```
# AEC2 - Decision-Making Models
# Name: Pablo Bas Genís

# ---------------------------------------
# MULTIPLE-CHOICE QUESTIONS
# ---------------------------------------

1. There is a wrong value. In which column is it? (where is it, no
a) SC
b) Df
c) CM
d) F
Answer: c

2. The shape of a Student's t-distribution is symmetric.
a) Always
b) Varies according to the degrees of freedom
c) Depends on the kurtosis
d) Never
Answer: a

3. When we perform statistical inference providing a contrast of hy
a) We contrast if we have a homogeneous coefficient of variation
b) We study the compatibility of our sample statistic with the popu
c) We use population data to test whether the sample is homogeneous
d) We predict an answer variable depending on the information of o
Answer: b

4. What is type I (α) error in a hypothesis contrast?
a) Rejecting the null hypothesis when it is actually true
b) Rejecting the null hypothesis when in fact it is false
c) Accepting the null hypothesis when it is reality is true
d) Accepting the null hypothesis when it is false
Answer: a

5. Find the value of the F-Ratio statistic
a) 168
b) 168.5
c) 169.4
d) 172
Answer: a

6. In the table below, how many populations are we contrasting if a
a) 4
b) 5
c) 3
d) 85
Answer: b

7. From the information in the table below, which of the following
a) No statistical differences were found with 99.9% confidence
b) A statistically different mean between population 1 and 3
c) No differences are found in any of the means for a level of sign
d) No differences are found in any of the means for a level of sign
Answer: c

8. Which of the following options do you pose as a bilateral null h
a) The average price of diesel gasoline is lower in Cádiz than in V
b) The Statistics grade is different between Engineering and Market
c) The variance of olive oil consumption is equal to the variance o
d) The weekly average consumption of a wealthy family is bigger tha
Answer: b

9. What is the study parameter in the following statement? We want
a) Population average
```

Notas de la versión

Please follow our blog to see more information about new features, tips and tricks, and featured notebooks such as Analyzing a Bank Failure with Colab.

2025-04-09

- Colab Data Science Agent launched!
- Julia language runtimes available with GPU and TPU support GitHub.
- Now your popular Kaggle datasets are cached for quick retrieval.
- Upgraded Colab runtimes to Python 3.11.

Python package upgrades

- bigframes 1.29.0 -> 1.42.0
- TensorFlow 2.17.1 -> 2.18.0
- tensorboard 2.17.1 -> 2.18.0
- keras 3.5.0 -> 3.8.0
- torch 2.5.1 -> 2.6.0
- torchaudio 2.5.1 -> 2.6.0
- torchvision 0.20.1 -> 0.21.0
- fastai 2.7.18 -> 2.7.19
- ipykernel 5.5.6 -> 6.17.1
- google-genai 0.3.0 -> 1.9.0
- google-auth 2.27.0 -> 2.38.0
- Tornado 6.3.3 -> 6.4.2
- jax 0.4.33 -> 0.5.2
- accelerate 1.2.1 -> 1.5.2
- transformers 4.47.1 -> 4.50.3
- openai 1.57.4 -> 1.70.0
- kagglehub 0.3.6 -> 0.3.11
- earthengine-api 1.4.3 -> 1.5.9
- google-cloud-bigquery 3.29.0 -> 3.31.0
- bigquery-magics 0.8.1 -> 0.9.0
- NumPy 1.26.4 -> 2.0.2

Python package inclusions

- cuml-cu12 24.12.0

2025-01-13

- Released version 1.2.0 of the (Open in Colab Chrome Extension).
- Released minimizable comments with indicators next to cell.
- TPU v5e-1 Runtimes are now available for selection (tweet).
- GPU prices were decreased (tweet).

