RATIOMERA

Exercise Sheet

Probability

Ratiomera Statistics

This sheet contains 160 exercises organized into 16 learning-objective groups. Work through each exercise before consulting its matching complete solution. Show the relevant formula or rule, substituted values, units, and an interpretation. All settings, values, data, and software outputs are constructed teaching material; they are not empirical findings.

Part I: Theory

A08: Probability Mass Functions and Densities

`T02-A08-V01`: From the number of exhibitions visited to the time spent in a museum

Define X as the number of exhibitions visited, a count, and define Y as the time spent in a museum, measured on a continuous scale. The two variables therefore require different probability representations. Work through these requests: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Place each rule next to the result it supports.

`T02-A08-V02`: From the number of messages received to the delay until the next message

Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Use this setting for the calculations:

Define X as the number of messages received, a count, and define Y as the delay until the next message, measured on a continuous scale. The two variables therefore require different probability representations. Report the following: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Make clear which information is given and which quantity is derived.

`T02-A08-V03`: From the count of transcription errors to the duration of an audio segment

Consider the following information. Define X as the count of transcription errors, a count, and define Y as the duration of an audio segment, measured on a continuous scale. The two variables therefore require different probability representations. Prepare a structured response that contains: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Use complete explanatory sentences around the notation.

`T02-A08-V04`: From the number of books borrowed to the mass of a returned parcel

Use the setting below to build the analysis step by step. Define X as the number of books borrowed, a count, and define Y as the mass of a returned parcel, measured on a continuous scale. The two variables therefore require different probability representations. Begin with (a) identify which variable uses a PMF and which uses a density; then (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; then (c) show how each variable obtains probability over an interval; then (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Check every step against the assumptions stated in the scenario.

`T02-A08-V05`: From the count of survey reminders to a respondent's completion time

Your goal is to connect the numerical work to its meaning. Define X as the count of survey reminders, a count, and define Y as a respondent's completion time, measured on a continuous scale. The two variables therefore require different probability representations. Address these items: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Interpret the result rather than merely repeating its numerical value.

`T02-A08-V06`: From the number of route changes to the distance traveled

Start by reading the assumptions in this scenario. Define X as the number of route changes, a count, and define Y as the distance traveled, measured on a continuous scale. The two variables therefore require different probability representations. Without skipping intermediate reasoning, provide the following: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Show enough working that another learner could reproduce the argument.

`T02-A08-V07`: From the count of missing fields to a participant's age measured precisely

This problem has 4 linked parts. Define X as the count of missing fields, a count, and define Y as a participant's age measured precisely, measured on a continuous scale. The two variables therefore require different probability representations. The required work is: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Finish by doing the following: Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. End with a brief check that the result answers the original question.

`T02-A08-V08`: From the number of workshop sessions to the sound level in the room

Treat the stated model as the working model. Define X as the number of workshop sessions, a count, and define Y as the sound level in the room, measured on a continuous scale. The two variables therefore require different probability representations. Separate your answer into these parts: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Distinguish model assumptions from conclusions produced by the model.

`T02-A08-V09`: From the count of preserved photographs to the temperature of the archive

Before calculating, note what is given and what is conditional or model-based. Define X as the count of preserved photographs, a count, and define Y as the temperature of the archive, measured on a continuous scale. The two variables therefore require different probability representations. Now answer: (a) identify which variable uses a PMF and which uses a density; (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$; (c) show how each variable obtains probability over an interval; (d) explain what a CDF records for both variables. Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. State relevant event definitions or measurement units explicitly.

`T02-A08-V10`: From the number of successful checks to the exact reaction time on a task

Define X as the number of successful checks, a count, and define Y as the exact reaction time on a task, measured on a continuous scale. The two variables therefore require different probability representations. Write a concise analysis with the following components:

- (a) identify which variable uses a PMF and which uses a density

- (b) explain the point probability $P(X = x)$ and contrast it with $P(Y = y)$
- (c) show how each variable obtains probability over an interval
- (d) explain what a CDF records for both variables

Use the geometry of mass, area, jumps, and accumulation rather than relying only on definitions. Keep the subpart labels aligned with the requested outputs.

A14: Population, Sample, and Selection Bias

`T02-A14-V01`: Park-use QR survey

A city estimates weekly park use by surveying 640 people who scan a code posted inside its largest central park. Work through these requests: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Place each rule next to the result it supports.

`T02-A14-V02`: Commuting survey of parking-permit holders

Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Use this setting for the calculations:

A university estimates students' mean commuting time from 820 replies to an email sent only to parking-permit holders. Report the following: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Make clear which information is given and which quantity is derived.

`T02-A14-V03`: Satisfaction after one sold-out exhibition

Consider the following information. A museum estimates season-wide visitor satisfaction from 510 responses collected at the exit of one sold-out evening exhibition. Prepare a structured response that contains: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Use complete explanatory sentences around the notation.

`T02-A14-V04`: Digital-access survey inside an app

Use the setting below to build the analysis step by step. A library estimates digital-access needs from 430 answers to a survey advertised only through its smartphone app. Begin with (a) identify the target population; then (b) distinguish the operational sampling frame from the achieved sample; then (c) state a population parameter that matches the research claim; then (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Check every step against the assumptions stated in the scenario.

`T02-A14-V05`: Volunteer hours from large-charity lists

Your goal is to connect the numerical work to its meaning. A region estimates mean weekly volunteer hours from records for 760 members listed by large registered charities. Address these items: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Interpret the result rather than merely repeating its numerical value.

T02-A14-V06: Course-workload survey after grades

Start by reading the assumptions in this scenario. A college estimates perceived course workload from 390 students still active on the learning platform after final grades were released. Without skipping intermediate reasoning, provide the following: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Show enough working that another learner could reproduce the argument.

T02-A14-V07: Transit delays inferred from hashtagged comments

This problem has 4 linked parts. A transit agency estimates the proportion of rider trips experienced as delayed from 1 240 social-media comments containing its campaign hashtag. The required work is: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Finish by doing the following: Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. End with a brief check that the result answers the original question.

T02-A14-V08: Neighborhood-interest forms after performances

Treat the stated model as the working model. A cultural center estimates neighborhood interest from 570 completed forms distributed only after ticketed performances. Separate your answer into these parts: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Distinguish model assumptions from conclusions produced by the model.

T02-A14-V09: Sleep records from year-long wearable users

Before calculating, note what is given and what is conditional or model-based. A research team estimates users' mean nightly sleep duration from 680 people who kept a wearable device active for a full year. Now answer: (a) identify the target population; (b) distinguish the operational sampling frame from the achieved sample; (c) state a population parameter that matches the research claim; (d) state the corresponding sample statistic and its observational unit. Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. State relevant event definitions or measurement units explicitly.

T02-A14-V10: Archive feedback shown only after a download

An archive estimates the proportion of search attempts ending in successful retrieval from 450 feedback forms shown only after a user downloaded at least one record. Write a concise analysis with the following components:

- (a) identify the target population
- (b) distinguish the operational sampling frame from the achieved sample
- (c) state a population parameter that matches the research claim
- (d) state the corresponding sample statistic and its observational unit

Explain at least two scenario-specific coverage, selection, or nonresponse mechanisms; state what a larger sample would and would not repair; and propose a more defensible design. Keep the subpart labels aligned with the requested outputs.

A15: Coverage Error and the Population Behind a Percentage

T02-A15-V01: Education levels among football supporters

A professional-networking platform reports that 64% of the profiles that name Northport FC as a favorite club also report a university degree. A headline turns this into the claim that 64% of all Northport FC supporters have a university degree. Work through these requests: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Place each rule next to the result it supports.

`T02-A15-V02`: Reading habits from an e-reader community

Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Use this setting for the calculations:

An e-reader forum finds that 71% of 2 400 responding members finish at least two books per month. A post describes 71% as the rate for all adults in the country. Report the following: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Make clear which information is given and which quantity is derived.

`T02-A15-V03`: Cycling frequency from a route-planning app

Consider the following information. A cycling app reports that 58% of active users record at least three rides per week. The result is presented as the share of city residents who cycle that often. Prepare a structured response that contains: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Use complete explanatory sentences around the notation.

