Out in the deepest part of the sea where the the water is most dark lies a kingdom so glamorous with all sorts of sea critters and sea plants and most importantly, the beautiful mermaids and mermen, sea people with who have normal human bodies but have a fish’s tail  in place for feet. Among the mermaids, there was a little princess named Aerie. Aerie lived in the royal sea castle with her father and the King of the Sea, King Gualcherani, and her four older sisters.

As a child, little Aerie enjoyed playing with the all the sea critters. As a hobby, Aerie especially enjoyed comparing the sizes and defining colors of her many fish friends. Looking out into the vast sea, Aerie would find red fish, blue fish, or even some teal colored fish. Here, color is an example of a categorical variable because fish are separated into categories based on their described color. Not only were there different colored fishes, but the fish were also in many different sizes; some were 4 inches long like clownfish, 5 inches long like a trout, or even the size of a school bus like a whale! In this case, fish size is considered to be a quantitative variable since numbers are used to describe the different sized fish.

“The sea is a marvelous wonder indeed, but I cannot wait until the day I could finally surface the sea and explore what walks the Earth and flutters by the heavens," Aerie would tell her fish friends. Because people of the sea were not allowed to leave the sea until they are 15 years-old, Aerie was too young to leave the ocean and only learned of the world above the ocean’s water from stories she had heard. Everyday Aerie would beg her older sisters to tell her all the interesting stories about their adventures at the surface; Aerie was especially interested in learning about the mysterious humans who walked the Earth on two legs.

On Aerie’s fifteenth birthday, the time finally arrived for Aerie to be able to venture above the water’s surface. However, before Aerie was allowed to go off and explore, King Gualcherani gave her a warning, “most mermaids can only stay above the water for about only an hour! And be careful, the surface is full of unknown dangers never before known to the people of the sea!” With these words, Aerie anxiously darted to the surface.

On her first adventure at the surface, Aerie was amazed to see the heavenly crimson sky, pure white clouds, and the streaking sun for the first time. At this beautiful scenery, Aerie noticed in the sky what she thought to be a school of fish swimming through coral reefs. Soon, Aerie learned that these creatures were not fish but were instead, winged animals called seagulls flying through the clouds. Aerie also realized that each seagull in the flock had a different wingspan. The range for the different lengths of the seagulls’ wingspans represents a distribution. Some seagulls had a wingspan as wide as King Gualcherani’s tail length (24 feet) while some had wingspans that only spanned the height of a small shrimp. Aerie laughed at the odd, outlier, seagulls that were either too big or too small since they stood out in the flock. To Aerie, the seagulls appeared to have a median wingspan of 8 feet, meaning that half of the seagulls Aerie saw had wingspans smaller than 8 ft and half had wingspans larger than 8 ft long. Aerie also noted that about half of the birds on average had wingspans between 6 - 10 ft wide. Her observation says that the birds that have an average wingspan length differ by a maximum of 4 ft. Apparently, the distribution wingspans of the birds were approximately symmetric because only very few seagulls had really small or really large wingspans, so most seagulls had a medium sized wingspan.

(6) Before Aerie knew it, the sun had set and Aerie’s sisters had come looking for her. “Aerie it’s time to come home. Father warned you not stay on the surface this long!” her oldest sister told her. “No I don’t want to go home yet! There’s still much more to see!” Aerie would complain. However, no matter how much Aerie tried to argue to stay at the surface for just a little longer, her sisters eventually dragged her back to her ocean palace home. At home, King Gualcherani yelled at Aerie for breaking the rules. In her argument, Aerie protested, “How come I can only stay above the water for only an hour? I have seen the mermen leave the sea in the morning and not come back until dusk!”