Python package upgrades

- accelerate 1.1.1 -> 1.2.1
- aiohttp 3.10.10 -> 3.11.11
- altair 4.2.2 -> 5.5.0
- bigframes 1.25.0 -> 1.29.0
- cmake 3.30.5 -> 3.31.2
- cvxpy 1.5.3 -> 3.6.0
- earthengine-api 1.2.0 -> 1.4.3
- folium 0.18.0 -> 0.19.3
- holidays 0.60 -> 0.63
- huggingface-hub 0.26.2 -> 0.27.0
- jsonpickle 3.4.2 -> 4.0.1
- kagglehub 0.3.3 -> 0.3.6
- keras 3.4.1 -> 3.5.0
- matplotlib 3.8.0 -> 3.10.0
- openai 1.54.3 -> 1.57.4
- pymc 5.18.0 -> 5.19.1
- safetensors 0.4.5 -> 0.5.0
- scikit-image 0.24.0 -> 0.25.0
- scikit-learn 1.5.2 -> 1.6.0
- sentence-transformers 3.2.1 -> 3.3.1
- tensorflow 2.17.0 -> 2.17.1

```
b) Population variance
c) Population proportion
d) Population median
Answer: b

10. From the information in the table below, what is the sample si
a) 39
b) 34
c) 40
d) 5
Answer: a

11. What is the correct answer from the information in the table b
a) No significant differences were found for a significance level
b) Significant differences found for 99% reliability
c) Significant differences found for 95% reliability
d) Significant differences found for 99.9% reliability
Answer: a

12. Knowing that a sample size of 200 cases has been taken, how mu
a) 199
b) 200
c) 201
d) Cannot be calculated with the available data
Answer: a

13. If the percentage of unexplained variance is 70%, from the inf
a) 100
b) Cannot be obtained
c) 70
d) 99
Answer: a

14. How much is the F-Ratio statistic, knowing that a sample of 30
a) 13.48
b) Cannot be obtained
c) 11.51
d) 12.94
Answer: d

15. What is the approach of the null hypothesis using the ANOVA te
a) The predicted value is not significant
b) Unexplained variance is significant
c) The regression model does not explain the behavior of the depen
d) None of the others
Answer: c

16. What is a residue from a statistical point of view?
a) The explained variability of a model
b) The distance from the observed value and the mean of the distri
c) The probability of failure associated with a model
d) The level of the factor that is significantly different from th
Answer: b

17. How do you interpret the following ANOVA test?
a) H0 is rejected for a significance level α = 0.001
b) There is no evidence to reject H0 for a type I error α = 0.001
c) All 2 first answers are correct
d) Neither of 2 first answers is correct
Answer: a

18. To determine the homoscedasticity of two samples, which test d
a) The Shapiro-Wilk test
b) The Bartlett test
c) Fisher's F-test
d) Student’s t-test
```

- torch 2.5.0 -> 2.5.1
- torchaudio 2.5.0 -> 2.5.1
- torchvision 0.20.0 -> 0.20.1
- transformers 4.46.2 -> 4.47.1
- wandb 0.18.6 -> 0.19.1
- xarray 2024.10.0 -> 2024.11.0

Python package inclusions

- google-genai 0.3.0

2024-11-11

- Users can now import Gemini API keys from AI Studio into their user secrets, all in Colab (tweet).
- Increased limit to 1000 characters for requests to Gemini in Chat and Generate windows.
- Improved saving notebook to GitHub flow
- Updated Gemini spark icon to be colorful.
- uv is pre-installed on the PATH for faster package installs.
- Fixed bugs
  - Dropdown text for GitHub repository not visible #4901.
  - Pre-installed California housing dataset README not correct #4862.
  - Backend execution error for scheduled notebook #4850.
  - Drive File Stream issues #3441.
  - Linking to the signup page does not preserve the authuser parameter.
  - Error messages in Gemini chat are not polished.
  - Clicking in Gemini chat feedback causes jitters the UI.
  - Hovering over a table of contents entry would show the menu icons for all entries.
  - Surveys display over open dialogs.
  - Playground mode banner not shown on mobile.