`T02-A15-V04`: Museum interest from newsletter subscribers

Use the setting below to build the analysis step by step. A museum newsletter survey finds that 82% of respondents plan to visit a new exhibition. The museum describes this as the level of interest among all regional residents. Begin with (a) state the population named in the broad claim; then (b) identify the units that actually had a route into the reported percentage; then (c) explain why the observed frame does not cover the named population; then (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Check every step against the assumptions stated in the scenario.

`T02-A15-V05`: Remote-work preference from a coworking platform

Your goal is to connect the numerical work to its meaning. A coworking platform reports that 76% of responding account holders prefer remote work on most weekdays. A news item attributes that preference to all employed adults. Address these items: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Interpret the result rather than merely repeating its numerical value.

`T02-A15-V06`: Language use from public profile fields

Start by reading the assumptions in this scenario. A social platform counts the languages listed on 50 000 public profiles and concludes that 43% of the country's population uses three languages every day. Without skipping intermediate reasoning, provide the following: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Show enough working that another learner could reproduce the argument.

T02-A15-V07: Student wellbeing from a study-planner app

This problem has 4 linked parts. A study-planner app finds that 61% of its respondents report high academic stress and treats this as an estimate for every university student. The required work is: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Finish by doing the following: Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. End with a brief check that the result answers the original question.

T02-A15-V08: Concert attendance from ticket-account profiles

Treat the stated model as the working model. A ticketing company observes that 67% of accounts followed at least one concert page last year and concludes that 67% of all residents attended a concert. Separate your answer into these parts: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Distinguish model assumptions from conclusions produced by the model.

T02-A15-V09: Public-transport satisfaction from a mobile-ticket sample

Before calculating, note what is given and what is conditional or model-based. A transport operator finds 74% satisfaction among users who bought mobile tickets and presents it as satisfaction among all passengers. Now answer: (a) state the population named in the broad claim; (b) identify the units that actually had a route into the reported percentage; (c) explain why the observed frame does not cover the named population; (d) rewrite the result so that it describes only the observed data. Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. State relevant event definitions or measurement units explicitly.

T02-A15-V10: Volunteer participation from organization websites

Profiles on the websites of large charities show that 69% of listed volunteers contribute every month. The figure is reported as the rate for all volunteers in the region. Write a concise analysis with the following components:

- (a) state the population named in the broad claim
- (b) identify the units that actually had a route into the reported percentage
- (c) explain why the observed frame does not cover the named population
- (d) rewrite the result so that it describes only the observed data

Then propose a sampling design that would match the broad population more closely, and explain why simply collecting more observations through the same restricted frame would not solve the problem. Keep the subpart labels aligned with the requested outputs.

A16: Survivorship Bias and Missing Outcomes

T02-A16-V01: Damage patterns on returned delivery drones

Engineers inspect only delivery drones that returned to base and notice many marks on the outer casing but few near the navigation unit. They must decide which area most needs added protection. Work through these requests: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Place each rule next to the result it supports.

T02-A16-V02: Study habits among course completers

Finish by describing the additional evidence or follow-up needed before making the intended population claim. Use this setting for the calculations:

A course team interviews only students who completed a difficult online course and finds that most used weekly planning sheets. It concludes that planning sheets describe the habits of everyone who enrolled. Report the following: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Make clear which information is given and which quantity is derived.

T02-A16-V03: Reliability among devices still in service

Consider the following information. A laboratory examines sensors that remain in service after two years and finds very little corrosion. It concludes that the original sensor model rarely corrodes. Prepare a structured response that contains: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Use complete explanatory sentences around the notation.

T02-A16-V04: Satisfaction among returning museum visitors

Use the setting below to build the analysis step by step. A museum surveys people on their fifth visit and finds very high satisfaction. It uses the result to describe everyone who ever visited the museum. Begin with (a) identify the cases that remain observable; then (b) identify the relevant cases missing from the observed group; then (c) explain how the outcome itself may influence whether a case is observed; then (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Check every step against the assumptions stated in the scenario.

T02-A16-V05: Workload reports from retained employees

Your goal is to connect the numerical work to its meaning. A company asks employees who have stayed for five years about their first-year workload and concludes that the answers represent every person hired in that year. Address these items: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Interpret the result rather than merely repeating its numerical value.

T02-A16-V06: Recovery among follow-up clinic attendees

Start by reading the assumptions in this scenario. A clinic estimates treatment recovery from patients who returned for the final follow-up appointment. Most of those attendees had recovered. Without skipping intermediate reasoning, provide the following: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Show enough working that another learner could reproduce the argument.

T02-A16-V07: Durability among surviving archive files

This problem has 4 linked parts. An archive checks digital files that can still be opened after ten years and finds that nearly all have intact metadata. It concludes that the original collection preserved metadata well. The required work is: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by doing the following:

Finish by describing the additional evidence or follow-up needed before making the intended population claim. End with a brief check that the result answers the original question.

`T02-A16-V08`: Confidence among competition finalists

Treat the stated model as the working model. Researchers ask only finalists in a public-speaking competition about confidence before the first round and infer the confidence level of every entrant. Separate your answer into these parts: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. Distinguish model assumptions from conclusions produced by the model.

`T02-A16-V09`: Travel times from completed app routes

Before calculating, note what is given and what is conditional or model-based. A navigation app calculates average travel time using only trips marked complete. It excludes trips whose users closed the app before arrival. Now answer: (a) identify the cases that remain observable; (b) identify the relevant cases missing from the observed group; (c) explain how the outcome itself may influence whether a case is observed; (d) state why an analysis of the observed cases alone can point toward the wrong conclusion. Finish by describing the additional evidence or follow-up needed before making the intended population claim. State relevant event definitions or measurement units explicitly.

`T02-A16-V10`: Reading progress among active subscribers

An e-book service studies reading progress only among people whose subscription was still active after one year and reports the result for all original subscribers. Write a concise analysis with the following components:

- (a) identify the cases that remain observable
- (b) identify the relevant cases missing from the observed group
- (c) explain how the outcome itself may influence whether a case is observed
- (d) state why an analysis of the observed cases alone can point toward the wrong conclusion

Finish by describing the additional evidence or follow-up needed before making the intended population claim. Keep the subpart labels aligned with the requested outputs.

Part II: Calculator Practice

A01: Sequential Conditional Probability

`T02-A01-V01`: Completing an archive search

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Success requires three ordered stages: first, locate the catalog record; second, request the box; and third, identify the relevant letter. The first-stage success probability is 0.62. Among those who clear stage one, the second-stage success probability is 0.81. Among those who clear both, the third-stage success probability is 0.74. Work through these requests: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Place each rule next to the result it supports.

`T02-A01-V02`: Passing a three-stage language assessment

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Use this setting for the calculations:

Success requires three ordered stages: first, pass the vocabulary section; second, pass the listening section; and third, pass the interview. The first-stage success probability is 0.68. Among those who clear stage one, the second-stage success probability is 0.77. Among those who clear both, the third-stage success probability is 0.84. Report the following: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Make clear which information is given and which quantity is derived.

`T02-A01-V03`: Finishing a digital registration

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. Success requires three ordered stages: first, verify the email address; second, complete the profile; and third, submit the consent form. The first-stage success probability is 0.73. Among those who clear stage one, the second-stage success probability is 0.86. Among those who clear both, the third-stage success probability is 0.79. Prepare a structured response that contains: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Use complete explanatory sentences around the notation.

`T02-A01-V04`: Solving a fieldwork sequence

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. Success requires three ordered stages: first, find the sampling point; second, record a valid measurement; and third, upload the record correctly. The first-stage success probability is 0.57. Among those who clear stage one, the second-stage success probability is 0.83. Among those who clear both, the third-stage success probability is 0.91. Begin with (a) find the probability of completing stages one and two; then (b) find the probability of completing the full three-stage sequence; then (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Check every step against the assumptions stated in the scenario.

`T02-A01-V05`: Completing a library research task

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. Success requires three ordered stages: first, find the database; second, retrieve a suitable article; and third, evaluate its methods accurately. The first-stage success probability is 0.66. Among those who clear stage one, the second-stage success probability is 0.72. Among those who clear both, the third-stage success probability is 0.88. Address these items: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Interpret the result rather than merely repeating its numerical value.

