Chapter 1

Designing studies

Multiple Choice

1. The Web portal AOL places opinion poll questions next to many of its news stories. Simply click your response to join the sample. One of the questions in January 2008 was "Do you plan to diet this year?" More than 30,000 people responded, with 68% saying "Yes." You can conclude that

   (a) about 68% of Americans planned to diet in 2008.

   (b) the poll used a convenience sample, so the results tell us little about the population of all adults.

   (c) the poll uses voluntary response, so the results tell us little about the population of all adults.

   (d) the sample is too small to draw any conclusion.

   (e) None of these.

2. To gather information about the validity of a new standardized test for tenth-grade students in a particular state, a random sample of 15 high schools was selected from the state. The new test was administered to every 10th-grade student in the selected high schools. What kind of sample is this?

   (a) A simple random sample

   (b) Stratified random sample

   (c) A cluster sample

   (d) A systematic random sample

   (e) A voluntary response sample

3. Suppose that 35% of the registered voters in a state are registered as Republicans, 40% as Democrats, and 25% as Independents. A newspaper wants to select a sample of 1000 registered voters to predict the outcome of the next election. If they randomly select 350 Republicans, randomly select 400 Democrats, and randomly select 250 Independents, did this sampling procedure result in a simple random sample of registered voters from this district?

   (a) Yes, because each registered voter had the same chance of being chosen.

   (b) Yes, because random chance was involved.

   (c) No, because not all registered voters had the same chance of being chosen.

   (d) No, because there were a different number of registered voters selected from each party.

   (e) No, because not all possible groups of 1000 registered voters had the same chance of being chosen.

4. A local news agency conducted a survey about unemployment by randomly dialing phone numbers until they had gathered responses from 1000 adults in their state. In the survey, 19% of those who responded said they were not currently employed. In reality, only 6% of the adults in the state were not currently employed at the time of the survey. Which of the following best explains the difference in the two percentages?

(a) The difference is due to sampling variability. We shouldnt expect the results of a random sample to match the truth about the population every time.

(b) The difference is due to response bias. Adults who are employed are likely to lie and say that they are unemployed.

(c) The difference is due to undercoverage bias. The survey included only adults and did not include teenagers who are eligible to work.

(d) The difference is due to nonresponse bias. Adults who are employed are less likely to be available for the sample than adults who are unemployed.

(e) The difference is due to voluntary response. Adults are able to volunteer as a member of the sample.

5. A simple random sample of 1200 adult Americans is selected, and each person is asked the following question: "In light of the huge national deficit, should the government at this time spend additional money to establish a national system of health insurance?" Only 39% of those responding answered "Yes." This survey

(a) is reasonably accurate since it used a large simple random sample.

(b) needs to be larger since only about 24 people were drawn from each state.

(c) probably understates the percent of people who favor a system of national health insurance.

(d) is very inaccurate but neither understates nor overstates the percent of people who favor a system of national health insurance. Because simple random sampling was used, it is unbiased.

(e) probably overstates the percent of people who favor a system of national health insurance.

6. Ann Landers, who wrote a daily advice column appearing in newspapers across the country, once asked her readers, "If you had it to do over again, would you have children?" Of the more than 10,000 readers who responded, 70% said no. What does this show?

(a) The survey is meaningless because of voluntary response bias.

(b) No meaningful conclusion is possible without knowing something more about the characteristics of her readers.

(c) The survey would have been more meaningful if she had picked a random sample of the 10,000 readers who responded.

(d) The survey would have been more meaningful if she had used a control group.

(e) This was a legitimate sample, randomly drawn from her readers and of sufficient size to allow the conclusion that most of her readers who are parents would have second thoughts about having children.

7. Which of the following is a true statement?

(a) If bias is present in a sampling procedure, it can be overcome by dramatically increasing the sample size.

(b) There is no such thing as a "bad sample."

(c) Sampling techniques that use probability techniques effectively eliminate bias.

(d) Convenience samples often lead to undercoverage bias.

(e) Voluntary response samples often underrepresent people with strong opinions.

8. Two possible wordings for a questionnaire on gun control are as follows:

   I. The United States has the highest rate of murder by handguns among all countries. Most of these murders are known to be crimes of passion or crimes provoked by anger between acquaintances. Are you in favor of a 7-day cooling-off period between the filing of an application to purchase a handgun and the resulting sale?