(7) King Gualcherani replied “Of course! Mermen have a duty to find and bring home any prized possessions lost at sea.” At that instant, King Gualcherani summoned spiraling pillars of water of different heights. “According to these two charts, or histograms, the amount of time mermen spend at the surface and the time mermaids spend, we will clearly notice that mermen on average do surface much longer than mermaids do! Not only that but mermen have duties that require them leave and return as they please, but mermaids are only allowed to stay up for an hour; therefore, mermen have much more flexibility with how they spend their time out of the sea while mermaids are limited to only one hour. However, for both mermaids and mermen, very few stay at the surface for either very long or very short times, so both the mermen and mermaids spend an average amount of time at the surface as estimated by their individual distributions. The time spent at the surface is approximately symmetric for both mermen and mermaids and appearance of outliers is rare. Blah, enough of this talk, Aerie my dear. You may surface for one hour again tomorrow, but tonight let us celebrate your honorable 15th birthday!”

(8) The next morning Aerie made another trip to the water's surface. Unlike yesterday, the waves today were so turbulent and violent that even Aerie was scared. Off in the distance Aerie heard clamorous shouting. As she approached the noise, Aerie saw a magnificent ship getting tossed and turned by the malevolent storm. Soon, the ship’s deck cracked and fell into the sea. With that, the ship began to sink and men cried for help.

(9) Swimming toward the wreck, Aerie stopped at where the ship used to be and found herself surrounded by debris. Aerie guessed that all the ship fragments were normally distributed around her, meaning that if she continues swimming in the direction from which the ship had come from, then she will encounter a greater volume of shipwreck per meter traveled and if she were to turn back and head home, she would run into lower volumes of debris per meter (this is because the waves carry the debris onto shore from the the ship had come from). The average volume of the ruins could be found at the actual site of the shipwreck. Aerie could no longer hear the cries of men, all she could hear was thunder cracking in the sky and the violent waves crashing against each other. However, Aerie was determined to find a survivor. She began swimming toward the area of higher concentration of debris. Along the way, Aerie decided to measure the distance she travels in standard deviations, how far has has traveled relative to the site of the wreck. She measured that within one standard deviation from the wreck yields 64% of total debris, within two standard deviations away contains 95% of total debris, and within three standard deviations away contains 99.7% of total volume of debris. By the time Aerie swam one standard deviation from the site of the shipwreck, Aerie found a survivor afloat on a wooden plank, hanging on for dear life. Aerie approached the survivor and when she saw his face, she immediately fell in love. She guessed the young man had to be a prince or some sort and was desperate to get him to safety. Aerie wanted to approximate how much debris still lay ahead. She knew that the standard deviation for the distribution of volume of debris was 1, and the the average volume of debris at the site of wreck was 25m2. Also, Aerie estimated that volume of debris around her right now was about 28m2s. With this information, Aerie can find the z - score, a measure of the volume of debris in terms of standard deviations. The z - score could indicate what percent of the total volume of debris Aerie had swam past so far and in order to calculate the percent of volume of debris that she will have to swim through, she will need to take 100% minus the percent of debris she had already swam passed. With careful calculations, Aerie still have to avoid about 0.13% of total volume of debris before she can safely bring the prince to shore.

(10) When finally on land, Aerie lay the prince down to rest on top of a rock and started to melodically sing to wake him wake, yet, sooner tried to kiss him but just when she was about to lay her lips on his, her sisters emerged from the waters and warned her to come home. Not wanting to anger her father nor to let her sisters find out what had happened, Aerie quickly dove back into the sea. At home, Aerie yearned to see the prince again. She wanted to have legs and be able to walk the Earth and live happily ever after with the dashing prince.

(11) Desperately  Longing for both the prince and to become human, Aerie sought the witch of the sea, Ursula. Aerie had heard of Ursula’s powers to grant anyone a wish come true, but in exchange for a deadly price.

“Oh witch of the sea, please help me with my sorrows. Grant me my wish of becoming a real human being with two legs I can use to walk Earth!” Aerie pleaded.

“Yes yes, I know what you want princess,” Ursula said, “but you must give me something in return.”

“Yes anything I will give you anything for my wish!”

