Decision Making
Deductive Reasoning

- In a reasoning task, it is possible to deduce the correct answer
  - i.e., reason from given information logically to a conclusion, using deductive reasoning
- A good example is the “Wason task”
  - Which of the following cards (each has a letter on one side and a number on the other), must be flipped to test the assertion
    - “If a card has a Q on one side, then it has a 4 on the other”?

```
Q  P  4  7
```
Deductive Reasoning

- Various “problem solving” tasks
  - e.g., move the fox, chicken and grain across the river
  - the boat can hold only the farmer and one other items
  - the fox will eat the chicken, the chicken will eat the grain
Inductive Decision-Making

- But most human decision-making involves induction
  - i.e., reasoning from a specific observation to a more general conclusion
    - which McValue meal to choose
    - what courses to enroll in
    - what career to pursue
    - which car to buy
- Two competing approaches:
  - ‘rational’ approaches: describe human decision making in terms of maximizing benefit or utility
  - heuristic approaches: describe human decision making in terms of ‘rules of thumb’ or ‘approximate solutions’
Rational Decision Making

- The idea is that people compute the value (or utility) that every available option has, and choose the one with maximum value
  - e.g., look at every feature of a kitchen machine, give a value to that feature, sum the values over all the features of each machine, and choose the machine with the greatest total value

<table>
<thead>
<tr>
<th></th>
<th>CHEF CLASSIC</th>
<th>CHEF PREMIER</th>
<th>CHEF PREMIER</th>
<th>CHEF TITANIUM</th>
<th>CHEF TITANIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brand</strong></td>
<td>Kenwood</td>
<td>Kenwood</td>
<td>Kenwood</td>
<td>Kenwood</td>
<td>Kenwood</td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td>KM336</td>
<td>KMC510</td>
<td>KMC580</td>
<td>KM3010</td>
<td>KM033</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>White with Silver trim</td>
<td>White</td>
<td>Silver</td>
<td>Silver Painted</td>
<td>Silver Painted</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>800W</td>
<td>1000W</td>
<td>1000W</td>
<td>1400W</td>
<td>1400W</td>
</tr>
<tr>
<td><strong>Bowl</strong></td>
<td>Stainless Steel</td>
<td>Brushed Stainless Steel</td>
<td>Stainless Steel</td>
<td>Stainless Steel with Handles</td>
<td>Stainless Steel with Handles</td>
</tr>
<tr>
<td><strong>Power Outlets</strong></td>
<td>Bowl, Slow, High</td>
<td>Bowl, Slow, High</td>
<td>Bowl, Slow, High</td>
<td>Bowl, Slow, Medium, High</td>
<td>Bowl, Slow, Medium, High</td>
</tr>
<tr>
<td><strong>Pulse Function</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Electronic Speed Control</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Total Bowl Capacity</strong></td>
<td>4.6 Litres</td>
<td>4.6 Litres</td>
<td>4.6 Litres</td>
<td>4.6 Litres</td>
<td>4.6 Litres</td>
</tr>
<tr>
<td><strong>Attachments included</strong></td>
<td>Acrylic Liquidiser</td>
<td>Acrylic Liquidiser</td>
<td>Acrylic Liquidiser</td>
<td>Glass Liquidiser, Food Processor, DVD</td>
<td>Blender, Mincer, Food Processor, Mill, Citrus Press, E-Scales</td>
</tr>
</tbody>
</table>
Rational Decision Making

- The idea is that people compute the value (or utility) that every available option has, and choose the one with maximum value
  - e.g., look at every feature of a kitchen machine, give a value to that feature, sum the values over all the features of each machine, and choose the machine with the greatest total value
Rational Decision Making

- So, for the Chef Classic, it might be that
  - Color = White has value 100
  - Power = 800W has value 50
  - Bowl = Stainless Steel has value 80
  - and so on

- The total value for Chef Classic might end up being 950

- This value would be compared to ones for all other options, and the best taken

- Note that “value” is an abstract scale of “utility” or “goodness”
Testing Rational Theories

- Most of the empirical evidence for evaluating utility-theory based models of decision-making comes from simple probabilistic tasks like choosing between gambles
  - $0.8 \times 0.25 = 0.20$ versus $0.4 \times 0.40 = 0.16$