`T02-A01-V06`: Advancing through a music audition

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. Success requires three ordered stages: first, pass the rhythm screen; second, pass the prepared piece; and third, pass the sight-reading task. The first-stage success probability is 0.71. Among those who clear stage one, the second-stage success probability is 0.69. Among those who clear both, the third-stage success probability is 0.82. Without skipping intermediate reasoning, provide the following: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Show enough working that another learner could reproduce the argument.

`T02-A01-V07`: Completing a laboratory protocol

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. Success requires three ordered stages: first, prepare the sample; second, obtain a usable reading; and third, label the result correctly. The first-stage success probability is 0.64. Among those who clear stage one, the second-stage success probability is 0.87. Among those who clear both, the third-stage success probability is 0.76. The required work is: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Finish by doing the following: Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. End with a brief check that the result answers the original question.

`T02-A01-V08`: Finishing an online safety course

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. Success requires three ordered stages: first, complete the first module; second, pass the scenario quiz; and third, submit the final reflection. The first-stage success probability is 0.78. Among those who clear stage one, the second-stage success probability is 0.75. Among those who clear both, the third-stage success probability is 0.89. Separate your answer into these parts: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Distinguish model assumptions from conclusions produced by the model.

`T02-A01-V09`: Completing a map-reading challenge

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. Success requires three ordered stages: first, select the correct route; second, reach the checkpoint; and third, identify the final landmark. The first-stage success probability is 0.59. Among those who clear stage one, the second-stage success probability is 0.82. Among those who clear both, the third-stage success probability is 0.85. Now answer: (a) find the probability of completing stages one and two; (b) find the probability of completing the full three-stage sequence; (c) find the probability of completing the first two stages but failing the third. Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. State relevant event definitions or measurement units explicitly.

`T02-A01-V10`: Passing a data-entry check

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Success requires three ordered stages: first, enter the first form correctly; second, resolve the validation warning; and third, submit the clean record. The first-stage success probability is 0.69. Among those who clear stage one, the second-stage success probability is 0.84. Among those who clear both, the third-stage success probability is 0.73. Write a concise analysis with the following components:

- (a) find the probability of completing stages one and two
- (b) find the probability of completing the full three-stage sequence
- (c) find the probability of completing the first two stages but failing the third

Define events for the stages and explain why the multiplication uses conditional rather than unrelated marginal probabilities. Keep the subpart labels aligned with the requested outputs.

A02: Independent Joint Events

`T02-A02-V01`: Two independent quality checks

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Let event A be that a scanned page passes the image check, with $P(A) = 0.78$. Let event B be that the same page passes the metadata check, with $P(B) = 0.64$. Assume A and B are independent. Work through these requests: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Place each rule next to the result it supports.

`T02-A02-V02`: Independent workshop attendance

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Name the rule used in each part and identify exactly which product calculations depend on independence. Use this setting for the calculations:

Let event A be that a resident attends the morning session, with $P(A) = 0.55$. Let event B be that the resident attends the evening session, with $P(B) = 0.72$. Assume A and B are independent. Report the following: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Make clear which information is given and which quantity is derived.

`T02-A02-V03`: Two independent sensor alerts

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. Let event A be that the temperature sensor triggers, with $P(A) = 0.18$. Let event B be that the vibration sensor triggers, with $P(B) = 0.27$. Assume A and B are independent. Prepare a structured response that contains: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Use complete explanatory sentences around the notation.

`T02-A02-V04`: Independent item selections

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. Let event A be that a selected book is a translation, with $P(A) = 0.36$. Let event B be that it has a hard cover, with $P(B) = 0.41$. Assume A and B are independent. Begin with (a) calculate the probability that both events occur; then (b) calculate the probability that at least one event occurs; then (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Check every step against the assumptions stated in the scenario.

`T02-A02-V05`: Independent survey events

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. Let event A be that a response arrives on Monday, with $P(A) = 0.22$. Let event B be that it is submitted from a mobile device, with $P(B) = 0.63$. Assume A and

B are independent. Address these items: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Interpret the result rather than merely repeating its numerical value.

`T02-A02-V06`: Two independent route events

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. Let event A be that a bus arrives within five minutes, with $P(A) = 0.74$. Let event B be that a connecting train has an available seat, with $P(B) = 0.58$. Assume A and B are independent. Without skipping intermediate reasoning, provide the following: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Show enough working that another learner could reproduce the argument.

`T02-A02-V07`: Independent coding checks

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. Let event A be that a record has a valid date, with $P(A) = 0.83$. Let event B be that it has a valid category code, with $P(B) = 0.69$. Assume A and B are independent. The required work is: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Finish by doing the following: Name the rule used in each part and identify exactly which product calculations depend on independence. End with a brief check that the result answers the original question.

`T02-A02-V08`: Two independent draws

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. Let event A be that a selected token is blue, with $P(A) = 0.45$. Let event B be that a second, replaced draw is triangular, with $P(B) = 0.32$. Assume A and B are independent. Separate your answer into these parts: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. Distinguish model assumptions from conclusions produced by the model.

`T02-A02-V09`: Independent study events

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. Let event A be that a participant completes the diary, with $P(A) = 0.67$. Let event B be that the laboratory file uploads successfully, with $P(B) = 0.88$. Assume A and B are independent. Now answer: (a) calculate the probability that both events occur; (b) calculate the probability that at least one event occurs; (c) calculate the probability that A occurs while B does not. Name the rule used in each part and identify exactly which product calculations depend on independence. State relevant event definitions or measurement units explicitly.

`T02-A02-V10`: Independent catalog features

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Let event A be that an item is digitized, with $P(A) = 0.39$. Let event B be that its creator field is complete, with $P(B) = 0.76$. Assume A and B are independent. Write a concise analysis with the following components:

- (a) calculate the probability that both events occur
- (b) calculate the probability that at least one event occurs
- (c) calculate the probability that A occurs while B does not

Name the rule used in each part and identify exactly which product calculations depend on independence. Keep the subpart labels aligned with the requested outputs.

A03: Contingency Tables and Event Relationships

T02-A03-V01: Reading format and course completion

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

The observed sample is summarized below.

Group	Completed	Not completed	Total
Audio	12	18	30
Text	28	42	70
Total	40	60	100

Let G denote membership in the Audio row and let Y denote the Completed outcome. The Text row is G^c.

Work through these requests: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Place each rule next to the result it supports.

T02-A03-V02: Museum membership and event attendance

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Use this setting for the calculations:

The observed sample is summarized below.

Group	Attended	Did not attend	Total
Member	24	16	40
Nonmember	18	42	60
Total	42	58	100

Let G denote membership in the Member row and let Y denote the Attended outcome. The Nonmember row is G^c.

Report the following: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Make clear which information is given and which quantity is derived.

T02-A03-V03: Study location and deadline success

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. The observed sample is summarized below.

Group	On time	Late	Total
Library	21	14	35
Home	27	18	45
Total	48	32	80

Let G denote membership in the Library row and let Y denote the On time outcome. The Home row is G^c.

Prepare a structured response that contains: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Use complete explanatory sentences around the notation.

`T02-A03-V04`: Caption use and quiz completion

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. The observed sample is summarized below.

Group	Completed	Not completed	Total
Captions	30	20	50
No captions	18	12	30
Total	48	32	80

Let G denote membership in the Captions row and let Y denote the Completed outcome. The No captions row is G^c.

Begin with (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; then (b) find the joint probability $P(G \cap Y)$; then (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Check every step against the assumptions stated in the scenario.

`T02-A03-V05`: Transit pass and campus visits

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. The observed sample is summarized below.

Group	Frequent	Infrequent	Total
Pass	16	24	40
No pass	14	46	60
Total	30	70	100

Let G denote membership in the Pass row and let Y denote the Frequent outcome. The No pass row is G^c.

Address these items: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Interpret the result rather than merely repeating its numerical value.

`T02-A03-V06`: Reminder choice and response

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. The observed sample is summarized below.

Group	Responded	No response	Total
Reminder	27	13	40
No reminder	33	27	60
Total	60	40	100

Let G denote membership in the Reminder row and let Y denote the Responded outcome. The No reminder row is G^c.

Without skipping intermediate reasoning, provide the following: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Show enough working that another learner could reproduce the argument.