Python package upgrades

- accelerate 0.34.2 -> 1.1.1
- arviz 0.19.0 -> 0.20.0
- bigframes 1.18.0 -> 1.25.0
- bigquery-magics 0.2.0 -> 0.4.0
- bokeh 3.4.3 -> 3.6.1
- blosc 2.0.0 -> 2.7.1
- cloudpickle 2.2.1 -> 3.1.0
- cudf-cu12 24.4.1 -> 24.10.1
- dask 2024.8.0 -> 24.10.0
- debugpy 1.6.6 -> 1.8.0
- earthengine-api 1.0.0 -> 1.2.0
- folium 0.17.0 -> 0.18.0
- gscfs 2024.6.1 -> 2024.10.0
- geemap 0.34.3 -> 0.35.1
- holidays 0.57 -> 0.60
- huggingface-hub 0.24.7 -> 0.26.2
- kagglehub 0.3.0 -> 0.3.3
- lightgbm 4.4.0 -> 4.5.0
- lxml 4.9.4 -> 5.3.0
- matplotlib 3.7.1 -> 3.8.0
- mizani 0.11.4 -> 0.13.0
- networkx 3.3 -> 3.4.2
- nltk 3.8.1 -> 3.9.1
- pandas 2.1.4 -> 2.2.2
- pillow 10.4.0 -> 11.0.0
- plotnine 0.13.6 -> 0.14.1
- polars 1.6.0 -> 1.9.0

```
Answer: c

19. What is a parametric test?
a) A statistical test that makes no assumptions about the populati
b) A statistical test that is only used when the sample size is ve
c) A statistical test that requires the sample data to meet certai
d) A statistical test that is used to analyze non-numerical data
Answer: c

20. What is the basic idea of ANOVA?
a) To compare the variability between multiple samples
b) To compare the means of two samples
c) To break down the total variability observed into data in a ser
d) To predict values from a variable following a linear model
Answer: c

21. When do we say collinearity occurs?
a) When a predictor is linearly related to one or more predictors
b) When it is a linear combination of other predictors
c) When a predictor is correlated to one or more predictors in the
d) All the other answers are correct
Answer: d

22. The simple linear regression model is constructed: Ŷi = 5 + 3
What is the average change in the dependent variable (DV)?
a) 5
b) 8
c) 3
d) 1.5
Answer: c

23. Considering the following LSD intervals at 95% confidence leve
a) No, because the LSD intervals are separated
b) Yes, because the LSD intervals are separated
c) It’s not possible to know if there are significant differences
d) These LSD intervals does not aim at comparing the means...
Answer: a

24. What is the least squares method in regression analysis?
a) It is the method of minimizing the arithmetic mean of the resid
b) It is the method of minimizing the absolute value of the residu
c) It is the method of minimizing the arithmetic mean of the indep
d) It is the method of minimizing the arithmetic mean of the depen
Answer: b

25. What is the coefficient of determination (R2)?
a) It is a measure of the variance in the residuals of a regressio
b) It is a measure of the linear relationship between two variable
c) It is a measure of the proportion of variance in the dependent
d) It is a measure of the proportion of variance in the independen
Answer: c



# PROBLEM 1

"""
We are told that the waiting times in an emergency department are
We took a sample of 100 people and found that the average waiting
with a standard deviation of 2.5 minutes. We want to test whether
from the known value of 15 minutes.

We'll use the Z-test since the sample size is large and the popula
"""

from math import sqrt
```

- protobuf 3.20.3 -> 4.25.5
- pyarrow 14.0.2 -> 17.0.0
- pydrive2 1.20.0 -> 1.21.1
- pymc 5.16.2 -> 5.18.0
- torch 2.4.1 -> 2.5.0
- torchaudio 2.4.1 -> 2.5.0
- torchvision 0.19.1 -> 0.20.0
- transformers 4.44.2 -> 4.46.2
- xarray 2024.9.0 -> 2024.10.0

Python package inclusions

- diffusers 0.31.0
- gitpython 3.1.43
- langchain 0.3.7
- openai 1.54.3
- pygit2 1.16.0
- pyspark 3.5.3
- sentence-transformers 3.2.1
- timm 1.0.11
- wandb 0.18.6

Library and driver upgrades

- drivefs upgraded from 89.0.2 to 98.0.0

2024-09-23

- Improved code snippet search
- Updated Marketplace image and public local runtime container
- Improved the look-and-feel of interactive form dropdowns and checkboxes
- Fixed bugs
  - activating the skip link caused the notebook to scroll out of view
  - toggling a checkbox too much caused the page to crash
  - lightning fast drags could cause orphaned tabs
  - custom widgets snippet would show for local runtimes