From Coombes, Bezembinder & Goode (1967)
Rational Decision Making

- Rational decision making models are important, and remain an active area of research, with new variants in modern Bayesian models of the mind
  - Probably best interpreted at the computational level in Marr’s hierarchy
  - It seems unlikely people go through these sorts of detailed computational processes at an algorithmic level
Heuristic Decision Making

- There is also evidence people do not always (or often) follow these rational ideals
  - Leads to the study of heuristic decision-making, which comes in two types
    - Heuristic as “rules of thumb”
    - Heuristic as “approximate solutions”
Heuristic Decision Making

- Tversky, Kahneman, and their collaborators have examined the heuristics and biases people show in reasoning
  - This is the heuristics as “rules of thumb” perspective
- Kahneman won the 2002 prize (in Economics) for his work on prospect theory
  - His 2011 book “Thinking, Fast and Slow” is accessible and compelling, and contains many of the examples we consider
Linda Question

- Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

- Please choose the most likely alternative:
  - (a) Linda is a bank teller
  - (b) Linda is a bank teller and is active in the feminist movement
Discussion of Linda Question

- Kahneman and Tversky (1982) asked this question of 86 participants, with nearly 90% choosing the feminist bank teller alternative, even though this is logically incorrect
  - Known as the conjunction fallacy, in which the combination of events is judged more probable than one alone
  - [Compare to “Paul has hair” vs “Paul has blond hair”]
Representativeness Heuristic

• Kahneman and Tversky (1982) explained these results using the **representativeness heuristic**
  – this is the tendency of people to judge probabilities or likelihoods according to how much one thing resembles another

• The description of Linda is more representative of a feminist bank teller than just a bank teller alone, so people conclude it is more likely Linda is a feminist bank teller
Other Examples of Representativeness

- The original “Linda problem” studies hid the two key probability questions among others
  - Linda is a teacher in elementary school, Linda works in a bookstore and takes yoga classes, ...
- The conjunction fallacy has been replicated with other vignettes ("jazz playing accountants"), and under many experimental conditions
- Alternative types of questions (that are not strictly conjunction fallacy) show representativeness leading to probably wrong decisions
  - e.g., the earthquake probability is almost certainly smaller from those below, but judged more probable
    - Probability of a massive flood somewhere in North America next year, in which more than 1000 people drown
    - Probability of an earthquake in California sometime next year, causing a flood in which more than 1000 people drown
Joint and Single Evaluation

• Hsee study (reported in Kahneman 2011) involved
  – joint evaluation, with both dinner sets priced by same person
  – single evaluation, with each dinner set priced separately by different people

• A preferred to B (priced higher) in joint evaluation, but B to A in single evaluation
  – because B is more representative of a high quality set

<table>
<thead>
<tr>
<th></th>
<th>Set A: 40 Pieces</th>
<th>Set B: 24 Pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinner plates</td>
<td>8, all good condition</td>
<td>8, all good condition</td>
</tr>
<tr>
<td>Soup/salad bowls</td>
<td>8, all good condition</td>
<td>8, all good condition</td>
</tr>
<tr>
<td>Dessert plates</td>
<td>8, all good condition</td>
<td>8, all good condition</td>
</tr>
<tr>
<td>Cups</td>
<td>8, 2 of them broken</td>
<td></td>
</tr>
<tr>
<td>Saucers</td>
<td>8, 7 of them broken</td>
<td></td>
</tr>
</tbody>
</table>
US Deaths Question

- Which was the more likely cause of death in the United States in the 1970s?
  - (a) shark attack
  - (b) falling airplane parts

- Combs and Slovic (1979) found that almost all participants rate shark attack death as more likely
  - in fact, death from falling airplane parts is (was?) 30 times more likely
Letter ‘k’ Question

• Are there more words in English that have the letter ‘k’ as their first letter (e.g., kick) or as their third letter (e.g., ink)?
  – (a) first letter
  – (b) third letter

• Kahneman and Tversky (1973) found 105 out of 152 participants judged words beginning with a ‘k’ to be more frequent
  – in fact, twice as many words have ‘k’ as their third letter
Paths Question

- Can more lines be drawn through structure A or structure B by moving to any point on the next line, as shown?
- Typical result is that 85% of participants judge structure A to have more paths, but they actually both have the same number of paths.
Availability Heuristic

