A Quantitative Model of the Perception of Randomness in Structured Two Dimensional Space

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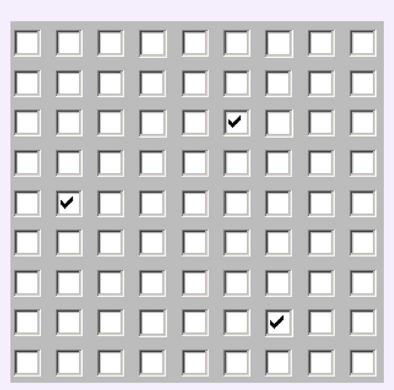
ABSTRACT

The literature on the perception and generation of randomness suggests that people deviate from true randomness in consistent ways. Representativeness, ease of encoding, and variety-seeking theories only provide partial explanations. In the context of 2D sets of cells in grid-like formations, we propose that people judge cells with higher perceived 'coverage' as being more random. Given a selected cell, we define its coverage as a perceptually-formed grouping of cells to which people assign similar probabilities: a cell 'covers' similar or nearby cells. We design a quantitative model for calculating coverage and demonstrate its ability to predict judgments of randomness in two experiments.

1. BACKGROUND



Consider prior observation of people randomly selecting three squares out of 81

Compared to random selections, people's selections are spread out, while avoiding the edges of the grid

Q: Can existing theories explain the observation?

1: Local representativeness[1]

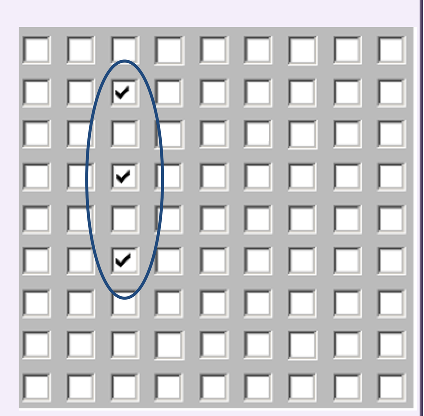
Selections are (locally) representative of randomness

But, why is spreading and avoidance of edges representative of chance?

2: Over-alternations[2]

Random selections have high probability of alternations P(A)

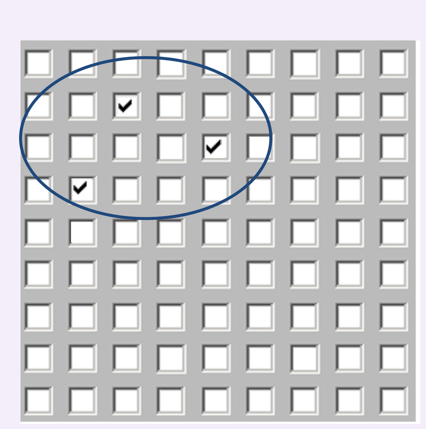
But, selections could have high P(A) and not be perceived random



3: Ease of encoding[2]