   II. The United States has one of the highest violent crime rates among all countries. Many people want to keep handguns in their homes for self-protection. Fortunately, U.S. citizens are guaranteed the right to bear arms by the Constitution. Are you in favor of a 7-day waiting period between the filing of an application to purchase a needed handgun and the resulting sale?

   One of these questions showed that 25% of the population favored a 7day waiting period between application for purchase of a handgun and the resulting sale, while the other question showed that 70% of the population favored the waiting period. Which produced which result and why?

   (a) The first question probably showed 70% and the second question 25% because of the lack of randomization in the choice of pro-gun and anti-gun subjects as evidenced by the wording of the questions.

   (b) The first question probably showed 25% and the second question 70% because of a placebo effect due to the wording of the questions.

   (c) The first question probably showed 70% and the second question 25% because of the lack of a control group.

   (d) The first question probably showed 25% and the second question 70% because of response bias due to the wording of the questions.

   (e) The first question probably showed 70% and the second question 25% because of response bias due to the wording of the questions.

9. Each of the 29 NBA teams has 12 players. A sample of 58 players is to be chosen as follows. Each team will be asked to place 12 cards with its players names into a hat and randomly draw out two names. The two names from each team will be combined to make up the sample. Will this method result in a simple random sample of the 348 basketball players?

   (a) Yes, because each player has the same chance of being selected.

   (b) Yes, because each team is equally represented.

   (c) Yes, because this is an example of stratified sampling, which is a special case of simple random sampling.

   (d) No, because the teams are not chosen randomly.

(e) No, because not each group of 58 players has the same chance of being selected.

10. To survey the opinions of bleacher fans at Wrigley Field, a surveyor plans to select every one-hundredth fan entering the bleachers one afternoon. Will this result in a simple random sample of Cub fans who sit in the bleachers?

    (a) Yes, because each bleacher fan has the same chance of being selected.

    (b) Yes, but only if there is a single entrance to the bleachers.

    (c) Yes, because the 99 out of 100 bleacher fans who are not selected will form a control group.

    (d) Yes, because this is an example of systematic sampling, which is a special case of simple random sampling.

    (e) No, because not every sample of the intended size has an equal chance of being selected.

11. Consider the following three events:

    I. Although 18% of the student body are minorities, in a random sample of 20 students, 5 are minorities.

    II. In a survey about sexual habits, an embarrassed student deliberately gives the wrong answers.

    III. A surveyor mistakenly records answers to one question in the wrong space

    Which of the following correctly characterizes the above?

    (a) I, sampling error; II, response bias; III, human mistake

    (b) I, sampling error; II, nonresponse bias; III, hidden error

    (c) I, hidden bias; II, voluntary sample bias; III, sampling error

    (d) I, undercoverage error; II, voluntary error; III, unintentional error

    (e) I, small sample error; II, deliberate error; III, mistaken error

12. A researcher plans a study to examine the depth of belief in God among the adult population. He obtains a simple random sample of 100 adults as they leave church one Sunday morning. All but one of them agree to participate in the survey. Which of the following is a true statement?

    (a) Proper use of chance as evidenced by the simple random sample makes this a well-designed survey.

    (b) The high response rate makes this a well-designed survey.

    (c) Selection bias makes this a poorly designed survey.

    (d) The validity of this survey depends on whether or not the adults attending this church are representative of all churches.

    (e) The validity of this survey depends upon whether or not similar numbers of those surveyed are male and female.

13. A study is made to determine whether taking AP Statistics in high school helps students achieve higher GPAs when they go to college. In comparing records of 200 college students, half of whom took AP Statistics in high school, it is noted that the average college GPA is higher for those 100 students who took AP Statistics than for those who did not. Based on this study, guidance counselors begin recommending AP Statistics for college bound students. Which of the following is incorrect?

    (a) While this study indicates a relation, it does not prove causation.

    (b) There could well be a confounding variable responsible for the seeming relationship.

    (c) It dose prove studying Latin helps students achieve higher scores.

    (d) This is an observational study, not an experiment.

14. In a 1927–32 Western Electric Company study on the effect of lighting on worker productivity, productivity increased with each increase in lighting but then also increased with every decrease in lighting. If it is assumed that the workers knew a study was in progress, this is an example of

    (a) the effect of a treatment unit.