• Tversky and Kahneman (1974) explain these sorts of results by claiming people use the availability heuristic:
  – people assess the frequency of a class or the probability of an event by the ease with which instances or occurrences can be brought to mind

• In other words
  – it is easier to imagine (or recall) instances of death by shark attack
  – it is easier to think of words beginning with the letter ‘k’
  – it is easier to picture paths through structure A
Impact of Availability Heuristic

- Salient events that attract attention will be easily retrieved, and judged to be more probable or more likely
  - e.g., overestimation of divorce rates between famous celebrities
- A specific dramatic event temporarily increase availability of the general class
  - e.g., a major plane crash affects judgments about safety of flying
- Vivid examples or personal experiences affect the judgments of an individual
  - e.g., a judicial error that affects you personally undermines your faith in the judicial system more than the same error reported in a newspaper
Disjunction Fallacy

- Yates (1990) gives an overview of the **disjunction fallacy**, in which the sum of partitioning event judged probabilities exceeds one
  - e.g., ask people what percentage of the day they “walk”, “sleep”, “eat” and so on, and the sum of the percentages is greater than 100%
  - e.g., in divorce settlements, when partners list what proportion of the time they are responsible for household chores, the total is often over 100% for each chore
- One explanation is that thinking about each event type brings available instances to mind, leading each to be over-estimated
Real-World Disjunction Fallacy

- Intrade prediction markets can provide real-world examples of disjunction fallacies
  - e.g., markets for which state will have the closest election result, with 9 markets that partition all possibilities
  - The sum of the value of these markets (values represent probabilities) on the right is about 126%
Anchoring Heuristic

- Tversky and Kahneman (1974) asked one group participants whether the percentage of African countries in the UN was greater or less than 65%, and then asked them to estimate the actual percentage
  - They then asked another group of participants whether the percentage of African countries in the UN was greater or less than 10%, and then also asked them to estimate the actual percentage
  - Participants in the first group gave a median estimate of 45%, while participants in the second group gave a median estimate of 25%

- These results were explained in terms of the anchoring heuristic, suggesting that decisions are disproportionately influenced by the first available pieces of information
Other Examples of Anchoring

• Any number considered as a possible solution to an estimation problem can play a role in influencing estimation
  – e.g., Ask whether Gandhi was more than 114 years old when he died vs whether he was more than 35 years old when he died
    – Subsequent estimate of his actual age at death is affected (answer is 78)
  – e.g., The asking price for a house can anchor a potential buyer’s estimate of what they are willing to pay

• Anchoring can also happen without an explicit anchoring number, but one that is naturally spontaneously generated
  – e.g., What is the boiling temperature of water (in Celsius) at the top of Mount Everest
    – Must be lower than 100 Celsius, which acts as an anchor
Anchoring Index

• The anchoring index provides a simple measure of how much impact an anchor has on estimation
  – Ranging from 0% for no impact, to 100% for maximum impact
• Concrete example from Kahneman (2011): “Is the height of the tallest redwood more or less than (1200 feet, 180 feet)? What is your best guess of the height of the tallest redwood?”
  – Mean answers were 844 and 282 feet for the high and low anchors, respectively, which differ by 844-282 = 562 feet
  – The difference between the anchors is 1200-180 = 1020 feet
  – The anchoring index is the difference between estimates as a percentage of the difference between anchors
    – Anchoring index is 562/1020 = 55%
    – 55% is a typical number for the index. It would be 0% if the estimates were unaffected, and 100% if they copied the anchors
Applications of Anchoring

• Visitors to an environment center were asked how much they would be willing to contribute “to save 50,000 offshore Pacific Coast seabirds from small offshore oil spills ...”
  – Some were asked before-hand “would you be willing to pay $5 ...”
  – Average donation was $64 without the anchor of the initial question, but only $20 with the initial question

• A case study at a store in Sioux City, involving a sales promotion for soup that was 10% off
  – On days where the sign on the shelf said NO LIMIT PER PERSON, people bought an average of 3.5 cans each
  – On days where the sign said LIMIT OF 12 PER PERSON, people bought an average of 7 cans each
Order Effects in Asking Questions

• Schuman and Presser (1981) studied two questions
  – A: “Do you think a communist country like Russia should let American newspaper reporters come in and send back to America the news as they see it?”
  – B: “Do you think the United States should let Communist newspaper reporters from other countries come in and send back to their papers the news as they see it?”