Python package upgrades

- accelerate 0.32.1 -> 0.34.2
- arviz 0.18.0 -> 0.19
- autograd 1.6.2 -> 1.7.0
- bigframes 1.14.0 -> 1.18.0
- dask 2024.7.1 -> 2024.8.0
- distributed 2024.7.1 -> 2024.8.0
- duckdb 0.10.3 -> 1.1.0
- earthengine-api 0.1.416 -> 1.0.0
- flax 0.8.4 -> 0.8.5
- gdown 5.1.0 -> 5.2.0
- geemap 0.33.1 -> 0.34.3
- geopandas 0.14.4 -> 1.0.1
- google-cloud-aiplatform 1.59.0 -> 1.67.1
- google-cloud-bigquery-storage 2.25.0 -> 2.26.0
- holidays 0.54 -> 0.57
- huggingface-hub 0.23.5 -> 0.24.7
- ibis-framework 8.0.0 -> 9.2.0
- jax 0.4.26 -> 0.4.33
- jaxlib 0.4.26 -> 0.4.33
- kagglehub 0.2.9 -> 0.3.0
- lightgbm 4.4.0 -> 4.5.0
- matplotlib-venn 0.11.10 -> 1.1.1
- mizani 0.9.3 -> 0.11.4
- Pillow 9.4.0 -> 10.4.0
- plotly 5.15.0 -> 5.24.1
- plotnine 0.12.4 -> 0.13.6
- polars 0.20.2 -> 1.6.0
- progressbar2 4.2.0 -> 4.5.0
- PyDrive2 1.6.3 -> 1.20.0
- pymc 5.10.4 -> 5.16.2
- pytensor 2.18.6 -> 2.25.4

```
# Given values
mu_0 = 15            # Hypothesized population mean
x_bar = 14.25        # Sample mean
sigma = 2.5          # Standard deviation
n = 100              # Sample size

# a) Test at 5% significance level
z_alpha_2 = 1.96
z_score = (x_bar - mu_0) / (sigma / sqrt(n))

print("Problem 1.a:")
print("Z-score:", z_score)
if abs(z_score) > z_alpha_2:
    print("Since the Z-score is greater than 1.96, we reject the nu
else:
    print("Since the Z-score is not greater than 1.96, we fail to r

# b) Test at 0.1% significance level
z_alpha_2_001 = 3.27

print("\nProblem 1.b:")
if abs(z_score) > z_alpha_2_001:
    print("Z-score is less than 3.27, so we fail to reject the null
else:
    print("Same as above: we fail to reject the null hypothesis.")

# c) Is there a contradiction?
print("\nProblem 1.c:")
print("No contradiction. At 5%, the difference is considered signi-


# PROBLEM 2

"""
We want to study how the number of pages of a job (X) relates to the
We're given summary statistics and regression output, and we need to
"""

# a) Estimate parameters
print("\nProblem 2.a:")
print("The regression equation is: Y = 2.6272 + 0.428601 * X. This m

# b) Goodness of fit (R^2)
SSR = 39343.3
SST = 47368.9
R2 = SSR / SST
print("\nProblem 2.b:")
print(f"R-squared = {R2:.4f}, which means that around {R2*100:.2f}%

# c) Correlation coefficient
Var_X = 8.08757
Var_Y = 640.121
Cov_XY = 65.5735

r = Cov_XY / sqrt(Var_X * Var_Y)
print("\nProblem 2.c:")
print(f"The correlation coefficient is {r:.4f}. This shows a strong

# d) Statistical significance
print("\nProblem 2.d:")
print("Looking at the output, both the constant and the slope have v

# e) Predict for 6 pages
X_new = 6
Y_pred = 2.6272 + 0.428601 * X_new
print("\nProblem 2.e:")
```

- scikit-image 0.23.2 -> 0.24.0
- scikit-learn 1.3.2 -> 1.5.2
- torch 2.3.1 -> 2.4.1
- torchaudio 2.3.1 -> 2.4.1
- torchvision 0.18.1 -> 0.19.1
- transformers 4.42.4 -> 4.44.2
- urllib3 2.0.7 -> 2.2.3
- xarray 2024.6.0 -> 2024.9.0