    (b) the placebo effect.

    (c) the control group effect.

    (d) sampling error.

    (e) voluntary response bias.

15. Which of the following is incorrect?

    (a) Blocking is to experiment design as stratification is to sampling design.

    (b) By controlling certain variables, blocking can make conclusions more specific.

    (c) The paired comparison design is a special case of blocking.

    (d) Blocking results in increased accuracy because the blocks have smaller size than the original group.

    (e) In a randomized block design, the randomization occurs within the blocks.

16. Consider the following studies being run by three different nursing home establishments.

    I. One nursing home has pets brought in for an hour every day to see if patient morale is improved.

    II. One nursing home allows hourly visits every day by kindergarten children to see if patient morale is improved.

    III. One nursing home administers antidepressants to all patients to see if patient morale is improved.

    Which of the following is true?

    (a) None of these studies uses randomization.

    (b) None of these studies uses control groups.

(c) None of these studies uses blinding.

(d) Important information can be obtained from all these studies, but none will be able to establish causal relationships.

(e) All of the above

17. A consumer product agency tests miles per gallon for a sample of automobiles using each of four different octanes of gasoline. Which of the following is true?

(a) There are four explanatory variables and one response variable.

(b) There is one explanatory variable with four levels of response.

(c) Miles per gallon is the only explanatory variable, but there are four response variables corresponding to the different octanes.

(d) There are four levels of a single explanatory variable.

(e) Each explanatory level has an associated level of response.

18. Can changing diet reduce high blood pressure? Vegetarian diets and low-salt diets are both promising. Men with high blood pressure are assigned at random to four diets: (1) normal diet with unrestricted salt; (2) vegetarian with unrestricted salt; (3) normal with restricted salt; and (4) vegetarian with restricted salt. In this experiment, what is the most important reason for random assignment?

(a) Random assignment eliminates the effects of other variables such as stress and body weight.

(b) Random assignment is a good way to create groups of subjects that are roughly equivalent at the beginning of the experiment.

(c) Random assignment makes it possible to make a conclusion about all men.

(d) Random assignment reduces the amount of variation in blood pressure.

(e) Random assignment prevents the placebo effect from ruining the results of the study.

19. To investigate whether standing up while studying affects performance in an algebra class, a teacher assigns half of the 30 students in his class to stand up while studying and assigns the other half to not stand up while studying. To determine who receives which treatment, the teacher identifies the two students who did best on the last exam and randomly assigns one to stand and one to not stand. The teacher does the same for the next two highest-scoring students and continues in this manner until each student is assigned a treatment. Which of the following best describes this plan?

(a) This is an observational study.

(b) This is an experiment with blocking.

(c) This is a completely randomized experiment.

(d) This is a stratified random sample.

(e) This is a cluster sample.

20. A gardener wants to try different combinations of fertilizer (none, 1 cup, 2 cups) and mulch (none, wood chips, pine needles, plastic) to determine which combination produces the highest yield for a variety of green beans. He has 60 green-bean plants to use in the experiment. If he wants an equal number of plants to be assigned to each treatment, how many plants will be assigned to each treatment?

    (a) 1 (b) 3 (c) 4 (d) 5 (e) 12

21. Corn variety 1 yielded 140 bushels per acre last year at a research farm. This year, corn variety 2, planted in the same location, yielded only 110 bushels per acre. Based on these results, is it reasonable to conclude that corn variety 1 is more productive than corn variety 2?

    (a) Yes, because 140 bushels per acre is greater than 110 bushels per acre.

    (b) Yes, because the study was done at a research farm.

    (c) No, because there may be other differences between the two years besides the corn variety.

    (d) No, because there was no use of a placebo in the experiment.

    (e) No, because the experiment wasnt double-blind.

22. A report in a medical journal notes that the risk of developing Alzheimers disease among subjects who regularly opted to take the drug ibuprofen was about half the risk among those who did not. Is this good evidence that ibuprofen is effective in preventing Alzheimers disease?

    (a) Yes, because the study was a randomized, comparative experiment.

    (b) No, because the effect of ibuprofen is confounded with the placebo effect.

    (c) Yes, because the results were published in a reputable professional journal.

    (d) No, because this is an observational study. An experiment would be needed to confirm (or not confirm) the observed effect.

