

WHAT IS THE TEST STATISTIC IF THE SAMPLE PROPORTION IS 20/50 AND THE HYPOTHESIZED PROPORTION WAS 0.5? PLEASE

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UNDERSTANDING HOW TO COMPUTE THE TEST STATISTIC FOR A SAMPLE PROPORTION IS FUNDAMENTAL IN STATISTICAL HYPOTHESIS TESTING, ESPECIALLY WHEN ASSESSING CLAIMS ABOUT POPULATION PROPORTIONS. IN THIS ARTICLE, WE WILL EXPLORE THE PROCESS STEP-BY-STEP, STARTING FROM THE GIVEN SAMPLE DATA—A SAMPLE PROPORTION OBTAINED FROM 50 OBSERVATIONS WITH 20 SUCCESSES—AND A HYPOTHESIZED POPULATION PROPORTION OF 0.5. WE WILL DEFINE THE RELEVANT CONCEPTS, DERIVE THE FORMULA FOR THE TEST STATISTIC, AND THEN APPLY IT TO THIS SPECIFIC SCENARIO. THIS COMPREHENSIVE GUIDE AIMS TO CLARIFY THE METHODOLOGY FOR CALCULATING THE TEST STATISTIC IN SUCH CASES, ENABLING YOU TO PERFORM HYPOTHESIS TESTS CONFIDENTLY.

UNDERSTANDING THE CONTEXT: WHAT IS A SAMPLE PROPORTION AND HYPOTHESIZED PROPORTION?

SAMPLE PROPORTION ($\hat{p}$)

A SAMPLE PROPORTION, OFTEN DENOTED AS $\hat{p}$ (P-HAT), IS A POINT ESTIMATE OF THE TRUE POPULATION PROPORTION BASED ON OBSERVED DATA. IT IS CALCULATED AS:

$$\hat{p} = \frac{\text{NUMBER OF SUCCESSES IN THE SAMPLE}}{\text{TOTAL NUMBER OF OBSERVATIONS}}$$

IN OUR CASE:

- NUMBER OF SUCCESSES (x) = 20
- TOTAL OBSERVATIONS (n) = 50

THUS:

$$\hat{p} = \frac{20}{50} = 0.4$$

HYPOTHESIZED POPULATION PROPORTION (p_0)

THE HYPOTHESIZED PROPORTION, DENOTED AS p_0 , IS A VALUE ASSUMED UNDER THE NULL HYPOTHESIS. IT REPRESENTS THE CLAIM OR EXPECTATION ABOUT THE POPULATION PROPORTION WE AIM TO TEST. HERE:

- $p_0 = 0.5$

FORMULATING THE HYPOTHESES

BEFORE CALCULATING THE TEST STATISTIC, IT'S ESSENTIAL TO DEFINE THE NULL AND ALTERNATIVE HYPOTHESES:

- NULL HYPOTHESIS (H_0): THE POPULATION PROPORTION IS EQUAL TO THE HYPOTHESIZED VALUE

$$H_0: p = p_0 = 0.5$$

- ALTERNATIVE HYPOTHESIS (H_1): THE POPULATION PROPORTION DIFFERS FROM THE HYPOTHESIZED VALUE (TWO-TAILED TEST)

$$H_1: p \neq 0.5$$

THE TEST STATISTIC FOR A PROPORTION

WHAT IS A TEST STATISTIC?

A TEST STATISTIC IS A STANDARDIZED VALUE THAT INDICATES HOW FAR THE OBSERVED DATA DEVIATE FROM THE NULL HYPOTHESIS, MEASURED IN UNITS OF STANDARD ERROR. IT FORMS THE BASIS FOR CALCULATING P-VALUES OR CRITICAL VALUES TO MAKE STATISTICAL DECISIONS.

STANDARD FORMULA FOR THE TEST STATISTIC

FOR TESTING A SINGLE PROPORTION, THE MOST COMMONLY USED TEST STATISTIC IS THE Z-SCORE:

$$Z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$$

WHERE:

- $\hat{p}$ = SAMPLE PROPORTION
- p_0 = HYPOTHESIZED POPULATION PROPORTION
- n = SAMPLE SIZE

THIS FORMULA ASSUMES THAT THE SAMPLING DISTRIBUTION OF $\hat{p}$ IS APPROXIMATELY NORMAL, WHICH IS REASONABLE WHEN BOTH np_0 AND $n(1 - p_0)$ ARE SUFFICIENTLY LARGE (TYPICALLY ≥ 10).