• Answers depended on the order in which they were asked
  – A then B gave yes responses of 82% for A then 75% for B
  – B then A gave yes responses of 55% for B then 64% for A
Recency Effects Within Questions

- Schuman and Presser (1981) also studied people’s tendency to choose the last (or later) possible responses disproportionately often
  - A: “Should divorce in this country be easier to obtain, more difficult to obtain, or stay as it is now?”
  - B: “Should divorce in this country be easier to obtain, stay as it is now, or be more difficult to obtain?”
- Randomly varied questions in a national opinion poll, and found
  - A: 23% easier, 36% more difficult, and 41% same
  - B: 26% easier, 29% the same, 46% more difficult
Taxi Question

- In a city, 85% of the taxis are green, and the remaining 15% are blue. A taxi is involved in a hit-and-run accident at night. An eyewitness reports that it was a blue, but eye tests show that this eyewitness is partly color-blind, and only accurately identifies blue over green 80% of the time.
  - What is the probability the taxi involved in the accident was actually blue?
Discussion of Taxis Question

- Many people answer 80%, but that is the conditional probability \( \text{Pr(seen blue|taxi is blue)} = .8 \)
  - i.e., the probability they will say it is blue given that it is blue is 0.8
- The probability that answers the question is a different conditional probability, \( \text{Pr(taxi is blue|seen blue)} \)
  - i.e., the probability the taxi is blue, given it was seen as blue
- In the taxi problem, people suffer from “confusion of the inverse”
  - believe that \( \text{Pr}(A|B) = \text{Pr}(B|A) \), which is almost never true
  - e.g., suppose \( A=\)“is over 2 meters tall”, and \( B=\)“is male”
    - \( \text{Pr}(A|B) \) is relatively low, since most males are shorter than 2 meters
    - \( \text{Pr}(B|A) \) is relatively high, since most people taller than 2 meters are males
Solving the Taxi Cab Problem

- Bayes’ Theorem shows how the two conditional probabilities are related, in a way that depends on the base-rates Pr(A) and Pr(B)
  - i.e., the proportion of blue and green cabs in the city
- It turns out the correct answer Pr(taxi is blue|seen blue) = .41
  - The fact that only 15% of the cabs are blue is relevant base-rate information, and brings the 80% correct identification down to 41% probability it was a blue cab
- There are lots of real-world decision-making situations where it is important to consider base rates, especially for very rare events
  - e.g., legal evidence and medical diagnosis
Kidney Cancer Question

- Kahneman (2011) gives the following example
  - A study of the incidence of kidney cancer in the 3141 counties of the United States reveals a remarkable pattern. The counties in which the incidence of cancer is lowest are mostly rural, sparsely populated, and located in traditionally Republican states in the Midwest, the South, and the West.
    - One sensible explanation of this is that the low cancer rates are due to clean living in a rural lifestyle, with no water pollution, and access to fresh food without additives.
  - But, the counties in which the incidence of the same cancer is highest are also mostly rural, sparsely populated, and located in traditionally Republican states in the Midwest, the South, and the West.
    - Again, a sensible explanation can be constructed, in terms of the rural lifestyle providing no good medical care, a high-fat diet, too much alcohol and tobacco, and so on.
Discussion of Kidney Cancer Question

- While both facts can be true simultaneously, the two explanations cannot be right simultaneously
  - The same counties having the highest and lowest rates is likely a simple statistical fact, coming from them having the smallest number of people
  - Fewer people in a county makes greater variability more likely, so small counties will have both the highest and lowest
    - Imagine counties with just 1 person, which will always have cancer rates of either 0% and 100%, and so always (equal) lowest or highest
Babies Question

- A small rural hospital has 50 births a year. A larger suburban hospital has 500 births a year. On average, they both deliver 50% girls in a year. In an unusual year, however, which hospital is more likely to deliver 60% girls?
  - (a) smaller hospital
  - (b) larger hospital
  - (c) they’re both equally likely
Discussion of Babies Question

- Many people judge the larger hospital to be more likely (or equally likely), when the smaller hospital is more likely to show the imbalance.
- The explanation for this mistake probably involves:
  - it being easier to imagine the required number of girls in a larger hospital
  - Tversky and Kahneman’s (1971) idea that people mistakenly believe in a law of small numbers, which is really another fallible decision-making heuristic
    - assumes that small samples will display the same regularities that would be expected of larger samples
A study of 250 neurology patients looked at how many had dizziness symptoms, and how many had brain tumors, with the following results:

- Do the results suggest that dizziness is associated with brain tumors?

