Notes on pp. 24 - 29 (ch. 2)

1. pp. 24 - 25

To make a decision using the tools of decision theory (and game theory), we need to have a clear value assigned to each outcome. If the outcomes are different amounts of money, as they are here, then we can use money as the measure of value.

	Sloppy Stan wins	**Wobbly Pete wins**	**Dave wins**
bet on Sloppy Stan	\$10	-\$4	-\$4
bet on Wobbly Pete	-\$4	\$10	-\$4
bet on Dave	-\$12	\$5	\$10

This, however, is a decision problem in which most of the outcomes are not amounts of money:

	red is drawn	**blue is drawn**	**yellow is drawn**	**green is drawn**
bet 1	trip to Rome	Ethan Allen sofa	1 year supply of dog food	trip to London
bet 2	65-inch TV	riding lawn mower	hot tub	\$1800

Each of these outcomes has a monetary value, of course, and so one way to assign a value to each outcome is to use each item's monetary value. One shortcoming of doing it this way is that a person might want a lower costing item more than a higher costing one. For instance, let's say that the monetary value of the riding mower is \$1,200 and the monetary value of the one-year supply of dog food is \$900, but the person making the decision lives in an apartment and has a dog. This person might want the one-year supply of dog food much more than the riding mower.

The alternative is to use utility values. Utility values are based on the "relative importance or utility of items in the class to the agent" (p. 24, bot.). Or, instead of *relative importance*, we might say that these values are based on how much the agent wants or desires the items. One way of determining utility values is to start with the agent's preference orderings for the outcomes. Let's say that the person making this decision has these preferences:

> hot tub **P** sofa, Rome **I** hot tub, sofa **I** $1800, sofa **P** London, dog food **I** mower, dog food **I** tv, London **P** tv, and $1800 **P** tv

Given these preferences, try listing these outcomes from most preferred to least preferred. (Since this hypothetical agent is indifferent between some of the items, there will be some ties.) Once we have the list, we assign utility values, which will just be whole number starting at 1 like Resnik has at the bottom of p. 24. So, after you have ranked the outcomes, assign the lowest valued outcomes (it will be a three-way tie) a 1, the next lowest a 2, and so on.

The list with utility values is at the end of this document.

Assigning utility values in this way gives us an **ordinal utility scale**. This means that the numbers represent the order but nothing else. They doesn't, for instance, tell us *how much more* the person values the trip to Rome than the sofa, just that it is more valued. (See also what Resnik says in the last full paragraph on p. 25—the paragraph that begins, "Ordinal scales represent.")

Nonetheless, with our utility values, we can now represent the decision problem this way:

	red is drawn	**blue is drawn**	**yellow is drawn**	**green is drawn**
bet 1	4	3	1	2
bet 2	1	1	4	3

Remember, when we do this, we are representing a decision problem *for a specific agent*. Anyone else (you for instance), might have different preferences and so end up with different utility values.

Nonetheless, once we have a decision table with utility values instead of just the items themselves, we can begin to apply the rules and principles of decision theory. You've already encountered the dominance principle on p. 9. On p. 25, Resnik formulates it in terms of utility values (but it's the same principle).

In this decision problem, does either option dominate the other? (No, for some states, bet 1 does better and for some states, bet 2 does better.)

Here is another decision problem with utility values. Does any option dominate any other option? Is there an option that dominates all of the others?

	state 1	**state 2**	**state 3**	**state 4**
option 1	6	1	0	-2
option 2	3	-3	5	4
option 3	7	2	1	-1

Between option 1 and option 2, neither option dominates the other. (Sometimes option 1 is better; sometimes option 2 is better.) Between option 2 and option 3, neither option dominates the other. (Sometimes option 2 is better; sometimes option 3 is better.)

Option 3 dominates option 1, however. For every state, choosing option 3 yields a higher valued outcome than option 1. Since option 1 is dominated, we rule it out. This, in effect, leaves us with this decision problem:

	state 1	**state 2**	**state 3**	**state 4**
option 2	3	-3	5	4
option 3	7	2	1	-1

The dominance principle can't help us choose between these two remaining options. So, we will turn to some other guidelines.