`T02-A03-V07`: Workshop track and certification

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. The observed sample is summarized below.

Group	Certified	Not certified	Total
Methods	18	12	30
Writing	24	36	60
Total	42	48	90

Let G denote membership in the Methods row and let Y denote the Certified outcome. The Writing row is G^c.

The required work is: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Finish by doing the following: Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. End with a brief check that the result answers the original question.

`T02-A03-V08`: Device type and form completion

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. The observed sample is summarized below.

Group	Complete	Incomplete	Total
Tablet	14	21	35
Laptop	30	15	45
Total	44	36	80

Let G denote membership in the Tablet row and let Y denote the Complete outcome. The Laptop row is G^c.

Separate your answer into these parts: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Distinguish model assumptions from conclusions produced by the model.

`T02-A03-V09`: Volunteer role and return visit

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. The observed sample is summarized below.

Group	Returned	Did not return	Total
Guide	22	18	40
Archive	11	29	40
Total	33	47	80

Let G denote membership in the Guide row and let Y denote the Returned outcome. The Archive row is G^c.

Now answer: (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution; (b) find the joint probability $P(G \cap Y)$; (c) decide whether G and Y are disjoint events. Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. State relevant event definitions or measurement units explicitly.

`T02-A03-V10`: Tutorial format and practice submission

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

The observed sample is summarized below.

Group	Submitted	Not submitted	Total
Live	26	14	40
Recorded	39	21	60
Total	65	35	100

Let G denote membership in the Live row and let Y denote the Submitted outcome. The Recorded row is G^c.

Write a concise analysis with the following components:

- (a) find $P(Y \mid G)$ and $P(Y \mid G^c)$, then decide whether the variables are independent in the empirical distribution
- (b) find the joint probability $P(G \cap Y)$
- (c) decide whether G and Y are disjoint events

Explain why an exact relationship in these sample counts is not, by itself, a conclusion about an unsampled population. Keep the subpart labels aligned with the requested outputs.

A04: Bayes' Theorem and Base Rates

`T02-A04-V01`: Accessibility-needs screening

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

A hypothetical screening tool is used to detect an accessibility support need. Its sensitivity is 0.72, and its specificity is 0.91. Let D mean that the condition is truly present and $+$ mean a positive result. Work through these requests: (a) calculate $P(D \mid +)$ when prevalence is 2%; (b) recalculate $P(D \mid +)$ when prevalence is 11%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Place each rule next to the result it supports.

`T02-A04-V02`: Rare transcription-error detection

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Use this setting for the calculations:

A hypothetical screening tool is used to detect a transcription error. Its sensitivity is 0.84, and its specificity is 0.93. Let D mean that the condition is truly present and $+$ mean a positive result. Report the following: (a) calculate $P(D \mid +)$ when prevalence is 1%; (b) recalculate $P(D \mid +)$ when prevalence is 8%; (c) compare the posterior probabilities and explain the base-rate effect. Make clear which information is given and which quantity is derived.

`T02-A04-V03`: Conservation-risk screening

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. A hypothetical screening tool is used to detect an object that is at conservation risk. Its sensitivity is 0.79, and its specificity is 0.88. Let D mean that the condition is truly present and $+$ mean a positive result. Prepare a structured response that contains: (a) calculate $P(D \mid +)$ when prevalence is 4%; (b) recalculate $P(D \mid +)$ when prevalence is 16%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Use complete explanatory sentences around the notation.

`T02-A04-V04`: Duplicate-record detection

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. A hypothetical screening tool is used to detect a record that is a duplicate. Its sensitivity is 0.90, and its specificity is 0.86. Let D mean that the condition is truly present and $+$ mean a positive result. Begin with (a) calculate $P(D \mid +)$ when prevalence is 3%; then (b) recalculate $P(D \mid +)$ when prevalence is 14%; then (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Check every step against the assumptions stated in the scenario.

`T02-A04-V05`: Language-support screening

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. A hypothetical screening tool is used to detect a need for language support. Its sensitivity is 0.76, and its specificity is 0.94. Let D mean that the condition is truly present and $+$ mean a positive result. Address these items: (a) calculate $P(D \mid +)$ when prevalence is 5%; (b) recalculate $P(D \mid +)$ when prevalence is 19%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Interpret the result rather than merely repeating its numerical value.

T02-A04-V06: Damaged-image detection

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. A hypothetical screening tool is used to detect an image that is damaged. Its sensitivity is 0.88, and its specificity is 0.90. Let D mean that the condition is truly present and $+$ mean a positive result. Without skipping intermediate reasoning, provide the following: (a) calculate $P(D \mid +)$ when prevalence is 2%; (b) recalculate $P(D \mid +)$ when prevalence is 12%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Show enough working that another learner could reproduce the argument.

T02-A04-V07: Research-integrity screening

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. A hypothetical screening tool is used to detect a submission that warrants integrity review. Its sensitivity is 0.81, and its specificity is 0.96. Let D mean that the condition is truly present and $+$ mean a positive result. The required work is: (a) calculate $P(D \mid +)$ when prevalence is 1%; (b) recalculate $P(D \mid +)$ when prevalence is 7%; (c) compare the posterior probabilities and explain the base-rate effect. Finish by doing the following: For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. End with a brief check that the result answers the original question.

T02-A04-V08: Equipment-failure warning

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. A hypothetical screening tool is used to detect an impending equipment failure. Its sensitivity is 0.85, and its specificity is 0.89. Let D mean that the condition is truly present and $+$ mean a positive result. Separate your answer into these parts: (a) calculate $P(D \mid +)$ when prevalence is 6%; (b) recalculate $P(D \mid +)$ when prevalence is 21%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Distinguish model assumptions from conclusions produced by the model.

T02-A04-V09: Cataloging-anomaly detection

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. A hypothetical screening tool is used to detect a record that contains a cataloging anomaly. Its sensitivity is 0.74, and its specificity is 0.92. Let D mean that the condition is truly present and $+$ mean a positive result. Now answer: (a) calculate $P(D \mid +)$ when prevalence is 3%; (b) recalculate $P(D \mid +)$ when prevalence is 15%; (c) compare the posterior probabilities and explain the base-rate effect. For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. State relevant event definitions or measurement units explicitly.

T02-A04-V10: Support-priority classification

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

A hypothetical screening tool is used to detect a case that genuinely has high support priority. Its sensitivity is 0.87, and its specificity is 0.95. Let D mean that the condition is truly present and $+$ mean a positive result. Write a concise analysis with the following components:

- (a) calculate $P(D \mid +)$ when prevalence is 4%
- (b) recalculate $P(D \mid +)$ when prevalence is 18%
- (c) compare the posterior probabilities and explain the base-rate effect

For each prevalence, show the true-positive and false-positive paths, and explain why sensitivity alone is not the requested posterior probability. Keep the subpart labels aligned with the requested outputs.

A05: Discrete Expectation, Variance, PMF, and CDF

`T02-A05-V01`: Number of follow-up questions

Let X represent the count described as "number of follow-up questions." Its proposed distribution is:

x	0	1	3	5
$P(X = x)$	0.20	0.35	0.30	0.15

Work through these requests: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and Var (X), using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Place each rule next to the result it supports.

`T02-A05-V02`: Daily archive requests

Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Use this setting for the calculations:

Let X represent the count described as "daily archive requests." Its proposed distribution is:

x	1	2	4	6
$P(X = x)$	0.25	0.40	0.20	0.15

Report the following: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and Var (X), using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Make clear which information is given and which quantity is derived.

`T02-A05-V03`: Completed practice sets

Consider the following information. Let X represent the count described as "completed practice sets." Its proposed distribution is:

x	0	2	3	7
$P(X = x)$	0.10	0.30	0.45	0.15

Prepare a structured response that contains: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and Var (X), using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Use complete explanatory sentences around the notation.

`T02-A05-V04`: Reported route changes

Use the setting below to build the analysis step by step. Let X represent the count described as "reported route changes." Its proposed distribution is:

x	0	1	2	4
$P(X = x)$	0.45	0.25	0.20	0.10

Begin with (a) verify that the table is a valid probability mass function; then (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; then (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Check every step against the assumptions stated in the scenario.