<table>
<thead>
<tr>
<th>DIZZINESS</th>
<th>BRAIN TUMOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>Present 160</td>
</tr>
<tr>
<td></td>
<td>Absent 40</td>
</tr>
<tr>
<td>Absent</td>
<td>Present 40</td>
</tr>
<tr>
<td></td>
<td>Absent 10</td>
</tr>
</tbody>
</table>
Discussion of Tumors Question

• Nisbett and Ross (1980) found that many people believe there is an association, either because
  – a large number (160) of patients have both dizzy spells and a tumor
  – the number who have both or neither of the symptoms (160+10=170), is larger than those who have one but not the other (40+40=80)

• In fact, the data provide no evidence for an association between dizziness and tumors (or almost no evidence)
  – whether people have dizzy spells or not, the same ratio (4:1) is observed to have tumors in this clinical sample
Illusory Correlation

• Nisbett and Ross (1980) argued that people rely heavily (although not necessarily exclusively) on positive events or instances in assessing whether variables are related.

• A related-decision making phenomenon is **illusory correlation**, in which people perceive a correlation where there is none, because the pairings that would indicate a correlation are more representative or available.
  
  – e.g., wearing a “lucky hat” (or something) when your favorite sport team wins games.
Coin Game Question

• Suppose you have the opportunity to play a game in which an unbiased coin is tossed until it comes up tails, at which point you are paid some money
• The amount of money you are paid depends on how many tosses are needed to get a tail
  – if $n$ tosses are needed, you get $2^n$
• This means if tails came up on the first toss, you would get $2$, if it came up on the second toss you would get $4$, if it came up on the tenth toss you would get $1024$, and so on
• How much money would you pay to play this game?
Discussion of Coin Game Question

- This problem was originally posed by Bernoulli, and is often known as the “St. Petersburg Paradox”
- The paradox arises because the expected return from playing the game is arbitrarily large, yet most people are willing to pay no more than a few dollars to play the game
- The expected return from playing = probability games ends in one toss x $2 + probability games ends in two tosses x $4 + probability games ends in three tosses x $8 ... 
  - this is $1/2 \times 2 + 1/4 \times 4 + 1/8 \times 8 + ... + (1/2)^n \times 2^n$
  - which is just $1 + 1 + 1 + ...$
  - which, given $n$ can be arbitrarily large, is an arbitrarily large reward
Diseases Question

• Imagine a new disease is about to strike, and two alternative treatment programs have been proposed, with the following consequences
  – A: 200 people will be saved
  – B: there is a 1/3 probability 600 people will be saved, but a 2/3 probability none will be saved

• Which treatment program would you choose?
Diseases Question

• Imagine now a second new disease is about to strike, and again two alternative treatment programs have been proposed, with the following consequences
  – C: 400 people will die
  – D: there is a 1/3 probability nobody will die, but a 2/3 probability that 600 people will die

• Which treatment program would you choose?
Discussion of Diseases Question

- Kahnemann and Tversky (1979) found the same pattern of results for choices between
  - Problem 1
    - A: A 50% chance of winning $1000
    - B: A sure win of $500
  - Problem 2
    - C: A 50% chance of losing $1000
    - D: A sure loss of $500
- Across 70 participants, most chose B (84%) over A, but most chose C (70%) over D
Discussion of Diseases Question

- This question is based on Tversky and Kahnemann’s (1981) “Asian disease” study
  - both programs A and B are equivalent in terms of the expected number of people they save
    - found participants were ‘risk averse’ in choosing between saving lives, with 72% choosing A
  - again, both programs C and D are equivalent in terms of expectations
    - found participants were ‘risk seeking’ in choosing how to avoid deaths, with 78% choosing D
Prospect Theory

- Kahneman and Tversky (1979) explain these sorts of result using prospect theory
Prospect Theory

- The ‘subjective value’ of a certain gain of $500
Prospect Theory

- The expected ‘subjective value’ of a 50-50 gamble between $0 and $1,000 gains
Prospect Theory

- Predicts people are risk averse for gains, because subjective value does not keep pace with objective gain
Prospect Theory

