# Week 1 Summary: Introduction. Decision Trees.

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## Contents



# 1 Peterson CH1: Introduction

## 1.1 Terms

| Term | Definition/Explanation | Notes |
|---|---|---|
| Risk | $\mathbb{P}$(outcomes) known | |

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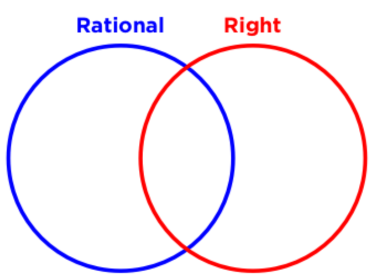
| **Term** | **Definition/Explanation** | **Notes** |
|---|---|---|
| Ignorance | $\mathbb{P}$(outcomes) unknown | |
| Uncertainty | (Ignorance) $\vee$ (Risk $\cup$ Ignorance) | Context-dependent :( |
| Rational | Most reasonable outcome (ex ante) | I assume reasonability is based on available info |
| Right | Outcome is (at least weakly) pareto dominant. (ex post) | |
| Social Choice Theory | More than one decision maker | Some collective entities can be reduced to single decision makers ($\therefore$ not SCT) |

### 1.1.1 Self-Explanatory

- Decision-maker
- Set of alternatives
- True state of the world
- Outcome
- Principle of maximizing expected value

## 1.2 Right vs Rational

Due to imperfect information, rationality does not necessarily correspond to rightness.




## 1.3 Claim: Pragmatically, Normative Decision Theory > Descriptive Decision Theory

Author claims that people behave rationally most of the time as they have good lives. Possibly flimsy argument (I don't like it).

### 1.3.1 My Problems with it

- `Rational` $\neq$ `right`, as seen above. E.g. maybe good lives are due to instinct rather than rationally correct behaviour
- People aren't living close to their best possible lives. Most of their lives suck. IMO people operate on habit more than reason

## 1.4 Instrumental Rationality

Presupposes an aim (which is external to `decision theory`)

#### 1.4.1 Is this aim always rational?

- Widely thought that single aims cannot be evaluated in terms of rationality (though sets of aims can be irrational, e.g. inconsistent)
- John Rawls argues some aims are irrational (e.g. counting blades of grass on a courthouse lawn is too unimportant to be rational)
  - IMO, problematic argument. Importance varies according to values, values vary between people and even within the same person they are temporally inconsistent

### 1.5 Jean-Jacques Rousseau's `Stag Hunt`

| | stag | rabbit |
|---|---|---|
| stag | 5 , 5 | 0 , 3 |
| rabbit | 3 , 0 | 3 , 3 |

- Tension between risk minimization and outcome maximization
- Rational choice is solely and directly dependent on `trust`

### 1.6 History of Decision Theory

#### 1.6.1 Period 1: Old Period (Ancient Greece)

- Normative decision examples instead of rules
- Followed by 1500 years of decision theory stagnation

#### 1.6.2 Period 2: Pioneering Period (>1650s)

- Probability theory developed (Pascal and Fermat through letter correspondence)
- Some resistance by Catholic Church in normative moral theory (of course)
- 1738, `moral value` (now known as utility) was coined

#### 1.6.3 Period 3: Axiomatic Period (>1920s)

- Attempt to make axioms from priciples of rational decision making
- 1950s was a golden age for decision theory
  - Still highly relevant to today

## 2 Peterson CH2: The Decision Matrix

### 2.1 Terms

| Notation | Term | Definition/Explanation |
|---|---|---|
| (square in decision tree) | Choice Node | - |
| (circle in decision tree) | Chance Node | - |
| $\pi$ | *Formal decision problem*, $\pi =< A, S, O >$ | <A, S, O> = Acts, States, Outcomes |
| $t(\pi) \succeq \pi$ | - | $t(\pi)$ is *at least* as reasonable as $\pi$ |
| $t(\pi) \sim \pi$ | - | $t(\pi)$ is *exactly* as reasonable as $\pi$ |
| $a \circ b$ | - | $(a \circ b)(\pi) = b(a(\pi))$ |
| - | Transformative decision rule | Decision rule that modifies formalization of a decision problem |
| - | Effective decision rule | Filter that singles out some set of recommended acts |
| - | Rival formalizations | $\geq$ 2 formalizations of same problem that are both 1. equally reasonable and 2. strictly better than other formalizations |

#### 2.1.1 Scales

| Scale | Strictly increasing | Difference information | Ratio information |
|---|---|---|---|
| Ordinal | Yes | No | No |
| Cardinal: Interval | Yes | Yes | No |
| Cardinal: Ratio | Yes | Yes | Yes |

Note: Ordinal scales are invariant up to positive monotone transformations

### 2.2 3 Transformative Decision Rules

#### 2.2.1 Order-Independence (OI)

If OI-condition holds for all $\pi \in \Pi$:

- $(u \circ t)(\pi) = (t \circ u)(\pi)$

#### 2.2.2 The Principle of Insufficient Reason (ir)

If state probabilities are unknon, $\pi$ may be transformed into $\pi'$ in which *equal probabilities are assigned to all states*

#### 2.2.3 Merger of states (ms)

If $\geq$ 2 states yield identical outcomes under all acts, they can be collapsed into one (with probabilities summed up, if known)

## 3 Gilboa CH1: Feasibility and Desirability

Can (feasibility) vs want (desirability)

### 3.1 No direct causal link

Usually, straightforwardly independent

### 3.1.1 Zen and the Absurd (as in Camus Absurd)

Under some cases (e.g. mathematicians who like challenges), feasibility alsely) appears to have direct negative causal link with desirability.

Author argues that the act of challenge is sought rather than the state of infeasibility, and thus the causal link still does not exist.

Violates Occam's razor, but makes sense

## 3.2 Uncertainty and Feasibility

Feasibility of states need not propogate to feasibility of states

### 3.2.1 Example

You can certainly perform the act try to solve a math problem for 2h, without being certain about whether the state of having it solved is indeed achievable)

## 3.3 Link is mediated by information

#### 3.3.0.1 Example

- Desire: Buy strawberries
- Situation: End of day; 1 box of strawberries left over ($\therefore$ feasible)
- Thought process: Why did no one buy that last box? Does it suck?
- Decision: Don't buy, even though feasible, as the unlikeliness of the feasibility itself may be a signal about quality