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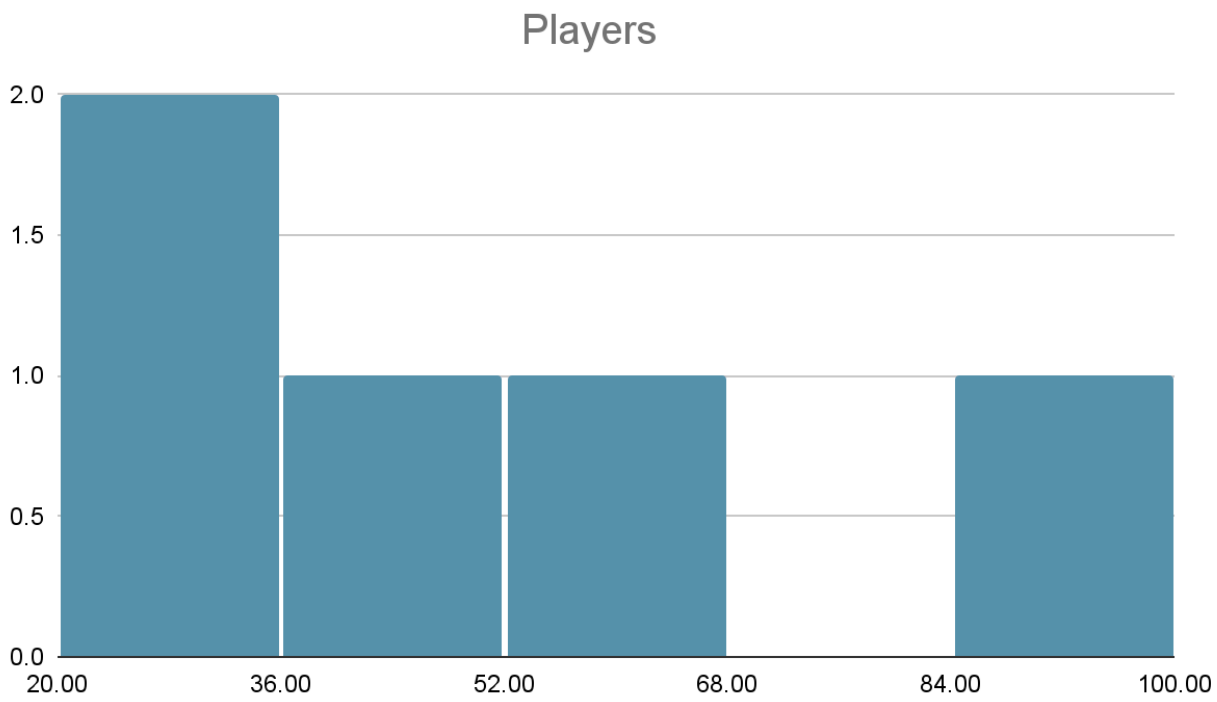
1: What is Statistics?

1.2: Histogram

The relative frequency histogram given was constructed from the number of lands in a sample of five 100-card decks.



a. What proportion of decks have between 20 and 36 lands?
    i. 0.2
b. What proportion of decks have more than 52 lands?
    i. 0.2

1.3: Variance, mean, standard deviation

Assuming that the cmc of a set of permanents is a mean of 3.73 and standard deviation of 2.7, what fraction of cards have a cmc between 3 and 4?

2: Probability

2.3: Set notation

If a set of 60 cards contains 26 creatures, 14 artifacts, and 7 artifact creatures, find the number of cards that are creatures, artifacts, or both.
26+14-7=33

2.4: A Probabilistic Model for an Experiment: The Discrete Case

On the first combat step of your opponent's turn, a creature they control can do nothing, activate a tap ability, or attack. The experiment consists of observing your opponent's choice of what to do with this creature.

List the sample space: {"do nothing", "activate a tap ability", "attack"}
If all choices are equally likely, what is the chance your opponent attacks? 0.33

2.5: Calculating the Probability of an Event: The Sample-Point Method

On your main phase, you rank three permanents in your hand as best, average, and worst.
What is a sample point?
List the sample space. {("best", "average", "worst"), ("best", "worst", "average"), ("average", "best", "worst"), ("average", "worst", "best"), ("worst", "best", "average"), ("worst", "average", "best")}
If you actually don't know anything, what is the probability that you rank the best card as either the best or average? 4 cases where "best" is ranked best or average / 6 total cases ≈ 0.67 chance

2.6: Tools for Counting Sample Points

If you have 5 opponents with no blockers, 4 creatures in your hand with haste, none on the board during your pre-combat main phase, assuming you have enough lands to play exactly 1 creature, how many different ways can you damage an opponent?

5 opponents*4 creatures=20 possibilities

2.7: Conditional Probability and the Independence of Events

Assume that from a 60 card deck, there are 15 lands, 15 creatures, 15 artifacts, and 15 enchantments. Assume no cards share a type. If you draw 3 lands when drawing your initial hand of 7 cards, what is the probability that your entire hand is lands?

$$\frac{\binom{15\ lands}{7\ cards}}{\binom{60\ total}{7\ cards}} \approx 0.00001006$$

2.8: two laws of probability

Suppose that if you attack with a creature on your turn, there is a 1/15 chance it dies.
If you attack with said creature for 3 turns, what is the probability it survives?

$$(1 - \frac{1}{15})^3 \approx 0.36$$

Your opponent claims that there is a 100% chance that the creature dies after 15 turns. Are they right? Explain. No, every turn is independent.

