CSP VARIANTS AND APPLICATIONS

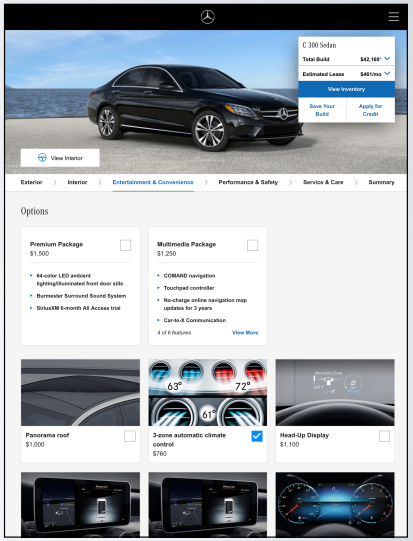
CSE 511A: Introduction to Artificial Intelligence

CSP VARIANTS

- Assume that the problems of interest are map coloring problems.
  - What is the minimum number of colors needed?
    - *Repeated CSPs*
  - What is the best solution if we don't have enough colors?
    - *Max-CSPs: find a solution with the smallest number of violated constraints*
  - What if the boundaries change over time?
    - *Dynamic CSPs: find solutions to a sequence of CSPs*
  - What is the best solution if we want to incorporate color contrasts?
    - *Weighted CSPs: constraints have associated costs; find solution that minimizes sum of constraint costs*

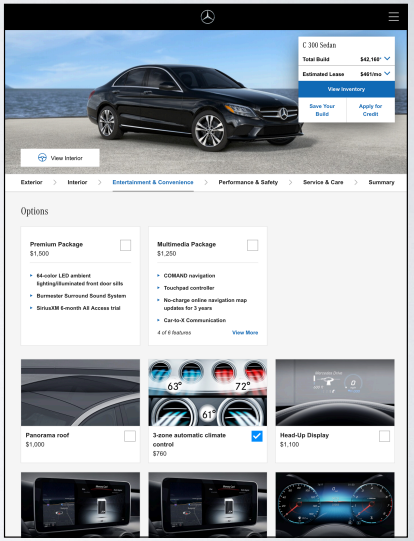
PRODUCT CONFIGURATION

- *Given a configuration of a product, is it feasible?*
- Example: Mercedes Benz C class
  - Thermotronic 3-zone air conditioning
  - Allows you to control the individual temperature and air supply settings while taking factors such as outside temperature, humidity and sunlight into account
  - Source: *http://www.mercedes-benz-nc.com/comfort.0002-13.html*



PRODUCT CONFIGURATION

- *Given a configuration of a product, is it feasible?*
- Example: Mercedes Benz C class
  - Thermotronic 3-zone air conditioning
  - May only be used if a high-capacity battery is also built in, except when combined with larger engines with 2.6 or 3.2 liters cylinder capacity
  - Source: *Carsten Sinz's PhD thesis*



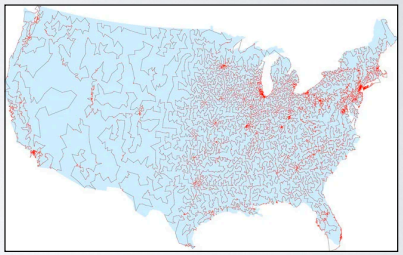
MULTIAGENT PATHFINDING

- *Given a fleet of vehicles and a set of destinations for each vehicle, what is the optimal route for each vehicle to get to its destination?*
  - Important for automated warehouses
  - Problem was initially solved using heuristic search techniques that generalize A*
  - Algorithms are now augmented with constraint propagation methods to further speed them up

Source: *https://www.youtube.com/watch?v=aYkG05Gy0rE*

VEHICLE ROUTING

- *Given a fleet of vehicles and a set of locations, what is the optimal route for each vehicle such that all locations are visited?*
  - Important for logistics companies (e.g., Amazon, FedEx, UPS, etc.)
  - Optimally solving the problem is too time consuming and often impractical because travel time on routes are uncertain due to traffic, weather, etc.
  - Finding good feasible solutions can be done quickly using optimized CP solvers



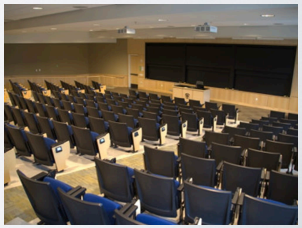
The shortest traveling salesman route going through all 13,509 cities in the United States with a population of at least 500 (as of 1998)

Source: *https://www.wired.com/2013/01/traveling-salesman-problem/*

SCHEDULING

- Flight scheduling:
  - *Given a set of flights departing an airport and their corresponding constraints (e.g., size of aircraft, airline, domestic/international flight), when should they depart and which gate should they depart from?*
- Classroom scheduling:
  - *Given a set of classes and their corresponding constraints (e.g., number of students enrolled, need for social distancing, technology requirements), when and where should they be scheduled?*

Source: *https://www.dreamstime.com/*



Source: *https://eventmanagement.wustl.edu/items/pooled-classrooms/*