CALCULATING THE TEST STATISTIC WITH GIVEN DATA

USING THE PROVIDED DATA:

- $\hat{p} = 0.4$
- $p_0 = 0.5$
- $n = 50$

SUBSTITUTING INTO THE FORMULA:

$$Z =$$

$$z = \frac{0.4 - 0.5}{\sqrt{\frac{0.5(1 - 0.5)}{50}}}$$

CALCULATING STEP-BY-STEP:

1. COMPUTE NUMERATOR:

$$0.4 - 0.5 = -0.1$$

2. COMPUTE DENOMINATOR:

$$\sqrt{\frac{0.5 \times 0.5}{50}} = \sqrt{\frac{0.25}{50}} = \sqrt{0.005} \approx 0.07071$$

3. COMPUTE Z-VALUE:

$$z = \frac{-0.1}{0.07071} \approx -1.414$$

THEREFORE, THE TEST STATISTIC (Z-VALUE) IS APPROXIMATELY -1.414.

INTERPRETING THE TEST STATISTIC

SIGNIFICANCE AND P-VALUE

THE CALCULATED Z-VALUE INDICATES HOW MANY STANDARD ERRORS THE OBSERVED SAMPLE PROPORTION IS FROM THE HYPOTHESIZED PROPORTION. TO DETERMINE WHETHER TO REJECT H_0 , COMPARE THIS Z-VALUE WITH CRITICAL VALUES OR COMPUTE THE P-VALUE.

FOR A TWO-TAILED TEST AT SIGNIFICANCE LEVEL α (COMMONLY 0.05):

- CRITICAL Z-VALUES ARE APPROXIMATELY ± 1.96 .
- P-VALUE IS OBTAINED FROM STANDARD NORMAL DISTRIBUTION TABLES OR SOFTWARE.

USING $z = -1.414$:

- THE P-VALUE FOR THE TWO-TAILED TEST:

$$P\text{-VALUE} = 2 \times P(Z \leq -1.414) \approx 2 \times 0.078 \approx 0.156$$

SINCE $0.156 > 0.05$, WE FAIL TO REJECT THE NULL HYPOTHESIS AT THE 5% SIGNIFICANCE LEVEL.

IMPLICATIONS OF THE RESULT

THE TEST STATISTIC SUGGESTS THAT THE OBSERVED SAMPLE PROPORTION (0.4) IS NOT SIGNIFICANTLY DIFFERENT FROM THE HYPOTHESIZED PROPORTION (0.5) AT TYPICAL SIGNIFICANCE LEVELS. THEREFORE, BASED ON THIS DATA, THERE IS INSUFFICIENT EVIDENCE TO CONCLUDE THAT THE TRUE POPULATION PROPORTION DIFFERS FROM 0.5.

ADDITIONAL CONSIDERATIONS IN COMPUTING THE TEST STATISTIC

CONDITIONS FOR VALIDITY

TO ENSURE THE VALIDITY OF THE Z-TEST FOR PROPORTIONS, CERTAIN CONDITIONS SHOULD BE MET:

- THE SAMPLE DATA ARE RANDOMLY SELECTED.
- BOTH np_0 AND $n(1 - p_0)$ ARE AT LEAST 10 TO JUSTIFY THE NORMAL APPROXIMATION:
- $np_0 = 50 \times 0.5 = 25 \geq 10$
- $n(1 - p_0) = 50 \times 0.5 = 25 \geq 10$

SINCE THESE CONDITIONS ARE SATISFIED, THE Z-TEST IS APPROPRIATE.

ALTERNATIVE APPROACHES

IF THESE CONDITIONS ARE NOT MET, ALTERNATIVE METHODS SUCH AS THE EXACT BINOMIAL TEST CAN BE USED, WHICH DO NOT RELY ON NORMAL APPROXIMATION.

