Heuristic Choice Models

Models based on sets of valued aspects

- Options are not based on dimensional representations
- Instead options are represented as sets of valued aspects
- Frank Restle book 1962
- Tversky 1972 Psych Rev

Restle's 1962 search for dominance model

- Pick an aspect
- If option A contains this aspect and option B does not, then choose option A
- otherwise repeat by picking another aspect and continue until dominance obtained
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$$\Pr\left[A|\left\{A,B\right\}\right]=\frac{v\left(A\cap\bar{B}\right)}{v\left(A\cap\bar{B}\right)+v\left(\bar{A}\cap B\right)}$$

Restle's multiiple alternative choice model

- For multiple alternatives e.g., A, B, C, use round robin tournement
  - pick one pair, e.g. A,B choose one from this set
  - carry first choice over and compare with another option
  - e.g. if A beats B, then compare A with C
  - repeat until reaching final remaining option
  - final choice is the winner of all the binary competitions

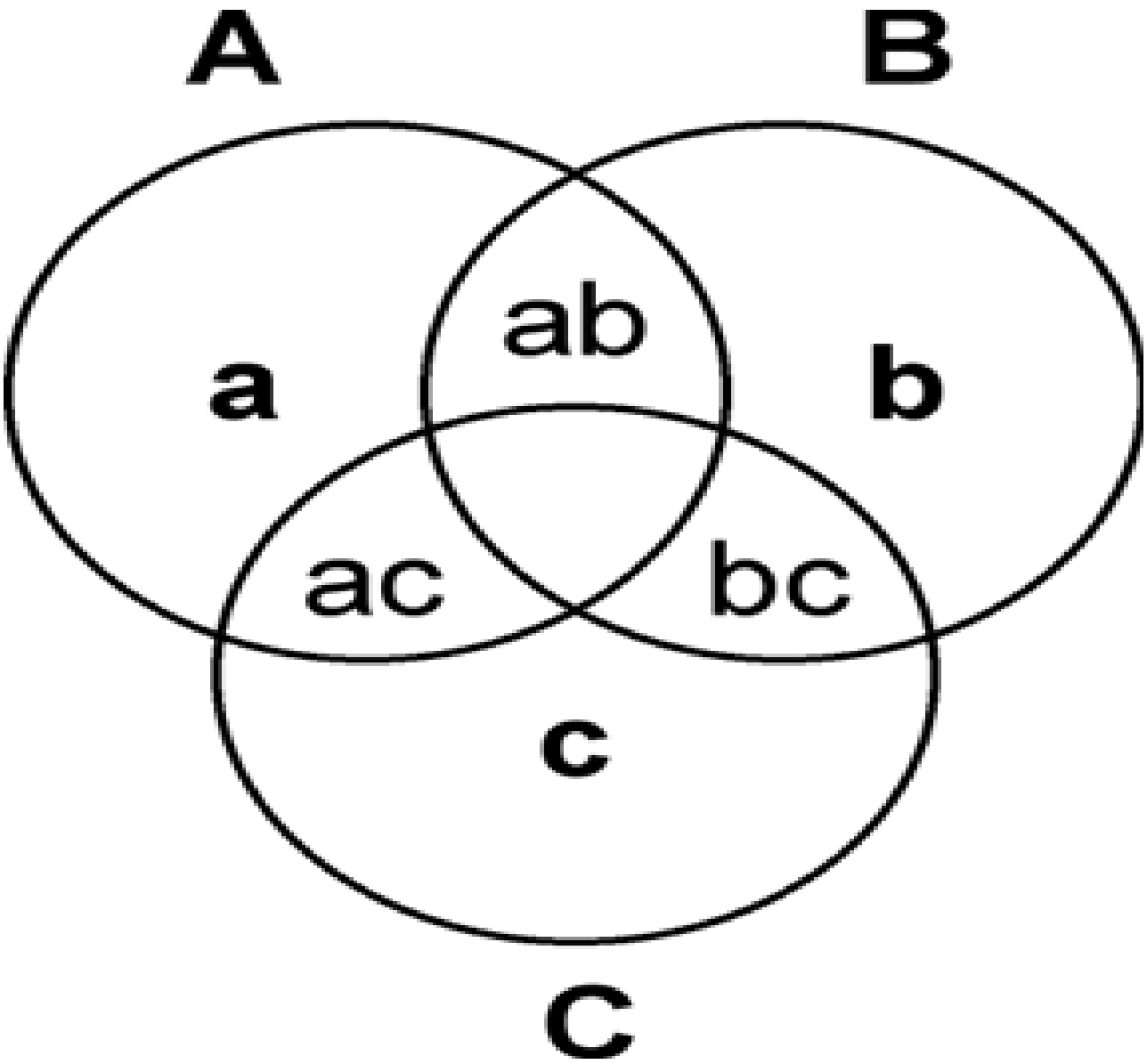
Similarity effects: Paris, Rome, Paris plus a dollar

$$
\begin{aligned}
\Pr\left[P\middle|\left\{P,R\right\}\right] &= \frac{v\left(P\cap\bar{R}\right)}{v\left(P\cap\bar{R}\right)+v\left(\bar{P}\cap R\right)} \\
&= \frac{1000}{1000+1000}=.50 \\
\Pr\left[P\$\middle|\left\{P,P\$\right\}\right] &= \frac{v\left(P\$\cap\bar{P}\right)}{v\left(P\$\cap\bar{P}\right)+v\left(\bar{P}\$\cap P\right)} \\
&= \frac{1}{1+0}=1 \\
\Pr\left[P\$\middle|\left\{P\$,R\right\}\right] &= \frac{v\left(P\$\cap\bar{R}\right)}{v\left(P\$\cap\bar{R}\right)+v\left(\bar{P}\$\cap R\right)} \\
&= \frac{1001}{1001+1000}=.499
\end{aligned}
$$

EBA Model Assumptions

1. Each option is represented by a set of valued aspects.
2. An aspect is probabilistically selected (with a probability that depends on strength)
3. Any option that does not have the selected aspect is eliminated.
4. Process continues until only one option remains, which is chosen.

