What is planning problem? Explain with example.

The *planning* problem in Artificial Intelligence is about the decision making performed by intelligent creatures like robots, humans, or computer programs when trying to achieve some goal. It involves choosing a sequence of actions that will (with a high likelihood) transform the state of the world, step by step, so that it will satisfy the goal. The world is typically viewed to consist of atomic *facts* (state variables), and actions make some facts true and some facts false.

Planning problems are everywhere! Have you ever moved houses and needed to fit all your belongings into a moving truck? Usually you put all the big stuff in first, and then cram the little stuff in between. But what is bigger? A tall, thin closest or a wide one-person couch? Maybe you could have stacked your stuff better so you didn't need to pay for that extra moving truck?

Have you ever wondered about how they schedule trains? They need to minimize the commune between any 2 relevant train stations, while complying to their resource limits: train sizes, train speed, physical location of train sets, employee working hours, employee qualifications, occupancy of train station platforms, weekly maintenance, ...

Did you ever try to plan a meeting, just to find that on the one day that all participants can attend, all meeting rooms are occupied? Or there's no available beamer?

The world is full of planning problems.

In this article I'll focus on solving a very simple lesson schedule:

* A school has teachers, student groups and a bunch of lessons (which combine 1 teacher with 1 student group). Those lessons need to fit into a limited number of timeslots.
* The goal is to avoid conflicts: a teacher can't teach 2 lessons in the same timeslot and a student group can't attend 2 lessons in the same timeslot either.
* A planning problem has a score function, which determines the score for any possible solution we can construct. Based on that score, we can compare solutions and determine the optimal solution. There is usually only 1 optimal solution, but the number of possible solutions is huge.
* For example, let's take a medium school with 30 student groups, 40 teachers and 33 timeslots. Each student group has a lesson in each timeslot, which makes 990 lessons. In how many distinct ways can those 990 lessons be scheduled into 33 timeslots? In other words, how many possible solutions does it have? Well, this example has 33 ^ 990 or a little over 2e1503 possible solutions. Yes, for a medium school, that number is a 2 with 1503 zero's behind it!
* Calculating the score of a single solution can take quite some time, as every teacher and student group needs to checked on conflicts with any other teacher or student group. Due the sheer size of the search space and real-world time constraints, it normally suffices to find a “good enough” solution, better than those of human planners.