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Discussing statistics: using problems with more than one correct answer to facilitate students' understanding

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Background

- A post-calculus introductory course in probability and statistics, aimed at second-year engineering students.
- 120-140 students.
- Lectures, problem-solving sessions, computer exercises with R.
- Traditional homework problems, where a single statistical method is to be applied.
- We have now skipped written homework problems in favour of “discussion problems”, treated during the problem-solving sessions.

Discussion problems

- Problems are handed out in advance.
- The students prepare written solutions.
- Discussion in groups of 4-5.
- Teaching assistants listen in and help out.
- Students must participate in at least 7 out of 12 problem discussions in order to pass the course.

A first example

An old textbook problem:
A sign in an elevator says "maximum 8 people or 630 kg". Assume that the weight of a randomly selected person is $N(70, 10^2)$ distributed. Compute the probability that 8 people overload the elevator by weighing more than 630 kg together.

Slightly altered:
A sign in an elevator says "maximum 8 people or 630 kg". Assume that the weight of a randomly selected person is normally distributed. Make assumptions about the mean and variance of this distribution and compute the probability that 8 people overload the elevator by weighing more than 630 kg together.

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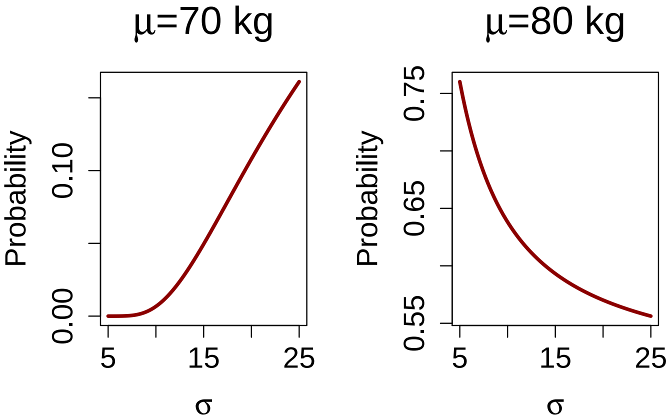
A first example



A first example

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- Assumptions about μ:
  - Most take $\mu \in \{70, 75, 80\}$.
  - Some take $\mu = 78.75 = 630/8$.
- Assumptions about σ:
  - Most students had problems with the meaning of σ.
  - The empirical rule: 95 % within 2σ from μ.
- Is normality a reasonable assumption?
- The perils of guessing parameter values.

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A second example

It is suspected that a new instrument A needs to be calibrated. 80 test measurements are performed to investigate this. For each of the 80 test situations one measurement is taken with A and one measurement is taken with a calibrated instrument B.

For 52 of these, A gives a higher value. If x_i is measurement i with A and y_i is measurement i with B we can let $z_i = x_i - y_i$ be the difference between the measurements. We find $z = 0.1$ and $s_z = 0.52$. The measured values can be assumed to be independent.

(a) Compute a 95 % confidence interval for the proportion of measurements for which A gives higher values than B.

(b) Compute a 95 % confidence interval for the difference in mean between the two devices.

(c) Judging from (a) and (b), would you say that device A needs to be calibrated?

A second example

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- In (a) the Wald interval for a binomial proportion is (0.545, 0.755).
- In (b) the interval is (-0.016,0.216) under the assumption of normality.
- Does A need to be calibrated?
- The binomial interval does not use all the available information!
- The interval for the difference of means relies on more assumptions!

Evaluation

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- Interviews with students and anonymous written course evaluations.
- – Students had to wait.
- – Important that the problems are handed out well in advance.
- + High praise in written course evaluations.
- + Less pressure than written homeworks. Less worried about producing a correct solution, and more keen to understand the problem and the solution.
- + The discussions became a learning opportunity.
- + Instant feedback from the teacher.
- + The teachers also received swift feedback on their teaching!