Locations that are easier to encode are perceived as less random

But, selections could be difficult to encode, yet not be spread out

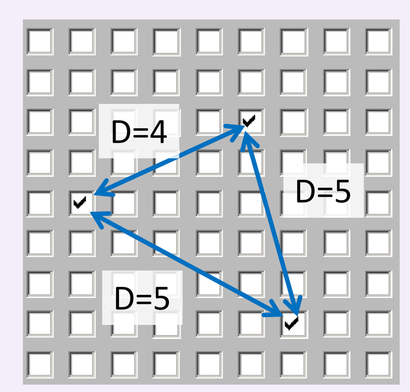


2. PROPOSED THEORY

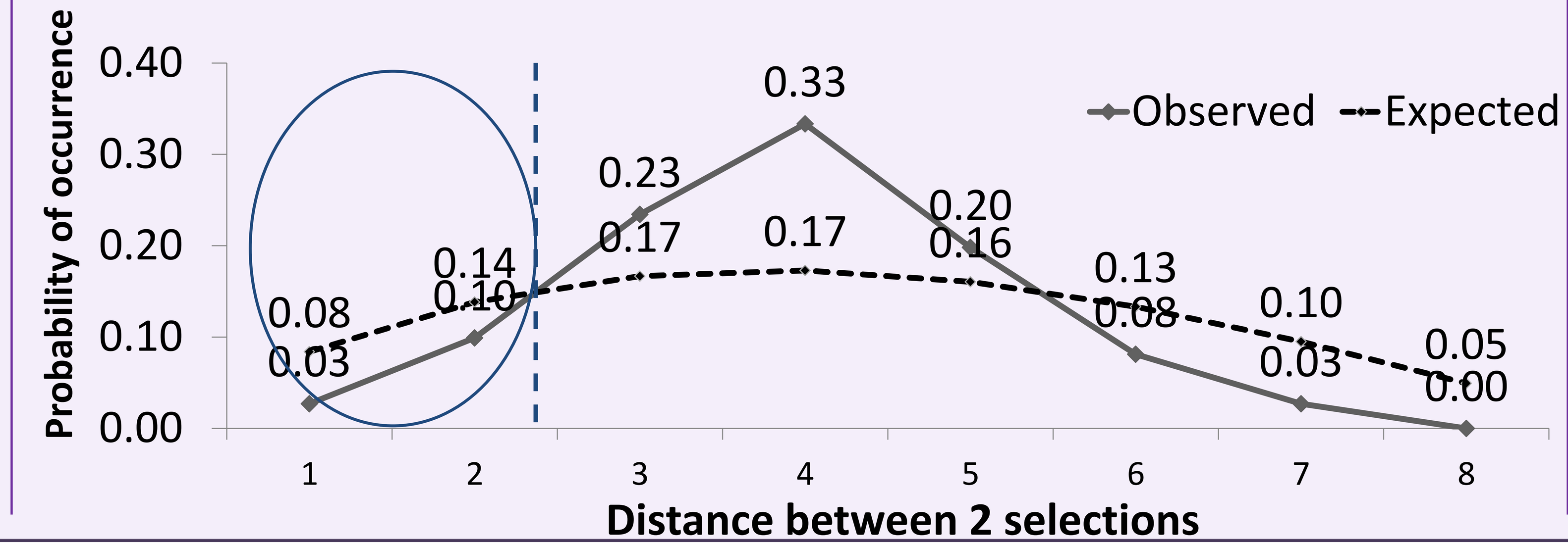
People perceive locations with highest coverage as being the most random.

Coverage by proximity (CP) of cell X refers to surrounding cells that people group with X.

Step 1: Define calculation of distance between selections



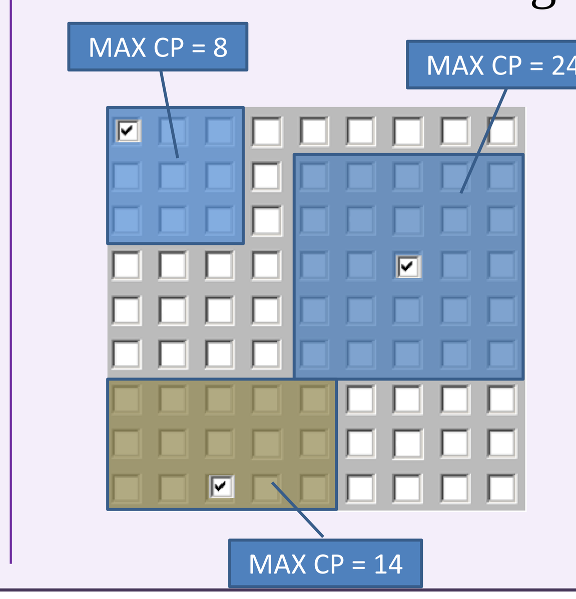
Step 2: Compare observed frequency of distances to their expected frequency (if selections were truly random and independent)



Step 3: Derive size of coverage for cells in 9x9 grid

In the 9x9 grid, each cell covers all cells within 2 units of distance

Step 4: Ponder implications to various locations in grid

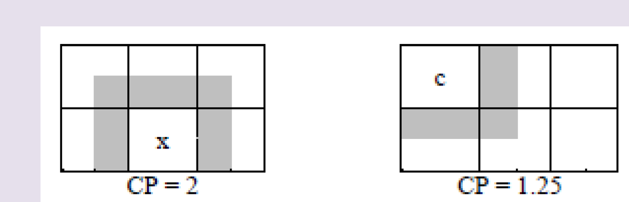


3. METHODOLOGY

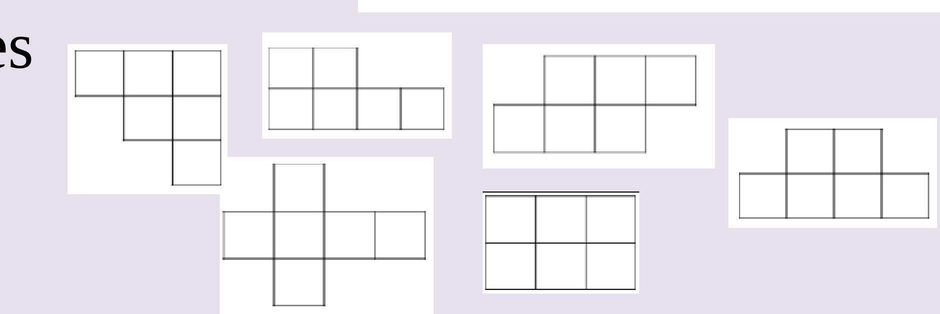
Test the coverage maximization model in simple 6-cell structures