SUMMARY

- THE SAMPLE PROPORTION ($\hat{p}$) IN THIS CASE IS 0.4.
- THE HYPOTHEZED PROPORTION (p_0) IS 0.5.
- THE TEST STATISTIC (z) IS CALCULATED AS:

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$$

- PLUGGING IN THE VALUES:

$$z \approx -1.414$$

- INTERPRETATION INDICATES NO SIGNIFICANT DIFFERENCE AT THE 5% LEVEL.

CONCLUSION

CALCULATING THE TEST STATISTIC FOR A SAMPLE PROPORTION INVOLVES UNDERSTANDING THE RELATIONSHIP BETWEEN THE OBSERVED DATA AND THE HYPOTHEZED POPULATION PARAMETER, APPLYING THE STANDARD FORMULA, AND INTERPRETING THE RESULTING Z-SCORE WITHIN THE CONTEXT OF THE HYPOTHESIS TEST. IN OUR SCENARIO, WITH A SAMPLE PROPORTION OF 0.4 FROM 50 OBSERVATIONS AND A HYPOTHEZED PROPORTION OF 0.5, THE RESULTING Z-VALUE SUGGESTS THAT THE OBSERVED DATA ARE CONSISTENT WITH THE NULL HYPOTHESIS, ASSUMING TYPICAL SIGNIFICANCE LEVELS. THIS PROCESS EXEMPLIFIES HOW STATISTICAL THEORY TRANSLATES INTO PRACTICAL STEPS FOR HYPOTHESIS TESTING, PROVIDING A FOUNDATION FOR MORE ADVANCED ANALYSES AND DECISION-MAKING BASED ON SAMPLE DATA.

REFERENCES:

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- MOORE, D. S., MCCABE, G. P., & CRAIG, B. A. (2012). INTRODUCTION TO THE PRACTICE OF STATISTICS. W.H. FREEMAN.
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FREQUENTLY ASKED QUESTIONS

WHAT IS THE TEST STATISTIC IF THE SAMPLE PROPORTION IS 20/50 AND THE HYPOTHESIZED PROPORTION IS 0.5?

THE TEST STATISTIC IS CALCULATED USING THE FORMULA: $z = (\hat{p} - p_0) / \sqrt{[p_0(1 - p_0)/n]}$, WHERE $\hat{p} = 20/50 = 0.4$, $p_0 = 0.5$, AND $n = 50$. PLUGGING IN THE VALUES: $z = (0.4 - 0.5) / \sqrt{[0.5 \cdot 0.5 / 50]} = -0.1 / \sqrt{0.005} = -0.1 / 0.0707 \approx -1.414$.

HOW DO YOU INTERPRET THE TEST STATISTIC IN THIS CONTEXT?

THE TEST STATISTIC (-1.414) INDICATES HOW MANY STANDARD ERRORS THE SAMPLE PROPORTION IS AWAY FROM THE HYPOTHESIZED PROPORTION OF 0.5. A VALUE CLOSE TO ZERO SUGGESTS LITTLE DEVIATION, WHILE LARGER ABSOLUTE VALUES INDICATE GREATER DEVIATION.

WHAT IS THE FORMULA USED TO CALCULATE THE TEST STATISTIC FOR A SAMPLE PROPORTION?

THE FORMULA IS $z = (\hat{p} - p_0) / \sqrt{[p_0(1 - p_0) / n]}$, WHERE $\hat{p}$ IS THE SAMPLE PROPORTION, p_0 IS THE HYPOTHESIZED PROPORTION, AND n IS THE SAMPLE SIZE.

IS THE SAMPLE PROPORTION OF 0.4 SIGNIFICANTLY DIFFERENT FROM 0.5 BASED ON THE TEST STATISTIC?

TO DETERMINE SIGNIFICANCE, COMPARE THE CALCULATED Z-VALUE (-1.414) TO CRITICAL Z-VALUES (E.G., ± 1.96 FOR A 5% SIGNIFICANCE LEVEL). SINCE -1.414 IS WITHIN ± 1.96 , THE DIFFERENCE IS NOT STATISTICALLY SIGNIFICANT AT THE 5% LEVEL.

WHAT IS THE PURPOSE OF CALCULATING THE TEST STATISTIC IN HYPOTHESIS TESTING?