`T02-A05-V05`: Weekly community meetings

Your goal is to connect the numerical work to its meaning. Let X represent the count described as "weekly community meetings." Its proposed distribution is:

x	1	3	4	8
$P(X = x)$	0.30	0.25	0.35	0.10

Address these items: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Interpret the result rather than merely repeating its numerical value.

`T02-A05-V06`: Successful file recoveries

Start by reading the assumptions in this scenario. Let X represent the count described as "successful file recoveries." Its proposed distribution is:

x	0	2	5	6
$P(X = x)$	0.15	0.25	0.40	0.20

Without skipping intermediate reasoning, provide the following: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Show enough working that another learner could reproduce the argument.

`T02-A05-V07`: Museum rooms visited

This problem has 3 linked parts. Let X represent the count described as "museum rooms visited." Its proposed distribution is:

x	2	4	5	9
$P(X = x)$	0.20	0.30	0.35	0.15

The required work is: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Finish by doing the following: Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. End with a brief check that the result answers the original question.

`T02-A05-V08`: Optional readings completed

Treat the stated model as the working model. Let X represent the count described as "optional readings completed." Its proposed distribution is:

x	0	1	4	6
$P(X = x)$	0.25	0.30	0.25	0.20

Separate your answer into these parts: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Distinguish model assumptions from conclusions produced by the model.

`T02-A05-V09`: Verified oral-history segments

Before calculating, note what is given and what is conditional or model-based. Let X represent the count described as “verified oral-history segments.” Its proposed distribution is:

x	1	2	3	5
$P(X = x)$	0.15	0.35	0.30	0.20

Now answer: (a) verify that the table is a valid probability mass function; (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance; (c) give $F(x)$ at every support point. Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. State relevant event definitions or measurement units explicitly.

`T02-A05-V10`: Data-quality warnings

Let X represent the count described as “data-quality warnings.” Its proposed distribution is:

x	0	2	4	7
$P(X = x)$	0.40	0.25	0.20	0.15

Write a concise analysis with the following components:

- (a) verify that the table is a valid probability mass function
- (b) calculate $E(X)$ and $\mathrm{Var}\ (X)$, using $E(X^2) - [E(X)]^2$ for the variance
- (c) give $F(x)$ at every support point

Describe how the PMF and CDF plots differ, and interpret the expectation in the context named above. Keep the subpart labels aligned with the requested outputs.

A06: Exact Binomial Probabilities

`T02-A06-V01`: Completed consent checks

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider 8 consent checks. Treat them as independent trials, and suppose the probability that any one is completed is constant at $\pi = 0.62$. Let X count how many satisfy that success definition. Work through these requests: (a) calculate $P(X = 5)$; (b) calculate $P(X = 7)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Place each rule next to the result it supports.

`T02-A06-V02`: Correctly classified images

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Show the binomial coefficient and every substituted model value before rounding. Use this setting for the calculations:

Consider 9 images. Treat them as independent trials, and suppose the probability that any one is classified correctly is constant at $\pi = 0.74$. Let X count how many satisfy that success definition. Report the following: (a) calculate $P(X = 6)$; (b) calculate $P(X = 8)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Make clear which information is given and which quantity is derived.

T02-A06-V03: Returned diary prompts

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. Consider 7 diary prompts. Treat them as independent trials, and suppose the probability that any one is returned is constant at $\pi = 0.58$. Let X count how many satisfy that success definition. Prepare a structured response that contains: (a) calculate $P(X = 3)$; (b) calculate $P(X = 5)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Use complete explanatory sentences around the notation.

T02-A06-V04: Successful archive searches

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. Consider 10 archive searches. Treat them as independent trials, and suppose the probability that any one succeeds is constant at $\pi = 0.43$. Let X count how many satisfy that success definition. Begin with (a) calculate $P(X = 4)$; then (b) calculate $P(X = 6)$; then (c) find $E(X)$ and $\mathrm{Var}\ (X)$; then (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Check every step against the assumptions stated in the scenario.

T02-A06-V05: Usable sensor readings

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. Consider 6 sensor readings. Treat them as independent trials, and suppose the probability that any one is usable is constant at $\pi = 0.81$. Let X count how many satisfy that success definition. Address these items: (a) calculate $P(X = 4)$; (b) calculate $P(X = 6)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Interpret the result rather than merely repeating its numerical value.

T02-A06-V06: On-time tutorial submissions

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. Consider 12 tutorial submissions. Treat them as independent trials, and suppose the probability that any one arrives on time is constant at $\pi = 0.67$. Let X count how many satisfy that success definition. Without skipping intermediate reasoning, provide the following: (a) calculate $P(X = 8)$; (b) calculate $P(X = 10)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Show enough working that another learner could reproduce the argument.

T02-A06-V07: Verified catalog entries

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 4 linked parts. Consider 9 catalog entries. Treat them as independent trials, and suppose the probability that any one is verified is constant at $\pi = 0.52$. Let X count how many satisfy that success definition. The required work is: (a) calculate $P(X = 4)$; (b) calculate $P(X = 7)$; (c) find $E(X)$ and $\mathrm{Var}\ (X)$; (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Finish by doing the following: Show the binomial coefficient and every substituted model value before rounding. End with a brief check that the result answers the original question.

`T02-A06-V08`: Completed interview appointments

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. Consider 11 interview appointments. Treat them as independent trials, and suppose the probability that any one is completed is constant at $\pi = 0.76$. Let X count how many satisfy that success definition. Separate your answer into these parts: (a) calculate $P(X = 8)$; (b) calculate $P(X = 9)$; (c) find $E(X)$ and Var (X); (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. Distinguish model assumptions from conclusions produced by the model.

`T02-A06-V09`: Correct route choices

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. Consider 8 route choices. Treat them as independent trials, and suppose the probability that any one is correct is constant at $\pi = 0.35$. Let X count how many satisfy that success definition. Now answer: (a) calculate $P(X = 2)$; (b) calculate $P(X = 4)$; (c) find $E(X)$ and Var (X); (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting. Show the binomial coefficient and every substituted model value before rounding. State relevant event definitions or measurement units explicitly.

`T02-A06-V10`: Successful audio transcriptions

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider 10 audio transcriptions. Treat them as independent trials, and suppose the probability that any one is successful is constant at $\pi = 0.69$. Let X count how many satisfy that success definition. Write a concise analysis with the following components:

- (a) calculate $P(X = 6)$
- (b) calculate $P(X = 8)$
- (c) find $E(X)$ and Var (X)
- (d) state the fixed-trial, binary-outcome, constant-probability, and independence assumptions in this setting

Show the binomial coefficient and every substituted model value before rounding. Keep the subpart labels aligned with the requested outputs.

A07: Binomial Tail Probabilities by Complement

`T02-A07-V01`: More than 3 records requiring manual review

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Among 40 records, model the cases independently. For each one, the event that it requires manual review has constant probability $\pi = 0.04$. Let X be the total number of such events. Work through these requests: (a) identify the binomial model and the complement of $X > 3$; (b) use that complement to evaluate $P(X > 3)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Place each rule next to the result it supports.

`T02-A07-V02`: More than 5 visitors requesting audio guides

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Retain unrounded component probabilities until the final reported result. Use this setting for the calculations:

Among 25 museum visitors, model the cases independently. For each one, the event that it requests an audio guide has constant probability $\pi = 0.12$. Let X be the total number of such events. Report the following: (a) identify the binomial model and the complement of $X > 5$; (b) use that complement to evaluate $P(X > 5)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Make clear which information is given and which quantity is derived.

`T02-A07-V03`: More than 4 invalid survey links

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. Among 30 survey links, model the cases independently. For each one, the event that it is returned as invalid has constant probability $\pi = 0.06$. Let X be the total number of such events. Prepare a structured response that contains: (a) identify the binomial model and the complement of $X > 4$; (b) use that complement to evaluate $P(X > 4)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Use complete explanatory sentences around the notation.

`T02-A07-V04`: More than 6 items needing preservation work

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. Among 35 items, model the cases independently. For each one, the event that it needs preservation work has constant probability $\pi = 0.09$. Let X be the total number of such events. Begin with (a) identify the binomial model and the complement of $X > 6$; then (b) use that complement to evaluate $P(X > 6)$, displaying every lower-tail term; then (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Check every step against the assumptions stated in the scenario.