    (e) Yes, because a 50% reduction cant happen just by chance.

23. When we take a census, we attempt to collect data from

    (a) a stratified random sample.

    (b) every individual chosen in a simple random sample.

    (c) every individual in the population.

    (d) a voluntary response sample.

    (e) a convenience sample.

24. You want to take a simple random sample (SRS) of 50 of the 816 students who live in a dormitory on campus. You label the students 001 to 816 in alphabetical order. In the table of random digits, you read the entries

    95592 94007 69769 33547 72450 16632 81194 14873

    The first three students in your sample have labels

(a) 955, 929, 400.
(b) 400, 769, 769.
(c) 559, 294, 007.
(d) 929, 400, 769.
(e) 400, 769, 335.

25. A study of treatments for angina (pain due to low blood supply to the heart) compared bypass surgery, angioplasty, and use of drugs. The study looked at the medical records of thousands of angina patients whose doctors had chosen one of these treatments. It found that the average survival time of patients given drugs was the highest. What do you conclude?

    (a) This study proves that drugs prolong life and should be the treatment of choice.
    (b) We can conclude that drugs prolong life because the study was a comparative experiment.
    (c) We cant conclude that drugs prolong life because the patients were volunteers.
    (d) We cant conclude that drugs prolong life because this was an observational study.
    (e) We cant conclude that drugs prolong life because no placebo was used.

26. Tonya wanted to estimate the average amount of time that students at her school spend on Facebook each day. She gets an alphabetical roster of students in the school from the registrars office and numbers the students from 1 to 1137. Then Tonya uses a random number generator to pick 30 distinct labels from 1 to 1137. She surveys those 30 students about their Facebook use. Tonyas sample is a simple random sample because

    (a) it was selected using a chance process.
    (b) it gave every individual the same chance to be selected.
    (c) it gave every possible sample of the same size an equal chance to be selected.
    (d) it doesnt involve strata or clusters.
    (e) it is guaranteed to be representative of the population.

27. Consider an experiment to investigate the effectiveness of different insecticides in controlling pests and their impact on the productivity of tomato plants. What is the best reason for randomly assigning treatment levels (spraying or not spraying) to the experimental units (farms)?

    (a) Random assignment allows researchers to generalize conclusions about the effectiveness of the insecticides to all farms.
    (b) Random assignment will tend to average out all other uncontrolled factors such as soil fertility so that they are not confounded with the treatment effects.
    (c) Random assignment eliminates the effects of other variables, like soil fertility.
    (d) Random assignment eliminates chance variation in the responses.
    (e) Random assignment helps avoid bias due to the placebo effect.

28. The most important advantage of experiments over observational studies is that

    (a) experiments are usually easier to carry out

    (b) experiments can give better evidence of causation.

    (c) confounding cannot happen in experiments.

    (d) an observational study cannot have a response variable.

    (e) observational studies cannot use random samples.

29. *Bias* in a sampling method is

    (a) any difference between the sample result and the truth about the population.

    (b) the difference between the sample result and the truth about the population due to using chance to select a sample.

    (c) any difference between the sample result and the truth about the population due to practical difficulties such as contacting the subjects selected.

    (d) any difference between the sample result and the truth about the population that tends to occur in the same direction whenever you use this sampling method.

    (e) racism or sexism on the part of those who take the sample

30. You wonder if TV ads are more effective when they are longer or repeated more often or both. So you design an experiment. You prepare 30-second and 60-second ads for a camera. Your subjects all watch the same TV program, but you assign them at random to four groups. One group sees the 30-second ad once during the program; another sees it three times; the third group sees the 60-second ad once; and the last group sees the 60-second ad three times. You ask all subjects how likely they are to buy the camera.

    (a) This is a randomized block design, but not a matched pairs design.

    (b) This is a matched pairs design.

    (c) This is a completely randomized design with one explanatory variable (factor).

    (d) This is a completely randomized design with two explanatory variables (factors).

    (e) This is a completely randomized design with four explanatory variables (factors).

31. A researcher wishes to compare the effects of two fertilizers on the yield of soybeans. She has 20 plots of land available for the experiment, and she decides to use a matched pairs design with 10 pairs of plots. To carry out the random assignment for this design, the researcher should

    (a) use a table of random numbers to divide the 20 plots into 10 pairs and then, for each pair, flip a coin to assign the fertilizers to the 2 plots.