2.9: Calculating the Probability of an Event: The Event-Composition Method

Assuming a card having any legal type is equally likely within a set of cards, and that there is a 10% chance that a card has the creature, artifact, or enchantment type, what is the probability it does not have all 3 types?

$$1 - 0.1^3 = 0.999$$

2.10: The Law of Total Probability and Bayes' Rule

Assume that a set of cards has 30 cards: 17 artifacts and 13 creatures. If artifacts have a 90% chance of having a mana ability, and creatures have a 20% chance. If a card picked at random has a mana ability, what is the probability it was a creature?

$$\frac{0.2*\frac{13}{30}}{(\frac{17}{30}*0.9)+(\frac{13}{30}*0.2)} \approx 0.15$$

3: Discrete Random Variables

3.2: The Probability Distribution for a Discrete Random Variable

A set of 4 cards contains 2 lands. A player draws 1 at a time until both lands are drawn. Let Y denote the number of draws it takes to draw a land, and find the probability distribution for Y.

1. 0.0

2. 0.17
3. 0.5
4. 0.33

3.3: The Expected Value of a Random Variable or a Function of a Random Variable

Assume a player draws a card from a set of cards containing an equal number of lands, creatures, artifacts, and enchantments, and that no card has more than 1 type. If said player is paid $10 for a land or enchantment, $5 for a creature, and owes $3 for an artifact, what is the expected gain after 1 play?

0.25*10+0.25*5+0.25*(-3)+0.25*10=5.5

3.4: Binominal Distribution

If you scry 1 then shuffle, 20 times, and there is a 14% chance of the card you see being a land when scrying, what is the probability that exactly 13 lands are seen? More than 11 but not more than 17?

a. $\binom{20}{13} * 0.14^{13} * (1 - 0.14)^{7} = 1.56 * 10^{-8}$

b. $\sum_{k=12}^{17} \binom{20}{k} * 0.14^{k} * (1 - 0.14)^{20-k} = 3.52 * 10^{-8}$

3.5: Geometric Distribution

Suppose that in a 5 player game, the chance of an opponent attacking any of their opponents is equally likely.

$(1 - 0.25)^{3} * 0.25 \approx 0.105$

What is the probability that the 4th turn that isn't yours is the first turn you are attacked?
If you are going to deck yourself (lose the game) in 10 turns, what is the probability you will not be attacked at all?

$(1 - 0.25)^{10} \approx 0.056$

3.6: Negative Binomial Distribution

If you control a permanent with an activated ability that, once a turn, has a 2% chance of activating, what is the probability that the first turn it activates will be your third turn? The third strike your fifth turn?

$(1 - 0.02)^{2} * 0.02 \approx 0.0192$

$\binom{5-1}{3-1} * 0.02^{3} * (1 - 0.02)^{5-3} \approx 4.61 * 10^{-5}$

3.7: Hypergeometric Distribution

A set of 13 cards contains 5 lands, 3 sorceries, and 5 instants. If 3 cards are drawn without replacement, what is the probability that all 3 will be instants?

$$\frac{\binom{8}{3}\binom{13-8}{3-3}}{\binom{13}{3}} \approx 0.043$$

3.8: Poisson Distribution

If a landfall ability causes you to roll a fair d20, and you play 1 land per turn, for 20 turns, what is the approximate probability of rolling at least one 7?

$$\frac{0.05^{1}e^{-0.05}}{1!} \approx 0.632$$

3.11: Tchebysheff's Theorem

If a mana ability causes you to toss a coin 4 times, let Y be the number of heads.
Use the binomial probability distribution to calculate the probability associated with y=0,1,2,3,4
Find the expected value and standard deviation of Y, using the formulas E(Y)=np and V(Y)=npq
Expected Value: 4*0.5=2
StDev: $(4 * 0.5 * (1 - 0.5))^{0.5} = 1$

Continuous Variables

4.2: The probability Distribution for a Continuous Random Variable

4.3: Expected Values for Continuous Random Variables

4.4: Uniform Probability Distribution

4.6: Gamma Probability distribution (exponential)

Multivariate Probability

5.2: Bivariate and Multivariate probability distribution

Assume that a card can have up to two of the types creature, artifact, and enchantment. If 2 cards have equal probability of having any type drawn, let Y1 be the number of creatures, and Y2 be the number of enchantments.
Find the joint probability function for Y_1 and Y_2: {

(0, 0): 4/36,
(0, 1): 8/36,
(0, 2): 4/36,
(1, 0): 8/36,
(1, 1): 8/36,
(1, 2): 2/36,
(2, 0): 2/36,
(2, 1): 0,
(2, 2): 0

}
Find F(1, 0): 4/36+8/36=12/36=4/12=1/3=0.33

5.3: Marginal and Conditional Probability Distributions

Assume that for a given game, you are able to play an average of 2 spells per turn. Assuming the number of spells you can play in a turn follows a poisson distribution, what is the probability of playing exactly 3 spells? Exactly 0? More than 2? What are the expected value and variance?

Exactly 0: $\frac{2^0 * e^{-2}}{0!} \approx 0.1353$

Exactly 3: $\frac{2^3 * e^{-2}}{3!} \approx 0.1804$

More than 2: $1 - (\frac{2^0 * e^{-2}}{0!} + \frac{2^1 * e^{-2}}{1!} + \frac{2^2 * e^{-2}}{2!}) \approx 0.3233$

CONCLUSION + FINDINGS