture, The Recitation, and in the homework assignment.