    (b) subjectively divide the 20 plots into 10 pairs (making the plots within a pair as similar as possible) and then, for each pair, flip a coin to assign the fertilizers to the 2 plots.

(c) use a table of random numbers to divide the 20 plots into 10 pairs and then use the table of random numbers a second time to decide on the fertilizer to be applied to each member of the pair.

(d) flip a coin to divide the 20 plots into 10 pairs and then, for each pair, use a table of random numbers to assign the fertilizers to the 2 plots.

(e) use a table of random numbers to assign the two fertilizers to the 20 plots and then use the table of random numbers a second time to place the plots into 10 pairs.

32. You want to know the opinions of American high school teachers on the issue of establishing a national proficiency test as a prerequisite for graduation from high school. You obtain a list of all high school teachers belonging to the National Education Association (the countrys largest teachers union) and mail a survey to a random sample of 2500 teachers. In all, 1347 of the teachers return the survey. Of those who responded, 32

(a) Because random sampling was used, we can feel confident that the percent of all American high school teachers who would say they favor a national proficiency test is close to 32%.

(b) We cannot trust these results, because the survey was mailed. Only survey results from face-to-face interviews are considered valid.

(c) Because over half of those who were mailed the survey actually responded, we can feel fairly confident that the actual percent of all American high school teachers who would say they favor a national proficiency test is close to 32%.

(d) The results of this survey may be affected by nonresponse bias.

(e) The results of this survey cannot be trusted due to voluntary response bias.

33. Do teenagers prefer sports drinks colored blue or green? Two different colorings, which have no effect on taste, are used on the identical drink to result in a blue and a green beverage; volunteer teenagers are randomly assigned to drink one or the other colored beverage; and the volunteers then rate the beverage on a one to ten scale. Because of concern that sports interest may affect the outcome, the volunteers are first blocked by whether or not they play on a high school team. Is blinding possible in this experiment?

(a) No, because the volunteers know whether they are drinking a blue or green drink.

(b) No, because the volunteers know whether or not they play on a high school team.

(c) Yes, by having the experimenter in a separate room randomly pick one of two containers and remotely have a drink poured from that container.

(d) Yes, by having the statistician analyzing the results not know which volunteer sampled which drink.

(e) Yes, by having the volunteers drink out of solid colored thermoses, so that they dont know the color of the drink they are tasting.

Free Response

1. In a recent study, 166 adults from the St. Louis area were recruited and randomly assigned to receive one of two treatments for a sinus infection. Half of the subjects received an antibiotic (amoxicillin) and the other half received a placebo.

   (a) Describe how the researchers could have assigned treatments to subjects if they wanted to use a completely randomized design.

   (b) All the subjects in the experiment had moderate, severe, or very severe symptoms at the beginning of the study. Describe one statistical benefit and one statistical drawback for using subjects with moderate severe, or very severe symptoms instead of just using subjects with very severe symptoms.

   (c) At different stages during the next month, all subjects took the sino-nasal outcome test. After 10 days, the difference in average test scores was not statistically significant. In this context, explain what it means for the difference to be not statistically significant.

   (d) One possible way that researchers could have improved the study is to use a randomized block design. Explain how the researchers could have incorporated blocking in their design.

2. An expert on worker performance is interested in the effect of room temperature on the performance of tasks requiring manual dexterity. She chooses temperatures of 70°F and 90°F as treatments. The response variable is the number of correct insertions, during a 30-minute period, in a peg-and-hole apparatus that requires the use of both hands simultaneously. Each subject is trained on the apparatus and then asked to make as many insertions as possible in 30 minutes of continuous effort.

   (a) Describe a completely randomized design to compare dexterity at 70° and 90° using 20 volunteer subjects.

   (b) Because individuals differ greatly in dexterity, the wide variation in individual scores may hide the systematic effect of temperature unless there are many subjects in each group. Describe in detail the design of a matched pairs experiment in which each subject serves as his or her own control.

3. **2010FRB2**
   In response to nutrition concerns raised last year about food served in school cafeterias, the Smallville School District entered into a one-year contract with the Healthy Alternative Meals (HAM) company. Under this contract, the company plans and prepares meals for 2,500 elementary, middle, and high school students, with a focus on good nutrition. The school administration would like to survey the students in the district to estimate the proportion of students who are satisfied with the food under this contract.