EBA Model for N=3 options



EBA Model for triadic choices from a set {A,B,C}

- Let K be the sum of the utilities of all of the aspects,

$$K = v(a) + v(b) + v(c) + v(ab) + v(ac) + v(bc).$$

- The probability of selecting A from the set, T, is:

$$\Pr[A|T] = \frac{v(a) + v(ab) \cdot \Pr[A|\{A, B\}] + v(ac) \cdot \Pr[A|\{A, C\}]}{K}$$

- First, aspect a could be selected from the set of aspects with probability $v(a)/K$. If so, A would be chosen with probability 1.
- Second, aspect ab could be selected from the set of aspects with probability $v(ab)/K$. IF so, A would be chosen with probability $\Pr[A|\{A, B\}]$
- Third, aspect ac could be selected from the set of aspects with probability $v(ac)/K$. IF so, A would be chosen with probability $\Pr[A|\{A, C\}]$

EBA Model for the binary choices

- $\Pr[A|\{A,B\}]$ determined by the ratio of the strength of the aspects in A and not in B relative to strength of aspects in B and not in A

$$\Pr[A|\{A,B\}] = \frac{v(a) + v(ac)}{v(a) + v(ac) + v(b) + v(bc)}$$

- $\Pr[A|\{A,C\}]$ determined by the ratio of the strength of the aspects in A and not in C relative to strength of aspects in C and not in A

$$\Pr[A|\{A,C\}] = \frac{v(a) + v(ab)}{v(a) + v(ab) + v(c) + v(bc)}$$

EBA Model for Similarity Effect

- $T = \{\text{Lexus, Infiniti, Focus}\}$
- Lexus and Infiniti both share a large number of quality features that are not share by Focus
- Focus has a number of unique economic features that are not shared by Lexus and Infiniti
- Quality features
  - $v_Q\left(L \cap I \cap F\right) = 1$
  - $v_Q\left(L \cap I \cap \bar{F}\right) = 10$
- Economic features
  - $v_E\left(L \cap I \cap F\right) = 2$
  - $v_E\left(\bar{L} \cap \bar{I} \cap F\right) = 12$
- Style
  - $v_S\left(L \cap I \cap \bar{F}\right) = 3$
  - $v_S\left(\bar{L} \cap I \cap \bar{F}\right) = 2$
  - $v_S\left(L \cap \bar{I} \cap \bar{F}\right) = 1$

EBA Model for Similarity Effect

- $\Pr[L|\{L,F\}] = \frac{10+3+1}{10+3+1+12} = .54$
- $\Pr[L|\{L,I\}] = \frac{1}{1+2} = .333$
- $\Pr[I|\{I,F\}] = \frac{10+3+2}{10+3+2+12} = .56$
- $\Pr[L|\{L,I,F\}] = \frac{1+(10+3)\cdot.333}{28} = .19$
- $\Pr[I|\{L,I,F\}] = \frac{2+(10+3)\cdot.666}{28} = .38$
- $\Pr[F|\{L,I,F\}] = \frac{12}{28} = .43$

$$v_Q\left(L \cap I \cap \bar{F}\right) = 10$$
$$v_E\left(\bar{L} \cap \bar{I} \cap F\right) = 12$$
$$v_S\left(L \cap I \cap \bar{F}\right) = 3$$
$$v_S\left(\bar{L} \cap I \cap \bar{F}\right) = 2$$
$$v_S\left(L \cap \bar{I} \cap \bar{F}\right) = 1$$

Tool box of heuristics

- Payne Bettman Johnson 1993
- Gigerenzer and Todd 1999
- Choose tool adaptively for appropriate environment
- Tools include
  - non-compensatory rules
  - compensatory rules
- Trade off effort for accuracy
  - heuristic rules fast and frugal but may be less accurate
  - optimal rules more accurate but more effortful
- Sometimes simple rules are both less effort and more accurate

Tools in the box

- Weighted sum rule
  - $U(option) = \sum w_i \cdot v_i$
- Equal weight rule
  - normalize values on common scale, sum values for each option with unit wgt
- Lexico graphic rule
  - Start with most important dimension
  - pick best on most important
  - if there are ties on most important , move to second most important
  - pick best of second most important
  - if ties remain on second most important, move to third most important
  - ect
- Majority of confirming dimensions
  - pick option that is best on the most attributes

Tool comparison

- Weighted sum rule
  - compensatory
  - within alternative across dimension processing
  - requires trade offs
  - requires common scale
  - requires process all dimensions
  - more effort but maybe more accurate
  - needed in environments with each dimension equally important
- Lexico graphic rule
  - non compensatory
  - across alternative within dimension processing
  - does not require trade offs
  - does not require common scale
  - processes limited number of dimensions
  - less effort but less accurate
  - works well in environments with one very important dimension