“I have a magic potion that will transform your fish tail into two legs, but I will warn you now that until you marry the man you love, every step you take will be feel as though you were walking the spines of sea urchins! However, if the man you love marries another woman, then you will vanish into sea foam! HAHAHA!” screamed  Ursula.

“I will take the potion! What do you require from me in return?” Aerie asked the witch.

“Your voice!” Ursula snickered. With a hesitant nod of her head, Aerie received the magic potion. As she left the witch’s cave, Aerie waved goodbye to her home palace and swam to the water’s surface. Once above the water, Aerie drank the magic potion and immediately fell into a deep slumber.

(12) When Aerie woke up, she gazed around and stared up into a beautiful pair of eyes. It was the prince she loved! Somehow she had been safely washed to shore and the prince had found her. She looked at what used to be her tail but found a pair of slender feet instead! Aerie was ecstatic and wanted to yell out in pure joy, but she remembered she had traded her precious voice to Ursula. The prince asked her all sorts of questions but all poor little Aerie could do was stare into his eyes and shake her head. Eventually the prince took her into his palace but as Aerie walked with him, she wanted to cry out in pain as every step she took was full of pain, yet she was still excited to walk with the handsome prince.

(13) Inside his royal palace, the prince gave Aerie some candy for he thought that Aerie was emotionally disturbed and too sad to talk. Then the prince decided to show Aerie his home, hoping that his elegant palace would make Aerie happy. As Aerie walked, she noticed that the more candy she ate, the less pain she felt in her new legs. Aerie decides to measure the amount of pain she feels in her feet by accounting for the number of steps she could take before she would need her candy ailment. She figured that there may be some sort of positive relationship between the amount of candy she eats at a time and the number of steps she is able to walk before she has to gobble down another handful of candy. In her mind, Aerie imagined a little comparison plot of the number of pieces of candy she eats against the number of steps she could walk. After numerous trials, since it was a long walk around the enormous palace, she found that there is indeed a trend between the two quantitative variables - the more she eats, the more expected steps she could walk before eating more candy! To verify this expected linear prediction model, Aerie imagined a line that divided the points relatively evenly above and below the line. Then as a rule of thumb, her prediction model would be appropriate if she rotates her imaginary plot along with the prediction line and the scatter of points is randomly distributed above and below the “rotated” prediction, or the regression, line without following any specific patterns. To Aerie’s surprise, her little comparison met all these requirements; therefore, Aerie could use her model to predict the number of steps she could take before she eats more candy to soothe her foot pains based on the amount of candy she eats at a time!

(14) While Aerie was still in her fantasies, the prince mentioned something that took her by surprise. “You should come to my wedding tomorrow! It will be very delightful and I would like you to join us!” the prince told Aerie. After hearing this Aerie felt as though her heart split. She immediately burst into tears and the felt as though she had just lost everything that had meaning in her life right before her. Aerie turned and ran towards the sea, fleeing from the prince and his heartbreaking news. Aerie jumped into the sea, hoping to be a mermaid again but she remembered what Ursula had warned her “if the man you love marries another woman, then you will vanish into sea foam!” and slowly, Aerie felt herself slowly disappearing.

(15) When Aerie woke up, she felt dizzy, but strangely invincible as well. Gazing around, she noticed she was not drifting in the sea or lying on land but rather, she was floating on the air. A mysterious being flew up to Arie and explained to her “Welcome! We are the wind spirits who have been watching over your life. As you may know, humans have immortal souls that go into the heavens but people of the sea do not, they simply evaporate into sea foam. Although the people of the sea can live up to 300 years, they have no soul. Humans on the other hand, live shortly but have eternal afterlife.” The wind spirit held out his hand to Aerie. “We have witnessed your kind being and all your grateful deeds. We may grant you your wish; you may join us and live for eternity.” Without hesitation, Aerie accepted the offer of immortality and became a wind spirit, agreeing to help watch over both the lands and seas from the skies above.