`T02-A07-V05`: More than 4 participants missing a reminder

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. Among 28 participants, model the cases independently. For each one, the event that it misses a reminder has constant probability $\pi = 0.08$. Let X be the total number of such events. Address these items: (a) identify the binomial model and the complement of $X > 4$; (b) use that complement to evaluate $P(X > 4)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Interpret the result rather than merely repeating its numerical value.

`T02-A07-V06`: More than 5 uploads needing a second attempt

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. Among 32 uploads, model the cases independently. For each one, the event that it needs a second attempt has constant probability $\pi = 0.07$. Let X be the total number of such events. Without skipping intermediate reasoning, provide the following: (a) identify the binomial model and the complement of $X > 5$; (b) use that complement to evaluate $P(X > 5)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Show enough working that another learner could reproduce the argument.

`T02-A07-V07`: More than 5 sampled pages containing annotations

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. Among 20 sampled pages, model the cases independently. For each one, the event that it contains annotations has constant probability $\pi = 0.15$. Let X be the total number of such events. The required work is: (a) identify the binomial model and the complement of $X > 5$; (b) use that complement to evaluate $P(X > 5)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Finish by doing the following: Retain unrounded component probabilities until the final reported result. End with a brief check that the result answers the original question.

`T02-A07-V08`: More than 4 interviews requiring rescheduling

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. Among 24 interviews, model the cases independently. For each one, the event that it requires rescheduling has constant probability $\pi = 0.11$. Let X be the total number of such events. Separate your answer into these parts: (a) identify the binomial model and the complement of $X > 4$; (b) use that complement to evaluate $P(X > 4)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. Distinguish model assumptions from conclusions produced by the model.

`T02-A07-V09`: More than 3 route observations showing delay

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. Among 36 route observations, model the cases independently. For each one, the event that it shows a delay has constant probability $\pi = 0.05$. Let X be the total number of such events. Now answer: (a) identify the binomial model and the complement of $X > 3$; (b) use that complement to evaluate $P(X > 3)$, displaying every lower-tail term; (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum. Retain unrounded component probabilities until the final reported result. State relevant event definitions or measurement units explicitly.

`T02-A07-V10`: More than 5 forms containing an optional comment

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Among 18 forms, model the cases independently. For each one, the event that it contains an optional comment has constant probability $\pi = 0.18$. Let X be the total number of such events. Write a concise analysis with the following components:

- (a) identify the binomial model and the complement of $X > 5$
- (b) use that complement to evaluate $P(X > 5)$, displaying every lower-tail term
- (c) interpret the tail probability and compare the number of terms with a direct upper-tail sum

Retain unrounded component probabilities until the final reported result. Keep the subpart labels aligned with the requested outputs.

A09: Standard-Normal Probabilities

`T02-A09-V01`: Standard-normal regions, set 1

Let $Z \sim N(0, 1)$ and write $\Phi(z) = P(Z \leq z)$. Work through these requests: (a) evaluate $P(Z \leq -0.45)$; (b) evaluate $P(Z > 1.36)$; (c) evaluate $P(-0.80 < Z \leq 0.95)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Place each rule next to the result it supports.

`T02-A09-V02`: Standard-normal regions, set 2

For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Use this setting for the calculations:

Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Report the following: (a) evaluate $P(Z \leq -1.12)$; (b) evaluate $P(Z > 0.84)$; (c) evaluate $P(-0.35 < Z \leq 1.42)$. Make clear which information is given and which quantity is derived.

`T02-A09-V03`: Standard-normal regions, set 3

Consider the following information. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Prepare a structured response that contains: (a) evaluate $P(Z \leq 0.28)$; (b) evaluate $P(Z > 1.74)$; (c) evaluate $P(-1.05 < Z \leq 0.62)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Use complete explanatory sentences around the notation.

`T02-A09-V04`: Standard-normal regions, set 4

Use the setting below to build the analysis step by step. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Begin with (a) evaluate $P(Z \leq -0.93)$; then (b) evaluate $P(Z > 1.18)$; then (c) evaluate $P(-0.44 < Z \leq 1.27)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Check every step against the assumptions stated in the scenario.

`T02-A09-V05`: Standard-normal regions, set 5

Your goal is to connect the numerical work to its meaning. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Address these items: (a) evaluate $P(Z \leq 0.67)$; (b) evaluate $P(Z > 2.05)$; (c) evaluate $P(-1.33 < Z \leq 0.71)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Interpret the result rather than merely repeating its numerical value.

`T02-A09-V06`: Standard-normal regions, set 6

Start by reading the assumptions in this scenario. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Without skipping intermediate reasoning, provide the following: (a) evaluate $P(Z \leq -1.48)$; (b) evaluate $P(Z > 0.56)$; (c) evaluate $P(-0.92 < Z \leq 1.08)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Show enough working that another learner could reproduce the argument.

`T02-A09-V07`: Standard-normal regions, set 7

This problem has 3 linked parts. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. The required work is: (a) evaluate $P(Z \leq 0.14)$; (b) evaluate $P(Z > 1.51)$; (c) evaluate $P(-0.68 < Z \leq 1.19)$. Finish by doing the following: For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. End with a brief check that the result answers the original question.

`T02-A09-V08`: Standard-normal regions, set 8

Treat the stated model as the working model. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Separate your answer into these parts: (a) evaluate $P(Z \leq -0.76)$; (b) evaluate $P(Z > 1.89)$; (c) evaluate $P(-1.21 < Z \leq 0.37)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Distinguish model assumptions from conclusions produced by the model.

`T02-A09-V09`: Standard-normal regions, set 9

Before calculating, note what is given and what is conditional or model-based. Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Now answer: (a) evaluate $P(Z \leq 0.91)$; (b) evaluate $P(Z > 1.24)$; (c) evaluate $P(-0.57 < Z \leq 1.63)$. For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. State relevant event definitions or measurement units explicitly.

`T02-A09-V10`: Standard-normal regions, set 10

Let $Z \sim N(0,1)$ and write $\Phi(z) = P(Z \leq z)$. Write a concise analysis with the following components:

- (a) evaluate $P(Z \leq -0.22)$
- (b) evaluate $P(Z > 2.17)$
- (c) evaluate $P(-1.46 < Z \leq 0.88)$

For each probability, state which region of the normal curve would be shaded and name the complement or CDF-subtraction rule used. Keep the subpart labels aligned with the requested outputs.

A10: Probabilities for a General Normal Distribution

`T02-A10-V01`: Modeling reading fluency score

Suppose X measures reading fluency score in score points and follows $N(72, 100)$, where the second parameter is the variance. Work through these requests: (a) standardize 79 and find $P(X \leq 79)$; (b) standardize 68 and find $P(X > 68)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Place each rule next to the result it supports.

`T02-A10-V02`: Modeling archive processing time

Keep the unrounded z-scores for the probability calculations and round only the reported results. Use this setting for the calculations:

Suppose X measures archive processing time in minutes and follows $N(45, 64)$, where the second parameter is the variance. Report the following: (a) standardize 51 and find $P(X \leq 51)$; (b) standardize 39 and find $P(X > 39)$; (c) identify each shaded region and interpret both probabilities in context. Make clear which information is given and which quantity is derived.

`T02-A10-V03`: Modeling wellbeing score

Consider the following information. Suppose X measures wellbeing score in score points and follows $N(58, 81)$, where the second parameter is the variance. Prepare a structured response that contains: (a) standardize 64 and find $P(X \leq 64)$; (b) standardize 52 and find $P(X > 52)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Use complete explanatory sentences around the notation.

`T02-A10-V04`: Modeling museum visit duration

Use the setting below to build the analysis step by step. Suppose X measures museum visit duration in minutes and follows $N(90, 225)$, where the second parameter is the variance. Begin with (a) standardize 105 and find $P(X \leq 105)$; then (b) standardize 78 and find $P(X > 78)$; then (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Check every step against the assumptions stated in the scenario.

`T02-A10-V05`: Modeling memory score

Your goal is to connect the numerical work to its meaning. Suppose X measures memory score in score points and follows $N(110, 144)$, where the second parameter is the variance. Address these items: (a) standardize 124 and find $P(X \leq 124)$; (b) standardize 103 and find $P(X > 103)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Interpret the result rather than merely repeating its numerical value.