   Two sampling plans for selecting the students to be surveyed are under consideration by the administration. One plan is to take a simple random sample of students in the district and then survey those students. The other plan is to take a stratified random sample of students in the district and then survey those students.

   (a) Describe a simple random sampling procedure that the administrators could use to select 200 students from the 2,500 students in the district.

   (b) If a stratified random sampling procedure is used, give one example of an effective variable on which to stratify in this survey. Explain your reasoning.

   (c) Describe one statistical advantage of using a stratified random sample over a simple random sample in the context of this study.

4. **2006FRB5**
When a tractor pulls a plow through an agricultural field, the energy needed to pull that plow is called the draft. The draft is affected by environmental conditions such as soil type, terrain, and moisture.

A study was conducted to determine whether a newly developed hitch would be able to reduce draft compared to the standard hitch. (A hitch is used to connect the plow to the tractor.) Two large plots of land were used in this study. It was randomly determined which plot was to be plowed using the standard hitch. As the tractor plowed that plot, a measurement device on the tractor automatically recorded the draft at 25 randomly selected points in the plot.

After the plot was plowed, the hitch was changed from the standard one to the new one, a process that takes a substantial amount of time. Then the second plot was plowed using the new hitch. Twenty-five measurements of draft were also recorded at randomly selected points in this plot.

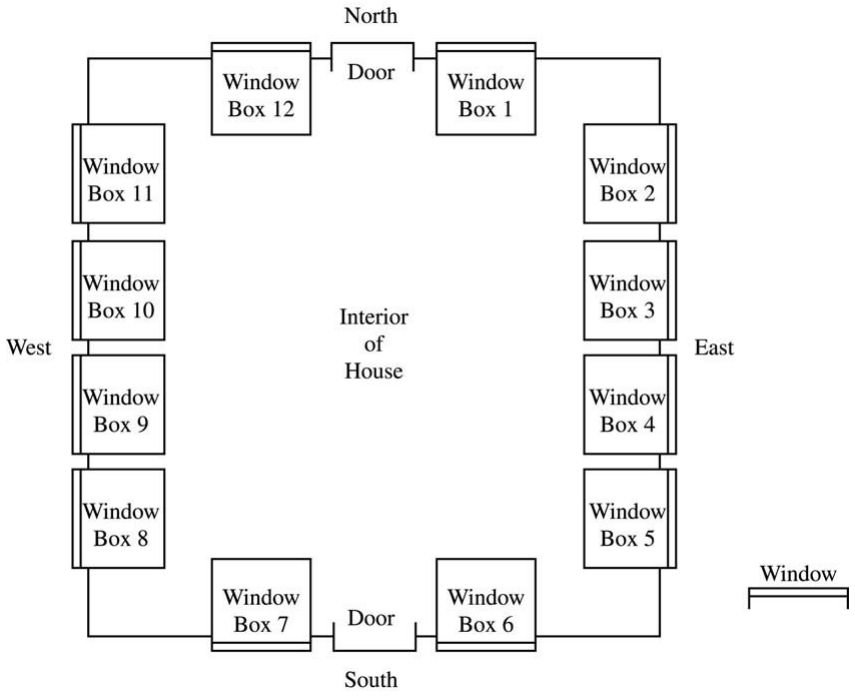
(a) What was the response variable in this study? Identify the treatments. What were the experimental units?

(b) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was randomization used properly in this study? Justify your answer.

(c) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was replication used properly in this study? Justify your answer.

(d) Plot of land is a confounding variable in this experiment. Explain why.

5. **2007FRB3**
The United States Department of Energy is conducting an experiment to compare the heat gain in houses using two different types of windows, A and B. Six windows of each type are available for the experiment. The Department has constructed a house with twelve windows as shown on the floor plan below.



In the interior of the house, each window is surrounded by a window box to capture and measure the amount of heat coming in through that window and to isolate the heat gain for each window.

(a) A randomized block experiment will be used to compare the heat gain for the two types (A and B) of windows. How would you group the window boxes into blocks? (Clearly indicate your blocks using the window box numbers.) Justify your choice of blocks.

(b) For the design in part (a), describe how you would assign window types (A and B) to the numbered window boxes.