THE TEST STATISTIC MEASURES HOW FAR THE SAMPLE DATA DEVIATES FROM THE NULL HYPOTHESIS, ALLOWING US TO ASSESS WHETHER THE OBSERVED DIFFERENCE IS STATISTICALLY SIGNIFICANT OR LIKELY DUE TO CHANCE.

CAN I USE THIS TEST STATISTIC TO DETERMINE THE P-VALUE? IF YES, HOW?

YES. ONCE YOU HAVE THE Z-VALUE (-1.414), YOU CAN FIND THE P-VALUE BY LOOKING UP THE CORRESPONDING PROBABILITY IN THE STANDARD NORMAL DISTRIBUTION TABLE OR USING STATISTICAL SOFTWARE.

WHAT ASSUMPTIONS ARE NECESSARY FOR CALCULATING THIS TEST STATISTIC?

THE MAIN ASSUMPTIONS INCLUDE RANDOM SAMPLING, INDEPENDENCE OF OBSERVATIONS, AND THAT THE SAMPLE SIZE IS LARGE ENOUGH FOR THE NORMAL APPROXIMATION TO BE VALID (np_0 AND $n(1 - p_0)$ BOTH GREATER THAN 5).

IF THE SAMPLE PROPORTION WAS 25/50 INSTEAD OF 20/50, WHAT WOULD THE

TEST STATISTIC BE?

With $p = 25/50 = 0.5$, the test statistic would be $z = (0.5 - 0.5) / \sqrt{0.5 \cdot 0.5 / 50} = 0 / 0.0707 = 0$, indicating no deviation from the null hypothesis.

ADDITIONAL RESOURCES

WHAT IS THE TEST STATISTIC IF THE SAMPLE PROPORTION IS 20/50 AND THE HYPOTHEZED PROPORTION WAS 0.5? PLEASE

IN THE REALM OF STATISTICS, HYPOTHESIS TESTING PLAYS A PIVOTAL ROLE IN MAKING DATA-DRIVEN DECISIONS. WHETHER IN RESEARCH, QUALITY CONTROL, OR POLICY FORMULATION, UNDERSTANDING HOW TO EVALUATE CLAIMS ABOUT POPULATION PARAMETERS IS ESSENTIAL. ONE COMMON SCENARIO INVOLVES TESTING WHETHER A SAMPLE PROPORTION SIGNIFICANTLY DIFFERS FROM A HYPOTHEZED POPULATION PROPORTION. FOR EXAMPLE, SUPPOSE A RESEARCHER OBSERVES A SAMPLE PROPORTION OF 20 SUCCESSES OUT OF 50 TRIALS AND WANTS TO TEST WHETHER THIS ALIGNS WITH A HYPOTHEZED PROPORTION OF 0.5. THIS ARTICLE DELVES INTO THE CONCEPT OF THE TEST STATISTIC IN SUCH A SCENARIO, EXPLAINING ITS CALCULATION, INTERPRETATION, AND PRACTICAL SIGNIFICANCE.

UNDERSTANDING THE BASICS: WHAT IS A TEST STATISTIC?

BEFORE DIVING INTO THE SPECIFICS, IT'S CRUCIAL TO GRASP WHAT A TEST STATISTIC IS AND WHY IT MATTERS IN HYPOTHESIS TESTING.

DEFINITION OF A TEST STATISTIC

A TEST STATISTIC IS A STANDARDIZED VALUE CALCULATED FROM SAMPLE DATA THAT MEASURES THE DEGREE OF AGREEMENT BETWEEN THE OBSERVED DATA AND THE NULL HYPOTHESIS (THE DEFAULT ASSUMPTION). ITS PURPOSE IS TO QUANTIFY HOW UNUSUAL THE OBSERVED DATA ARE UNDER THE ASSUMPTION THAT THE NULL HYPOTHESIS IS TRUE.

WHY IS THE TEST STATISTIC IMPORTANT?