When you are given a decision table without any further information about the decision itself, you can assume that numbers without a $ are utility numbers. You don't need to worry about the transformation of utility scales that Resnik discusses on p. 25. And numbers that start at 1 and increase by single digits (e.g., 1, 2, 3, etc.) are the best way to think about (and understand) utility values that are on an ordinal scale.
But the concept of transformations lets us have numbers that are negative and are non-consecutive—e.g., -3, -1, 3, 4, 7. There might be some decision problem in which having those utility values instead of just 1, 2, 3, 4 5, serves some purpose, but we won't get into that in this chapter. Resnik (and I) will use utility numbers that are negative and are non-consecutive, though, because they often make it easier to learn the decision rules that are covered in chapter 1.

2. Section 2-2, pp. 26 - 27

First, we have the **maximin rule**. (And this can be used with monetary values or utility values.)

Read Resnik's explanation of this rule in the first paragraph of section 2-2. It's pretty simple. For each option, identify the lowest valued outcome. Pick the option that has the highest minimum.

So, for our previous decision problem, the lowest valued outcome for option 2 is -3 (if state 2 happens) and for option 3 it's -1 (if state 4 happens). The higher of these two minimums is the -1, and so according to the maximin rule, we should choose option 3.

	state 1	**state 2**	**state 3**	**state 4**
option 2	3	-3	5	4
option 3	7	2	1	-1

If we are using the maximin rule and end up with a tie (i.e., two options have the same highest minimum values), then we use the **lexical maximin rule** (p. 27, top), which just tells us to look at the next lowest values for those two options and choose the highest.

At the end of section 2-2, Resnik gives us this decision problem. If we are using the maximin rule, which option should we choose?

	state 1	state 2
option 1	$1.50	$1.75
option 2	$1.00	$10,000

What point is Resnik making with this example?

3. Section 2-3, pp. 28 - 29

Our next rule is the **minimax regret rule**. Resnik explains the motivation behind this rule in the first paragraph of section 2-3.

When we use this rule, we start with a regular decision table. (That is, one that represents a decision problem.) We then create a second table called the ***regret table***.

Let's start with the decision problem from the end of section 2-2.

	state 1	state 2
option 1	$1.50	$1.75
option 2	$1.00	$10,000

To create the regret table, we compare the outcomes for each state (i.e., in each column). First, identify the highest valued outcome in a column. (That's what Resnik refers to as MAX on p. 28.) Then, subtract each value in that column from MAX, and put the result in the corresponding cell in the regret table. (On p. 28, Resnik only refers to utility values, but this rule can be used with utility or monetary values.) This is the regret table:

	state 1	state 2	*maximum regret*
option 1	$0 ($1.50 - $1.50)	$9998.25 ($10,000 - $1.75)	$9998.25
option 2	$0.50 ($1.50 - $1.00)	$0 ($10,000 - $10,000)	$0.50

Once we have the regret table completed, we need to find the highest regret for each option. (In other words, how much regret are you opening yourself up to if you pick each option?)

Then, we select the option with the ***lowest maximum regret***. In this case, if we are following the minimax regret rule, we would select option 2—in doing so, we minimize our possible regret.

If you don't exactly remember how to manipulate negative numbers when you are subtracting, you should make sure that you figure it out before the test. Here is the basic idea for the calculations that you might have to do to create a regret table:

four minus negative one = 4 - (-1) = 4 + 1 = 5

negative one minus negative six = -1 - (-6) = -1 + 6 = 5

When applying the minimax regret rule, the first value can be positive or negative, but the second number has to be smaller. If the second number is negative, then the operation, in effect, becomes addition—e.g., '… - (-7)' becomes '… + 7'.

If you are using the calculator on your phone, use the +/- key to designate a negative number, not the minus operator.

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utility	**outcome**
4	hot tub, trip to Rome
3	Ethan Allen sofa, $1800
2	Trip to London
1	65-inch TV, one-year supply of dog food, riding mower