- The ‘subjective value’ of a certain loss of $500
Prospect Theory

- The expected ‘subjective value’ of a 50-50 gamble between $0 and $1,000 losses
Prospect Theory

- Predicts people are risk seeking for losses, because ‘losses loom large’ (and are weighted more heavily than gains)
Prospect Theory

- Key elements of prospect theory are that
  - value function for gains is concave
  - value function for losses is convex and relatively more steep
- This implies
  - being risk averse for gains but risk seeking for losses
  - losses “loom large” and are weighted more heavily than gains
Two Interpretations of “Heuristic”

- The Kahneman and Tversky view of heuristic is that people do not reason rationally, but apply “rules of thumb”
  - Lead to heuristics, biases, errors, mis-perceptions and is generally a bad (if necessary) property of people’s decision-making
- An alternative perspective, led by Gigerenzer, Todd, and colleagues, views heuristics as “approximate” solutions
  - Leads to fast and effective decision processes that perform well in real-world settings, and are generally a good thing
Fast and Frugal Heuristics

- Limited search and simple decision-making because
  - The world is competitive, and resources are valuable, so you need to be fast
Fast and Frugal Heuristics

- Limited search and simple decision-making because
  - The world is competitive, and resources are valuable, so you need to be **fast**
  - The world is changeable, so you need the robustness that comes from **simplicity**
The ‘Recognition’ Heuristic

- The ‘recognition’ heuristic is perhaps the simplest of all fast and frugal heuristics:
  - “If one of two objects is recognized, and the other is not, then infer that the recognized object has the higher value”
- If recognition is correlated negatively with the criterion, then change the word “higher” to “lower”
- The recognition heuristic can only be applied when people are at least partly ignorant, so it addresses the issue of reasoning under uncertainty
City Comparison Task

- Gigerenzer and colleagues have extensively studied the recognition heuristic in a series of studies asking people which of two cities had the larger population
  - e.g., Berlin or Karlsruhe?
  - e.g., Munich or Frankfurt?
  - e.g., Augsburg or Kassel?
  - e.g., St Louis or Plano?
  - e.g., Los Angeles or Seattle?
  - e.g., Lincoln or Fort Wayne?
Empirical Evidence

- There is good empirical evidence that people follow the recognition heuristic almost all of the time in city comparison tasks
  - Todd and Gigerenzer (2000) report a 90%+ rate over a series of studies

- There is also suggestive evidence from a wide range of other decision making situations
  - e.g., Norway rats prefer to eat food with smells they recognize (i.e., items they have smelled on the breath of others)
Environmental Structure for Recognition

- The recognition heuristic leads to accurate decision making because of the structure of the environment
  - e.g., for city comparisons, there is a correlation between cities with many people, and the frequency with which people read about those cities, hear about those cities, meet people from those cities, and so on....
Reflections of the Environment in Memory

• Bigger cities tend to be recognized more
  – But note exceptions like “Dallas”

Table 2-1: Recognition of German and American Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Articles</th>
<th>Recognition (%)</th>
<th>City</th>
<th>Articles</th>
<th>Recognition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berlin</td>
<td>3484</td>
<td>99</td>
<td>New York</td>
<td>493</td>
<td>100</td>
</tr>
<tr>
<td>Hamburg</td>
<td>1009</td>
<td>96</td>
<td>Los Angeles</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>Munich</td>
<td>1240</td>
<td>100</td>
<td>Chicago</td>
<td>175</td>
<td>97</td>
</tr>
<tr>
<td>Cologne</td>
<td>461</td>
<td>82</td>
<td>Houston</td>
<td>73</td>
<td>80</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>1804</td>
<td>96</td>
<td>Philadelphia</td>
<td>67</td>
<td>63</td>
</tr>
<tr>
<td>Essen</td>
<td>93</td>
<td>28</td>
<td>San Diego</td>
<td>78</td>
<td>47</td>
</tr>
<tr>
<td>Dortmund</td>
<td>84</td>
<td>19</td>
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<td>Indianapolis</td>
<td>20</td>
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</table>

_left side:_ Number of articles in 12 years of the Chicago Tribune mentioning the 12 largest German cities and the percentage of 67 University of Chicago students who recognized each city. Cities are ranked according to their actual size. _Right side:_ Number of articles in 2 years of Die Zeit mentioning the 12 largest U.S. cities and the percentage of 30 University of Salzburg students who recognized each city.

