

Assignment 1: Cat and Mouse

A cat chases a mouse in and out of a house. Due to the hot weather and malfunctioning air conditioner, all doors and windows are open. This provides a rousing game of tag, as both the mouse and the cat are small enough to fit through all doorways and window frames. Is it possible for the cat and mouse to run through every doorway and window frame exactly once? If so, then draw such a route. If not, then prove that such a route is not possible.

Search online for “house plan diagram” and select a sufficiently detailed plan of a house for this exercise. Is it possible for the cat and mouse to run through every doorway and window frame exactly once? If so, then draw such a route. If not, then prove that such a route is not possible.

Make sure to write up your proof in Claim-Proof form, stating the answer at the beginning with a claim and using complete sentences and paragraphs in your proof. Be sure to include any figures that may assist the reader when reading your answer. You may assume that the reader is familiar with basic graph theory terminology.

Your paper should consist of the following sections:

- Abstract: briefly state the intent of your paper,
- Introduction: state the problem and explain its background,
- Main Result(s): state and prove your result,
- Conclusion: state similar or generalized conjectures that arise from your result.

Assignment 2: Poker Hands

During a 5-card Poker game between five of the most famous (fictional) Poker players, tension rises when James Bond, Kenny Rogers, and Rusty Ryan each go “all in,” putting a combined \$5 million into the pot. The players reveal their hands to find that

- James Bond has a _____,
- Kenny Rogers has a _____, and
- Rusty Ryan has a _____.

No one wants to let go of any money; each player demands to know the exact likelihood of each hand; only then can the winner be declared. Since all hands are *different*, this will require five *separate* calculations.

As the dealer, you must determine the winner. Find the general probabilities of each of the five Poker hands---that is, you must state how likely it would be to get each of the hands after drawing 5 cards from a 52-card deck (consisting of 13 values, each with 4 suits). Naturally, the hand with the lowest probability wins. It is important that you prove your answers accurately and concisely, in no more than 2 or 3 pages.

Make sure to write up your proofs in Claim-Proof form, stating the answer at the beginning with a claim and using complete sentences and paragraphs in your proof. Write a separate claim and proof for each player's hand. While you may not need any figures to assist you, you must use proper notation when referring to combinations and permutations.

Your paper should consist of the following sections:

- Abstract: briefly state the problem and the intent of your paper,
- Introduction: state the basic history and rules of Poker; also define combinations and probability,
- Main Result(s): state and prove your result(s),
- Conclusion: summarize your work, and make conjectures that arise from your result(s).

You may choose any 5 of the following **non-crossed out** Poker hands:

- ~~**Royal Flush:** The values 10, J, Q, K, A of the same suit.~~
- ~~**Straight Flush:** Any 5 consecutive values with the same suit.~~
- ~~**Four of a Kind:** All 4 copies of the same value and one additional card.~~
- **Full House:** Any 3 copies of one value and any 2 copies of a different value.
- **Flush:** Any 5 cards of the same suit that do not form a Royal Flush or Straight Flush.
- **Three of a Kind:** Any 3 copies of one value and any 2 different values.
- **Two Pair:** Any 2 copies of one value and any 2 copies of another value and one additional value.
- **Pair:** Any 2 copies of one value and any 3 different values.
- **High Card:** All other Poker hands not previously described.