- DECISION-MAKING TOOL: IT FORMS THE CORE OF HYPOTHESIS TESTING, ALLOWING STATISTICIANS TO DECIDE WHETHER TO REJECT OR FAIL TO REJECT THE NULL HYPOTHESIS.
- STANDARDIZATION: IT CONVERTS RAW DATA INTO A COMMON SCALE, ENABLING COMPARISON ACROSS DIFFERENT STUDIES OR SCENARIOS.
- PROBABILITY CALCULATION: THE VALUE OF THE TEST STATISTIC IS USED TO COMPUTE P-VALUES, WHICH INDICATE THE PROBABILITY OF OBSERVING SUCH DATA IF THE NULL HYPOTHESIS IS TRUE.

SCENARIO BREAKDOWN: SAMPLE PROPORTION AND HYPOTHEZED PROPORTION

LET'S CONSIDER THE SPECIFIC SITUATION:

- SAMPLE DATA: 20 SUCCESSES OUT OF 50 TRIALS, WHICH GIVES A SAMPLE PROPORTION ($\hat{p}$) OF:

$$\hat{p} = \frac{20}{50} = 0.4$$

- NULL HYPOTHESIS (H_0): THE POPULATION PROPORTION WAS 0.5, I.E., ($p = 0.5$).

THE KEY QUESTION: WHAT IS THE TEST STATISTIC WHEN TESTING WHETHER THIS SAMPLE PROPORTION SIGNIFICANTLY DIFFERS FROM 0.5?

CALCULATING THE TEST STATISTIC FOR A PROPORTION

THE MOST COMMON APPROACH TO THIS PROBLEM INVOLVES THE USE OF A Z-TEST FOR PROPORTIONS. THIS METHOD ASSESSES WHETHER THE OBSERVED SAMPLE PROPORTION DEVIATES SIGNIFICANTLY FROM THE HYPOTHESIZED POPULATION PROPORTION.

STEP-BY-STEP CALCULATION

THE FORMULA FOR THE Z-TEST STATISTIC FOR PROPORTIONS IS:

$$Z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$$

WHERE:

- ($\hat{p}$) = SAMPLE PROPORTION (0.4 IN THIS CASE)
- (p_0) = HYPOTHESIZED POPULATION PROPORTION (0.5)
- (n) = SAMPLE SIZE (50)

APPLYING THE VALUES

PLUGGING IN THE NUMBERS:

$$Z = \frac{0.4 - 0.5}{\sqrt{\frac{0.5(1 - 0.5)}{50}}}$$

CALCULATE THE NUMERATOR:

$$0.4 - 0.5 = -0.1$$

CALCULATE THE DENOMINATOR:

$$\sqrt{\frac{0.5 \times 0.5}{50}} = \sqrt{\frac{0.25}{50}} = \sqrt{0.005} \approx 0.0707$$

THEREFORE,

$$Z = \frac{-0.1}{0.0707} \approx -1.414$$

INTERPRETATION

THE COMPUTED TEST STATISTIC IS APPROXIMATELY -1.414.

INTERPRETING THE TEST STATISTIC

UNDERSTANDING THE SIGNIFICANCE OF THE Z-VALUE INVOLVES COMPARING IT TO A STANDARD NORMAL DISTRIBUTION.

SIGNIFICANCE LEVELS AND CRITICAL VALUES

- COMMON SIGNIFICANCE LEVELS: 0.05 (5%), 0.01 (1%)
- CRITICAL Z-VALUES:
- FOR A TWO-TAILED TEST AT $(\alpha = 0.05)$: APPROXIMATELY ± 1.96
- FOR $(\alpha = 0.01)$: APPROXIMATELY ± 2.576

WHAT DOES THE Z-VALUE TELL US?

- SINCE $(z \approx -1.414)$, WHICH LIES WITHIN THE RANGE OF -1.96 TO 1.96 , IT INDICATES THAT THE OBSERVED DIFFERENCE IS NOT STATISTICALLY SIGNIFICANT AT THE 5% LEVEL.
- THIS SUGGESTS THAT, BASED ON THIS SAMPLE, THERE ISN'T STRONG EVIDENCE TO REJECT THE NULL HYPOTHESIS THAT THE TRUE PROPORTION IS 0.5.

PRACTICAL IMPLICATIONS OF THE TEST STATISTIC

UNDERSTANDING THE CALCULATION AND INTERPRETATION OF THE TEST STATISTIC IS VITAL FOR DRAWING MEANINGFUL CONCLUSIONS.