From Gigerenzer & Todd (1999)
Three Question Types

• In terms of whether or not you recognize the names of the cities, there are 3 possibilities for every pair
  – You do not recognize either of the cities, perhaps is in “Augsburg or Kassel”?
    – Answer by guessing, and right half the time
  – You recognize both of the cities, perhaps as in “Munich or Frankfurt”?   
    – Answer by using your knowledge
  – You recognize one, but not the other, perhaps as in “Berlin or Karlsruhe”?   
    – You could answer by using the recognition heuristic
The “Less is More” Effect

- If the recognition heuristic is more accurate than decisions based on knowledge, it is possible for the “less is more” effect to occur
  - you are more accurate in judging which city is larger when you know less about the cities!

- There is some empirical evidence for this effect in the city comparison task (Goldstein & Gigerenzer 2002, Hoffrage 1995)
  - e.g., Germans being better at “San Diego vs San Antonio” than Americans
Less is More Theory

- If the recognition heuristic is more accurate than knowledge, partial familiarity will lead to the greatest accuracy
World, German and Australian Cities Examples

- When this effect was first published, I asked students in Australia to decide between a series of “Australian” (all recognized), “German” (partly recognized) and “World” (mostly not recognized) cities
  - World Cities (about 45% correct)
    - Sendai                    Fuzhou
    - Mandalay                 Lubumbashi
  - German Cities (about 69% correct)
    - Stuttgart                Weisbaden
    - Essen                    Leipzig
  - Australian Cities (about 59% correct)
    - Cairns                   Townsville
    - Sydney                   Melbourne

- The recognition heuristic (i.e., the environmental regularity) was more accurate than recognized decisions (i.e., decision processes)
Application of Recognition Heuristic

- In a bull market, Gigerenzer and colleagues constructed share portfolios based on the companies people recognized.

From Gigerenzer & Todd (1999)
Application of Recognition Heuristic

- Predictions for the Wimbledon men’s tennis tournament in 2003, choosing the winner of each match in various way (Serwe & Frings 2006)
  - Recognition-based decisions from tennis amateurs performed best (“experts” is Wimbledon seeding)
Environmental Structure

- The correlation between recognition and decision criterion is just one type of (fairly specific) environmental regularity
  - Many real-world environments have more general types of regularities that can aid more general decision-making
- Two of the most important regularities are
  - **correlated environments**, where the first piece of information predicts the rest
    - e.g., many real-estate agents believe the first pieces of information (approaching the house, the first room seen) determine whether a viewer will decide they want to buy the house
  - **environments of diminishing returns**, where the first pieces of information are more important
    - e.g., the starting five in basketball are much more important than the bench in determining the outcome
Other Fast and Frugal Heuristics

- Gigerenzer and his colleagues have developed other fast and frugal heuristics, including
  - “take the best”, which chooses between two recognized alternatives
  - “categorization by elimination”, which assigns a stimulus to a category
  - “quickest”, which estimates the value of a stimulus along a dimension
- They all make assumptions about the nature of the environment to enable fast, robust and accurate decisions
Two Types of Heuristic Decision Making

- The Tversky and Kahneman “heuristics and biases” approach argues people do not apply rational reasoning to problems, and make systematic errors by their use of heuristics.

- The Gigerenzer and colleagues “fast and frugal” view argues that people’s heuristics use this structure to enable fast, robust and accurate non-compensatory decision making.
  - Under this view, the Tversky-type examples are seen as “trick questions.”
Naturalistic Decision Making

- Klein’s (1998, p.5) features of naturalistic decision making
  - study decisions made under time pressure
  - study decisions that have high stakes
  - often more interested in experienced decision makers
  - study situations where there is inadequate information
  - study decision making where the goals are unclear
  - study poorly defined decision procedures
  - study domains with complicated stimuli
  - study decisions situated in a detailed context
  - study decision making under dynamic conditions
  - often interested in team or group decision making
Klein’s (1998) Example 4.1 The Sixth Sense

It is a simple house fire in a one-story house in a residential neighborhood. The fire is in the back, in the kitchen area. The lieutenant leads his hose crew into the building, to the back, to spray water on the fire, but the fire just roars back at them.

"Odd," he thinks. The water should have more of an impact. They try dousing it again, and get the same results. They retreat a few steps to regroup.