Python package inclusions

- bigquery-magics 0.2.0

2024-08-20

- TPU memory usage and utilization can now be checked with `!tpu-info`
- Gemini Chat responses are now grounded in relevant sources
- Added a new "Create Gemini API key" link in the user secrets panel
- Added a new "Gemini: Creating a prompt" snippet and touched up the existing "Gemini: Connecting to Gemini" snippet
- Added the ability to specify custom placeholder text for various interactive form params (see examples)
- Keyboard navigation a11y improvements to comments UI
- Various minor rendering improvements to interactive forms UI
- A11y improvements for the run button and header
- Updated tooltip styling
- A11y improvements for the file browser's disk usage bar
- On mobile, tooltips now trigger on long press
- On mobile, release notes updates will no longer display automatically
- Python package upgrades
  - astropy 5.3.4 -> 6.1.2
  - bigframes 1.11.1 -> 1.14.0
  - bokeh 3.3.4 -> 3.4.3
  - dask 2023.8.1 -> 2024.7.1
  - earthengine-api 0.1.412 -> 0.1.416
  - geopandas 0.13.2 -> 0.14.4
  - kagglehub 0.2.8 -> 0.2.9
  - keras 2.15.0 -> 3.4.1
  - lightgbm 4.1.0 -> 4.4.0
  - malloy 2023.1067 -> 2024.1067
  - numba 0.58.1 -> 0.60.0
  - numpy 1.25.2 -> 1.26.4
  - opencv-python 4.8.0.76 -> 4.10.0.84
  - pandas 2.0.3 -> 2.1.4
  - pandas-gbq 0.19.2 -> 0.23.1
  - panel 1.3.8 -> 1.4.5
  - requests 2.31.0 -> 2.32.3
  - scikit-learn 1.2.2. -> 1.3.2
  - scipy 1.11.4 -> 1.13.1
  - tensorboard 2.15.2 -> 2.17.0
  - tensorflow 2.15.0 -> 2.17.0
  - tf-keras 2.15.1 -> 2.17.0
  - xarray 2023.7.0 -> 2024.6.0
  - xgboost 2.0.3 -> 2.1.1
- Python package inclusions
  - einops 0.8.0

```
print(f"If a job has 6 pages, the expected printing time is approxim

# f) Residual variance
Residual_SS = 8025.61
Residual_df = 73
residual_variance = Residual_SS / Residual_df
print("\nProblem 2.f:")
print(f"The residual variance is {residual_variance:.2f}. This tells
```

2024-07-22

- You can now embed Google sheets directly into Colab to streamline interactions with data with InteractiveSheet.

  Example:

  ```
  from google.colab import sheets
  sh = sheets.InteractiveSheet()
  df = sh.as_df()
  ```

- Fixed multiple rendering bugs in cell editors with wide text content (i.e. text is no longer hidden or clipped)
- Fixed multiple accessibility issues in Colab's comments feature (e.g. proper keyboard focus management, added accessibility landmarks, etc)
- Fixed bug where AI code generation would fail for extremely long broken code snippets
- Fixed multiple scrollbar bugs in the user secrets panel
- Added the ability for workspace admin to purchase Colab Pro and Pro+ Subscriptions for users
- Fixed bug where user secrets couldn't be moved to a tab
- Fixed several focus management accessibility issues in tabs, the table of contents, the left toolbar, and the run button
- Fixed bug where overflowing cells may be omitted when pasting from Google Sheets
- Fixed bug where the generate code button did not activate on touch
- Python package upgrades
  - bigframes 1.9.0 -> 1.11.1
  - cvxpy 1.3.4 -> 1.5.2
  - earthengine-api 0.1.408 -> 0.1.412
  - google-api-core 2.11.1 -> 2.19.1
  - google-api-python-client 2.84.0 -> 2.137.0
  - google-cloud-aiplatform 1.56.0 -> 1.59.0
  - google-cloud-bigquery 3.21.0 -> 3.25.0
  - google-cloud-core 2.3.3 -> 2.4.1
  - google-cloud-datastore 2.15.2 -> 2.19.0
  - google-cloud-firestore 2.11.1 -> 2.16.1
  - google-cloud-functions 1.13.3 -> 1.16.4
  - google-generativeai 0.5.4 -> 0.7.2
  - kagglehub 0.2.5 -> 0.2.8
  - pip 23.1.2 -> 24.1.2
  - setuptools 67.7.2 -> 71.0.4
  - sympy 1.12.1 -> 1.13.1
  - torch 2.3.0 -> 2.3.1
  - transformers 4.41.2 -> 4.42.4
- Python package inclusions
  - accelerate 0.32.1

2024-06-18

- Inline AI completions are now available to users on the free-of-charge tier