WHEN THE TEST STATISTIC IS CLOSE TO ZERO

- THE SAMPLE PROPORTION CLOSELY ALIGNS WITH THE HYPOTHESIZED PROPORTION.
- THERE IS LITTLE EVIDENCE TO SUGGEST A DIFFERENCE EXISTS.

WHEN THE TEST STATISTIC IS LARGE IN MAGNITUDE

- INDICATES A GREATER DEVIATION FROM THE HYPOTHESIZED PROPORTION.
- MAY LEAD TO REJECTING THE NULL HYPOTHESIS IF IT EXCEEDS THE CRITICAL VALUE.

P-VALUES AND DECISION-MAKING

- THE P-VALUE ASSOCIATED WITH $(z = -1.414)$ CAN BE OBTAINED FROM STANDARD NORMAL DISTRIBUTION TABLES OR SOFTWARE.
- FOR $(z = -1.414)$, THE P-VALUE (TWO-TAILED) IS APPROXIMATELY 0.157.
- SINCE $0.157 > 0.05$, WE FAIL TO REJECT (H_0) , IMPLYING INSUFFICIENT EVIDENCE TO CONCLUDE THE TRUE PROPORTION DIFFERS FROM 0.5.

SUMMARY AND PRACTICAL TAKEAWAYS

- THE TEST STATISTIC IN THIS SCENARIO IS APPROXIMATELY -1.414 .
- IT IS CALCULATED USING THE FORMULA:

$$Z = \frac{\hat{P} - P_0}{\sqrt{\frac{P_0(1 - P_0)}{N}}}$$

- THIS STATISTIC MEASURES HOW MANY STANDARD ERRORS THE OBSERVED SAMPLE PROPORTION IS AWAY FROM THE HYPOTHESIZED PROPORTION.
- IN THIS CASE, THE DATA DOES NOT PROVIDE ENOUGH EVIDENCE TO REJECT THE NULL HYPOTHESIS AT COMMON SIGNIFICANCE LEVELS.

BROADER CONTEXT

THIS PROCESS EXEMPLIFIES A FUNDAMENTAL ASPECT OF INFERENTIAL STATISTICS: USING SAMPLE DATA TO MAKE INFORMED JUDGMENTS ABOUT A POPULATION PARAMETER. WHETHER IN SCIENTIFIC RESEARCH, QUALITY ASSURANCE, OR MARKET ANALYSIS, UNDERSTANDING HOW TO COMPUTE AND INTERPRET THE TEST STATISTIC ENABLES PRACTITIONERS TO ASSESS HYPOTHESES OBJECTIVELY.

CONCLUSION

CALCULATING THE TEST STATISTIC FOR A SAMPLE PROPORTION INVOLVES UNDERSTANDING THE RELATIONSHIP BETWEEN THE OBSERVED DATA AND THE HYPOTHESIZED PARAMETER, STANDARDIZED BY THE STANDARD ERROR. IN THE SCENARIO WHERE THE SAMPLE PROPORTION IS 20/50 (OR 0.4), AND THE HYPOTHESIZED PROPORTION IS 0.5, THE Z-TEST PROVIDES A QUANTITATIVE MEASURE — APPROXIMATELY -1.414 — INDICATING THAT THE OBSERVED DATA DOES NOT SIGNIFICANTLY DEVIATE FROM THE NULL HYPOTHESIS AT CONVENTIONAL SIGNIFICANCE LEVELS.

MASTERING THIS CALCULATION FOSTERS A DEEPER APPRECIATION FOR STATISTICAL INFERENCE, EMPOWERING ANALYSTS AND RESEARCHERS TO DISTINGUISH BETWEEN RANDOM VARIATION AND MEANINGFUL DIFFERENCES. AS DATA CONTINUES TO INFLUENCE DECISION-MAKING ACROSS DIVERSE FIELDS, SUCH FOUNDATIONAL KNOWLEDGE REMAINS INDISPENSABLE FOR RIGOROUS ANALYSIS AND CREDIBLE CONCLUSIONS.

What Is The Test Statistic If The Sample Proportion Is 20 50 And The Hypothesized Proportion Was 0 5 Please

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