Experiment 1A – Single selection

Step 1: Define single-selection CP in 6-cell 2D structures

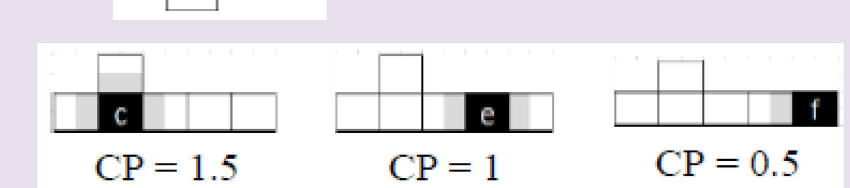


Step 2: Select a number of 6-cell 2D structures to be chosen in the experiment



Step 3: Choose possible selection locations, calculate CP, and rank accordingly

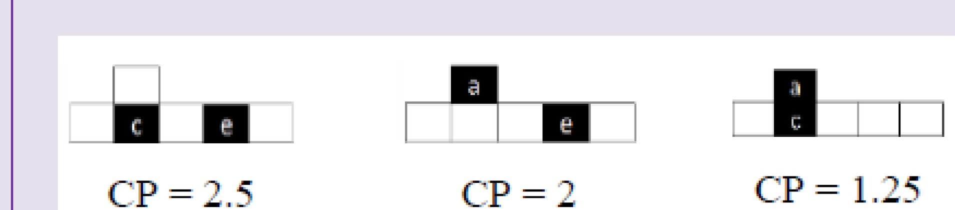
Step 4: Ask participants to rank same based on perceived randomness



Experiment 1B – Double selection

Step 1: Define double-selection CP in 6-cell 2D structures

Steps 2-4: Same as Experiment 1A

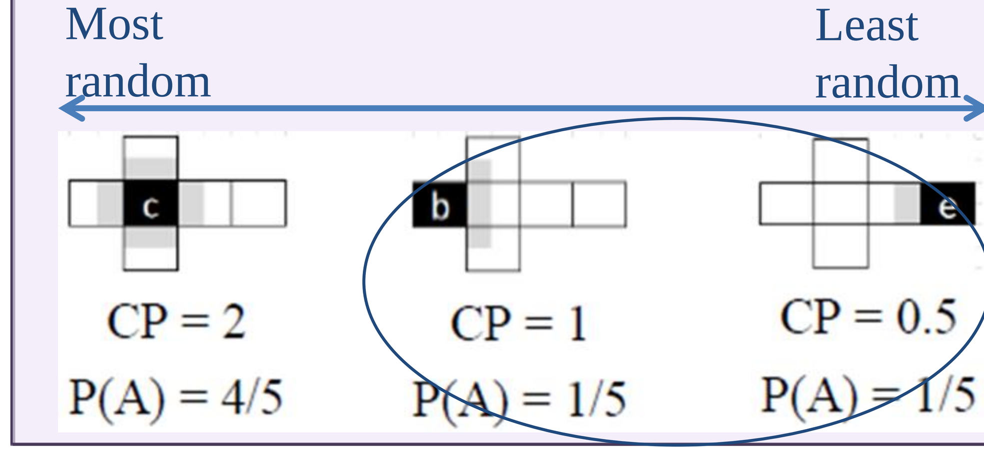


Result: There is an observed agreement (p<0.01) among participant rankings and expected rankings*.

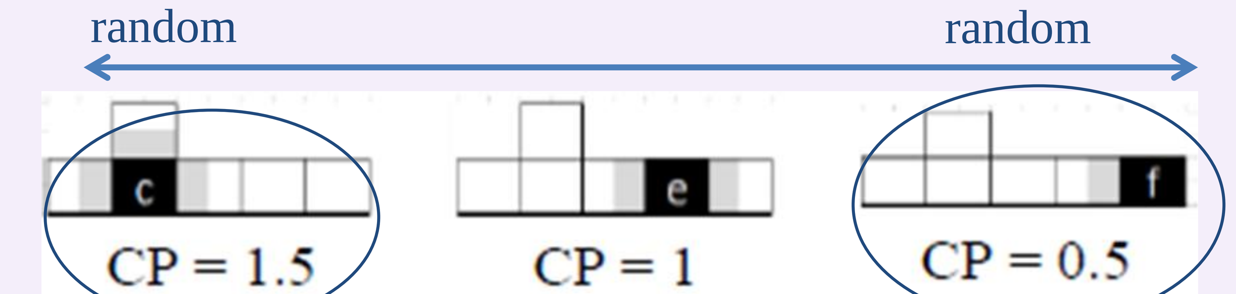
3. DISCUSSION

Coverage predicts perceived randomness of cells better than existing theories

1. CP makes a (correct) prediction where P(A) makes no prediction



2. CP makes a (correct) prediction where ease of encoding makes incorrect prediction



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1. Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgement of representativeness. *Cognitive Psychology*, 3, 430-454. doi: 10.1007/978-94-010-2288-0_3
2. Falk, R., & Konold, C. (1997). Making sense of Randomness: Implicit encoding as a basis for judgment. *Psychological Review*, 104(2), 301-318. doi: 10.1037/0033-295X.104.2.301