`T02-A10-V06`: Modeling sound-level index

Start by reading the assumptions in this scenario. Suppose X measures sound-level index in index points and follows $N(38, 49)$, where the second parameter is the variance. Without skipping intermediate reasoning, provide the following: (a) standardize 42 and find $P(X \leq 42)$; (b) standardize 33 and find $P(X > 33)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Show enough working that another learner could reproduce the argument.

`T02-A10-V07`: Modeling course confidence score

This problem has 3 linked parts. Suppose X measures course confidence score in score points and follows $N(66, 121)$, where the second parameter is the variance. The required work is: (a) standardize 75 and find $P(X \leq 75)$; (b) standardize 59 and find $P(X > 59)$; (c) identify each shaded region and interpret both probabilities in context. Finish by doing the following: Keep the unrounded z-scores for the probability calculations and round only the reported results. End with a brief check that the result answers the original question.

`T02-A10-V08`: Modeling response time

Treat the stated model as the working model. Suppose X measures response time in milliseconds and follows $N(520, 3600)$, where the second parameter is the variance. Separate your answer into these parts: (a) standardize 575 and find $P(X \leq 575)$; (b) standardize 485 and find $P(X > 485)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. Distinguish model assumptions from conclusions produced by the model.

`T02-A10-V09`: Modeling community trust score

Before calculating, note what is given and what is conditional or model-based. Suppose X measures community trust score in score points and follows $N(48, 64)$, where the second parameter is the variance. Now answer: (a) standardize 54 and find $P(X \leq 54)$; (b) standardize 43 and find $P(X > 43)$; (c) identify each shaded region and interpret both probabilities in context. Keep the unrounded z-scores for the probability calculations and round only the reported results. State relevant event definitions or measurement units explicitly.

`T02-A10-V10`: Modeling cataloging accuracy score

Suppose X measures cataloging accuracy score in score points and follows $N(84, 36)$, where the second parameter is the variance. Write a concise analysis with the following components:

- (a) standardize 88 and find $P(X \leq 88)$
- (b) standardize 79 and find $P(X > 79)$
- (c) identify each shaded region and interpret both probabilities in context

Keep the unrounded z-scores for the probability calculations and round only the reported results. Keep the subpart labels aligned with the requested outputs.

A11: Inverse Standard-Normal Quantiles

`T02-A11-V01`: Finding the 70% and 92% z-quantiles

For $Z \sim N(0, 1)$, one cumulative area is 0.70 and the other is 0.92. The unknown quantities are the z-axis cutoffs, not the probabilities. Work through these requests: (a) find $z_{70\%}$ such that $P(Z \leq z) = 0.70$; (b) find $z_{92\%}$ such that $P(Z \leq z) = 0.92$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Place each rule next to the result it supports.

`T02-A11-V02`: Finding the 15% and 88% z-quantiles

Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Use this setting for the calculations:

For $Z \sim N(0, 1)$, one cumulative area is 0.15 and the other is 0.88. The unknown quantities are the z-axis cutoffs, not the probabilities. Report the following: (a) find $z_{15\%}$ such that $P(Z \leq z) = 0.15$; (b) find $z_{88\%}$ such that $P(Z \leq z) = 0.88$. Make clear which information is given and which quantity is derived.

`T02-A11-V03`: Finding the 80% and 96% z-quantiles

Consider the following information. For $Z \sim N(0, 1)$, one cumulative area is 0.80 and the other is 0.96. The unknown quantities are the z-axis cutoffs, not the probabilities. Prepare a structured response that contains: (a) find $z_{80\%}$ such that $P(Z \leq z) = 0.80$; (b) find $z_{96\%}$ such that $P(Z \leq z) = 0.96$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Use complete explanatory sentences around the notation.

`T02-A11-V04`: Finding the 28% and 90% z-quantiles

Use the setting below to build the analysis step by step. For $Z \sim N(0, 1)$, one cumulative area is 0.28 and the other is 0.90. The unknown quantities are the z-axis cutoffs, not the probabilities. Begin with (a) find $z_{28\%}$ such that $P(Z \leq z) = 0.28$; then (b) find $z_{90\%}$ such that $P(Z \leq z) = 0.90$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Check every step against the assumptions stated in the scenario.

T02-A11-V05: Finding the 50% and 94% z-quantiles

Your goal is to connect the numerical work to its meaning. For $Z \sim N(0,1)$, one cumulative area is 0.50 and the other is 0.94. The unknown quantities are the z-axis cutoffs, not the probabilities. Address these items: (a) find $z_{50\%}$ such that $P(Z \leq z) = 0.50$; (b) find $z_{94\%}$ such that $P(Z \leq z) = 0.94$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Interpret the result rather than merely repeating its numerical value.

T02-A11-V06: Finding the 75% and 97% z-quantiles

Start by reading the assumptions in this scenario. For $Z \sim N(0,1)$, one cumulative area is 0.75 and the other is 0.97. The unknown quantities are the z-axis cutoffs, not the probabilities. Without skipping intermediate reasoning, provide the following: (a) find $z_{75\%}$ such that $P(Z \leq z) = 0.75$; (b) find $z_{97\%}$ such that $P(Z \leq z) = 0.97$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Show enough working that another learner could reproduce the argument.

T02-A11-V07: Finding the 32% and 68% z-quantiles

This problem has 2 linked parts. For $Z \sim N(0,1)$, one cumulative area is 0.32 and the other is 0.68. The unknown quantities are the z-axis cutoffs, not the probabilities. The required work is: (a) find $z_{32\%}$ such that $P(Z \leq z) = 0.32$; (b) find $z_{68\%}$ such that $P(Z \leq z) = 0.68$. Finish by doing the following: Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. End with a brief check that the result answers the original question.

T02-A11-V08: Finding the 82% and 95% z-quantiles

Treat the stated model as the working model. For $Z \sim N(0,1)$, one cumulative area is 0.82 and the other is 0.95. The unknown quantities are the z-axis cutoffs, not the probabilities. Separate your answer into these parts: (a) find $z_{82\%}$ such that $P(Z \leq z) = 0.82$; (b) find $z_{95\%}$ such that $P(Z \leq z) = 0.95$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Distinguish model assumptions from conclusions produced by the model.

T02-A11-V09: Finding the 11% and 62% z-quantiles

Before calculating, note what is given and what is conditional or model-based. For $Z \sim N(0,1)$, one cumulative area is 0.11 and the other is 0.62. The unknown quantities are the z-axis cutoffs, not the probabilities. Now answer: (a) find $z_{11\%}$ such that $P(Z \leq z) = 0.11$; (b) find $z_{62\%}$ such that $P(Z \leq z) = 0.62$. Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. State relevant event definitions or measurement units explicitly.

T02-A11-V10: Finding the 78% and 93% z-quantiles

For $Z \sim N(0,1)$, one cumulative area is 0.78 and the other is 0.93. The unknown quantities are the z-axis cutoffs, not the probabilities. Write a concise analysis with the following components:

- (a) find $z_{78\%}$ such that $P(Z \leq z) = 0.78$
- (b) find $z_{93\%}$ such that $P(Z \leq z) = 0.93$

Predict each cutoff's sign from its position relative to 0.50, then explain why this is an inverse rather than a forward CDF calculation. Keep the subpart labels aligned with the requested outputs.

A12: Sampling Distribution of the Mean

T02-A12-V01: Precision of a sample mean for reading score

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

A population variable measuring reading score in score points has mean $\mu = 64$ and variance $\sigma^2 = 196$. Consider samples containing $n = 49$ independent observations from this population. Work through these requests: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 100 while $n = 49$; (c) find the standard error if variance remains 196 but sample size changes to $n = 121$. Explain separately how population variability and sample size change the precision of the sample mean. Place each rule next to the result it supports.

`T02-A12-V02`: Precision of a sample mean for processing time

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Explain separately how population variability and sample size change the precision of the sample mean. Use this setting for the calculations:

A population variable measuring processing time in minutes has mean $\mu = 52$ and variance $\sigma^2 = 225$. Consider samples containing $n = 36$ independent observations from this population. Report the following: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 144 while $n = 36$; (c) find the standard error if variance remains 225 but sample size changes to $n = 100$. Make clear which information is given and which quantity is derived.

