# Assignment3: Decisions

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## Exercise 3.4 (Decision Network)

You need a new car. Your local dealership has two models on offer

- $C_1$ for \$1500 with market value \$2000
- $C_2$ for \$1150 with market value \$1400

Either car can be of good quality or bad quality. if $C_1$ is of bad quality, repairing it will cost \$700, if $C_2$ is of bad quality, repairing it will cost \$150.

You have the choice between two tests:

1. $Test_1$ at cost \$50: This will confirm that $C_1$ is of good quality (if it is) with certainty 85% probability, and that it is of bad quality (if it is) with certainty 65%.
2. $Test_2$ at cost \$20: This will confirm that $C_2$ is of good quality (if it is) with 75% certainty, and that it is of bad quality (if it is) with certainty 70%.

The a priori probability (without any tests) that a car is of good quality is 70% for $C_1$ and 65% for $C_2$.

The utility function is the monetary value, i.e., the difference of the market value of the acquired car and the amount of money spent on test, car, and repair.

1. Explain the involved random variables and their domains.

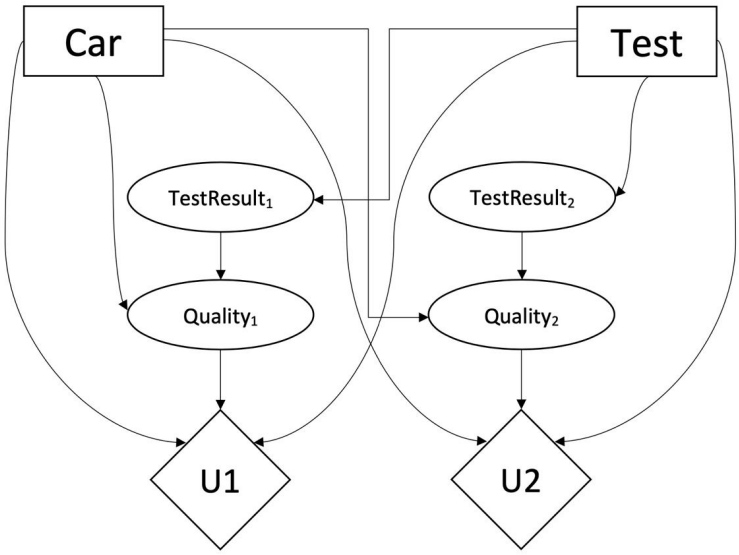
   Random variables:

   - $Quality_1 \in \{good, bad\}$ - quality of $C_1$
   - $Quality_2 \in \{good, bad\}$ - quality of $C_2$
   - $TestResult_1 \in \{good, bad\}$ - the result of quality of $C_1$
   - $TestResult_2 \in \{good, bad\}$ - the result of quality of $C_2$

Variables:

- $Test \in \{noTest, Test_1, Test_2\}$ - a type of test
- $Car \in \{C_1, C_2\}$ - a car

2. Draw the decision network for which test to apply and which car to buy in either case. This should include:
   - an action node for the test decision
   - an action node for which car to buy
   - utility nodes for each of the two cars
   - chance nodes for the quality of the cars and the outcomes of the tests




3. Explain the difference regarding the probability tables of the three kinds of nodes.
   - action node(rectangle) - there is no any table here, because it's our action. It depends only on set of possible actions.
   - random variable node(ellipse) - the probability table with a dimension equal to the number of parents
   - utility node(diamond) - the utility table with a dimension equal to the number of parents

4. Assume we have chosen to do $Test_1$ and the outcome was good. Compute which car to buy.

   $EU_1(Car = car_1 | Test = Test_1, TestResult_1 = good) = \sum_{Q \in Quality_1} P(Q | TestResult_1 = good) \cdot U_1(Car = car_1, Test = Test_1, Quality_1 = Q) = 0.85 \cdot (2000 - 1500 - 50 - 0) + (1 - 0.85) \cdot (2000 - 1500 - 50 - 700) = 345$

   $EU_2(Car = car_2 | Test = Test_1, TestResult_1 = good) = \sum_{Q \in Quality_2} P(Q) \cdot U_2(Car = car_2, Test = noTest, Quality_2 = Q) = 0.65 \cdot (1400 - 1150 - 0 - 0) + (1 - 0.65) \cdot (1400 - 1150 - 0 - 150) = 197.5$

   Since $EU_1 > EU_2$ It would be better to buy $C_1$ given to do $Test_1$ and the outcome was good.