Then the lieutenant starts to feel as if something is not right. He doesn't have any clues; he just doesn't feel right about being in that house, so he orders his men out of the building - a perfectly standard building with nothing out of the ordinary.

As soon as his men leave the building, the floor where they had been standing collapses. Had they still been inside, they would have plunged into the fire below.
Analysis of Fire-Commander’s Decision

- According to Klein (1998), questioning of the fire commander revealed
  - he had no suspicion there was a basement in the house
  - he did not suspect the seat of the fire was in the basement, underneath the living room
  - he was wondering why the fire did not react as expected
  - the living room was hotter than it should have been
  - the fire was too quiet for one with its level of heat
Reliance on Recognition and Familiarity

• The decision to retreat was based being uncomfortable about the situation not being familiar or typical
  – shows how people rely on recognition to make decisions

• On this basis, Klein (1998) argues that “intuition” is not innate, but develops through experience
  – comes about through recognizing situations (or blends of situations), without realizing that we are recognizing

• In terms of applied implications, this suggests that training can improve people’s intuitive decision making
  – expand their experience base so that they can pattern-match and recognize more familiar and typical cases
Summary of Recognition Primed Decision Making

- Klein originally approached the study of these sorts of incidents believing people would ‘wrestle with choices’ that they often solved by analogical reasoning.
- Instead, they found very little evidence that options were directly being compared to one another when making decisions.
- Came to the belief that experienced commanders could generate good courses of action (decision) from the outset, and did not need to compare options.
- Klein’s (1998, p. 30) summary is that the RPD claims, for experienced decision makers, that:
  - the focus is on the way they assess the situation and judge it familiar, not on comparing options.
  - courses of action can be quickly evaluated by imagining how they will be carried out, not by formal analysis.
  - they look for the first workable option, not the best one.
Summary of Recognition Primed Decision Making

– since their first option is usually workable, they do not have to consider a large set of options to get a good one
– they generate and evaluate options one at a time, and do not compare the advantages and disadvantages of alternatives
– by imagining options being carried out, they can spot weaknesses and avoid these, thereby making the option stronger (many conventional model just select the best, without seeing how it can be improved)
– the emphasis is on being poised to act rather than being paralyzed until all the evaluations have been completed
Practice Question

- Rational decision-making, based on maximizing utility, involves
  a) Assigning a value to every property of every option, and choosing the one with the greatest totally value over all properties
  b) Weighting losses more than gains (so that “losses loom large”) in combining positive and negative aspects of alternative choices
  c) Choosing the alternative that is the most useful in the relevant real-world context
  d) Choosing the alternative that is the most familiar, or most readily-recognized
• If a basketball team has a large lead at half time in a game, and people expect the second half to be the same as the first, so that the team will win easily, that is an example of
  a) Assuming the basketball game environment has diminishing returns
  b) Assuming correlated structure in the basketball game environment
  c) Using anchoring to assume to final score will not deviate from the half time score
  d) Using the representativeness heuristic to assume the “hot hand” phenomenon is true
Practice Question

• Prospect theory typically assumes
  a) The median of two options provides the best summary of their overall value
  b) All options are perceived in positive terms, focusing on the prospects they offer
  c) The best recognized option is the one most often chosen
  d) A non-linear relationship between actual (physical) and perceived (psychological) value
The St Petersburg Paradox involves a game that has infinite expected return, but which people typically will not pay much to play. This could be viewed as consistent with

a) Why it is statistically unlikely to make a profit in gambling games
b) Why a $400 meal is not four times as good as a $100 meal
c) Why there is no universally agreed method for combining votes to determine the winner of an election
d) Why Russian travel agencies have more business in Summer than Winter months
Practice Question

- Recognition primed decision making theory argues that expertise develops from
  a) Experience with relevant situations
  b) Increased working-memory capacity
  c) Rational analysis of situations that overcome heuristics and biases
  d) The application of expected utility to evaluate options
Practice Question

- Describe a similarity and a difference between the Kahneman and Tversky ‘heuristics and biases’ view of human decision-making, and the Gigerenzer ‘fast and frugal heuristics’ view.
Practice Question

• In studies of juror decision-making, it is often found that the judged probability of guilt depends on whether the prosecution case or defense case is presented first. Explain how the anchoring heuristic might cause this.