`T02-A12-V03`: Precision of a sample mean for wellbeing index

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Consider the following information. A population variable measuring wellbeing index in index points has mean $\mu = 71$ and variance $\sigma^2 = 144$. Consider samples containing $n = 64$ independent observations from this population. Prepare a structured response that contains: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 256 while $n = 64$; (c) find the standard error if variance remains 144 but sample size changes to $n = 81$. Explain separately how population variability and sample size change the precision of the sample mean. Use complete explanatory sentences around the notation.

`T02-A12-V04`: Precision of a sample mean for memory score

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Use the setting below to build the analysis step by step. A population variable measuring memory score in score points has mean $\mu = 105$ and variance $\sigma^2 = 324$. Consider samples containing $n = 81$ independent observations from this population. Begin with (a) find $E(\bar{X})$ and SD $(\bar{X})$; then (b) find the standard error if the population variance changes to 225 while $n = 81$; then (c) find the standard error if variance remains 324 but sample size changes to $n = 144$. Explain separately how population variability and sample size change the precision of the sample mean. Check every step against the assumptions stated in the scenario.

`T02-A12-V05`: Precision of a sample mean for trust rating

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Your goal is to connect the numerical work to its meaning. A population variable measuring trust rating in rating points has mean $\mu = 48$ and variance $\sigma^2 = 100$. Consider samples containing $n = 25$ independent observations from this population. Address these items: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 169 while $n = 25$; (c) find the standard error if variance remains 100 but sample size changes to $n = 64$. Explain separately how population variability and sample size change the precision of the sample mean. Interpret the result rather than merely repeating its numerical value.

`T02-A12-V06`: Precision of a sample mean for reaction time

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Start by reading the assumptions in this scenario. A population variable measuring reaction time in milliseconds has mean $\mu = 480$ and variance $\sigma^2 = 2500$. Consider samples containing $n = 100$ independent observations from this population. Without skipping intermediate reasoning, provide the following: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 1600 while $n = 100$; (c) find the standard error if variance remains 2500 but sample size changes to $n = 400$. Explain separately how population variability and sample size change the precision of the sample mean. Show enough working that another learner could reproduce the argument.

`T02-A12-V07`: Precision of a sample mean for confidence score

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

This problem has 3 linked parts. A population variable measuring confidence score in score points has mean $\mu = 59$ and variance $\sigma^2 = 121$. Consider samples containing $n = 49$ independent observations from this population. The required work is: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 196 while $n = 49$; (c) find the standard error if variance remains 121 but sample size changes to $n = 100$. Finish by doing the following: Explain separately how population variability and sample size change the precision of the sample mean. End with a brief check that the result answers the original question.

`T02-A12-V08`: Precision of a sample mean for visit duration

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Treat the stated model as the working model. A population variable measuring visit duration in minutes has mean $\mu = 82$ and variance $\sigma^2 = 400$. Consider samples containing $n = 64$ independent observations from this population. Separate your answer into these parts: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 256 while $n = 64$; (c) find the standard error if variance remains 400 but sample size changes to $n = 144$. Explain separately how population variability and sample size change the precision of the sample mean. Distinguish model assumptions from conclusions produced by the model.

`T02-A12-V09`: Precision of a sample mean for accuracy score

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

Before calculating, note what is given and what is conditional or model-based. A population variable measuring accuracy score in score points has mean $\mu = 88$ and variance $\sigma^2 = 81$. Consider samples containing $n = 36$ independent observations from this population. Now answer: (a) find $E(\bar{X})$ and SD $(\bar{X})$; (b) find the standard error if the population variance changes to 144 while $n = 36$; (c) find the standard error if variance remains 81 but sample size changes to $n = 49$. Explain separately how population variability and sample size change the precision of the sample mean. State relevant event definitions or measurement units explicitly.

`T02-A12-V10`: Precision of a sample mean for sound index

Reason first. Before calculating, state the relationship, rule, or expected pattern that makes the calculation appropriate.

A population variable measuring sound index in index points has mean $\mu = 42$ and variance $\sigma^2 = 169$. Consider samples containing $n = 25$ independent observations from this population. Write a concise analysis with the following components:

- (a) find $E(\bar{X})$ and SD $(\bar{X})$
- (b) find the standard error if the population variance changes to 100 while $n = 25$
- (c) find the standard error if variance remains 169 but sample size changes to $n = 64$

Explain separately how population variability and sample size change the precision of the sample mean. Keep the subpart labels aligned with the requested outputs.

A13: Intervals under a Normal Model

`T02-A13-V01`: Interval probabilities for focus score

Suppose X measures focus score in score points and follows $N(50, 81)$, where the second parameter is the variance. Work through these requests: (a) calculate $P(50 < X \leq 59)$; (b) calculate $P(43 < X \leq 61)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Place each rule next to the result it supports.

`T02-A13-V02`: Interval probabilities for reading score

For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Use this setting for the calculations:

Suppose X measures reading score in score points and follows $N(70, 100)$, where the second parameter is the variance. Report the following: (a) calculate $P(65 < X \leq 82)$; (b) calculate $P(58 < X \leq 76)$. Make clear which information is given and which quantity is derived.

`T02-A13-V03`: Interval probabilities for visit duration

Consider the following information. Suppose X measures visit duration in minutes and follows $N(80, 225)$, where the second parameter is the variance. Prepare a structured response that contains: (a) calculate $P(80 < X \leq 95)$; (b) calculate $P(62 < X \leq 101)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Use complete explanatory sentences around the notation.

`T02-A13-V04`: Interval probabilities for memory score

Use the setting below to build the analysis step by step. Suppose X measures memory score in score points and follows $N(105, 144)$, where the second parameter is the variance. Begin with (a) calculate $P(96 < X \leq 117)$; then (b) calculate $P(88 < X \leq 122)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Check every step against the assumptions stated in the scenario.

`T02-A13-V05`: Interval probabilities for trust index

Your goal is to connect the numerical work to its meaning. Suppose X measures trust index in index points and follows $N(44, 64)$, where the second parameter is the variance. Address these items: (a) calculate $P(40 < X \leq 52)$; (b) calculate $P(33 < X \leq 49)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Interpret the result rather than merely repeating its numerical value.

`T02-A13-V06`: Interval probabilities for response time

Start by reading the assumptions in this scenario. Suppose X measures response time in milliseconds and follows $N(500, 2500)$, where the second parameter is the variance. Without skipping intermediate reasoning, provide the following: (a) calculate $P(475 < X \leq 560)$; (b) calculate $P(410 < X \leq 535)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Show enough working that another learner could reproduce the argument.

`T02-A13-V07`: Interval probabilities for wellbeing score

This problem has 2 linked parts. Suppose X measures wellbeing score in score points and follows $N(62, 121)$, where the second parameter is the variance. The required work is: (a) calculate $P(62 < X \leq 74)$; (b) calculate $P(48 < X \leq 69)$. Finish by doing the following: For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. End with a brief check that the result answers the original question.

T02-A13-V08: Interval probabilities for cataloging score

Treat the stated model as the working model. Suppose X measures cataloging score in score points and follows $N(86, 49)$, where the second parameter is the variance. Separate your answer into these parts: (a) calculate $P(81 < X \leq 93)$; (b) calculate $P(74 < X \leq 90)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Distinguish model assumptions from conclusions produced by the model.

T02-A13-V09: Interval probabilities for sound level

Before calculating, note what is given and what is conditional or model-based. Suppose X measures sound level in decibels and follows $N(36, 36)$, where the second parameter is the variance. Now answer: (a) calculate $P(36 < X \leq 42)$; (b) calculate $P(27 < X \leq 39)$. For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. State relevant event definitions or measurement units explicitly.

T02-A13-V10: Interval probabilities for confidence rating

Suppose X measures confidence rating in rating points and follows $N(55, 64)$, where the second parameter is the variance. Write a concise analysis with the following components:

- (a) calculate $P(51 < X \leq 63)$
- (b) calculate $P(43 < X \leq 59)$

For both intervals, standardize each endpoint, subtract CDF values in the correct order, and interpret the result as a modeled proportion. Keep the subpart labels aligned with the requested outputs.