【DSE M1 公式表：微積分及統計】DSE M1 Formula Sheet: Calculus and Statistics

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本頁按範疇列出 DSE M1 所用的公式。考試時會提供**標準正態分佈表**；其餘公式應預計要自行記熟。分佈表給出 $A(z) = P(0 \le Z \le z)$。This page lists the formulas used in DSE M1, grouped by area. In the examination a **standard normal distribution table** is provided; plan to know the other formulas by heart. The table gives $A(z) = P(0 \le Z \le z)$.

問某條公式如何運用 Ask how to use a formula

微積分公式（DSE M1） Calculus Formulas (DSE M1)

二項展開式Binomial expansion $(a + b)^n = \Sigma\, C(n, r)\, a^{n-r}\, b^r$

指數級數Exponential series $e^x = 1 + x + x^2/2! + x^3/3! + \dots$

導數Derivatives

$(x^n)' = nx^{n-1}, (e^x)' = e^x, (\ln x)' = 1/x, (a^x)' = a^x \ln a$

積／商法則Product / quotient $(uv)' = u'v + uv', (u/v)' = (u'v - uv')/v^2$

鏈式法則Chain rule $dy/dx = (dy/du)(du/dx)$

積分Integrals

$\int x^n\, dx = x^{n+1}/(n + 1) + C, \int (1/x)\, dx = \ln|x| + C, \int e^{kx}\, dx = e^{kx}/k + C$

定積分Definite integral $\int_a^b f(x)\, dx = F(b) - F(a)$

梯形法則Trapezoidal rule

$(h/2)[y_0 + 2(y_1 + \dots + y_{n-1}) + y_n], h = (b - a)/n$

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概率及離散分佈 Probability and Discrete Distributions

- **條件概率：** $P(A \mid B) = P(A \cap B) / P(B)$
- **貝葉斯定理：** $P(B \mid D) = P(D \mid B)P(B) / [P(D \mid A)P(A) + P(D \mid B)P(B)]$
- **期望值：** $E(X) = \Sigma\ x\ P(X = x)$
- **方差：** $Var(X) = E(X^2) - [E(X)]^2$
- **線性變換：** $E(aX + b) = aE(X) + b$，$Var(aX + b) = a^2Var(X)$
- **二項分佈 $B(n, p)$：** $P(X = k) = C(n, k)\ p^k(1 - p)^{n-k}$，平均值 np，方差 $np(1 - p)$
- **泊松分佈 $Po(\lambda)$：** $P(X = k) = e^{-\lambda}\lambda^k / k!$，平均值 λ，方差 λ

- **Conditional probability:** $P(A \mid B) = P(A \cap B) / P(B)$
- **Bayes' theorem:** $P(B \mid D) = P(D \mid B)P(B) / [P(D \mid A)P(A) + P(D \mid B)P(B)]$
- **Expectation:** $E(X) = \Sigma\ x\ P(X = x)$
- **Variance:** $Var(X) = E(X^2) - [E(X)]^2$
- **Linear change:** $E(aX + b) = aE(X) + b$, $Var(aX + b) = a^2Var(X)$
- **Binomial $B(n, p)$:** $P(X = k) = C(n, k)\ p^k(1 - p)^{n-k}$, mean np, variance $np(1 - p)$
- **Poisson $Po(\lambda)$:** $P(X = k) = e^{-\lambda}\lambda^k / k!$, mean λ, variance λ

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正態分佈、抽樣及置信區間 Normal Distribution, Sampling and Confidence Intervals

- **標準化：** $Z = (X - \mu)/\sigma$，其中 $X \sim N(\mu, \sigma^2)$
- **分佈表：** $A(z) = P(0 \le Z \le z)$；當 $z > 0$，$P(Z > z) = 0.5 - A(z)$
- **樣本平均值：** $\bar{X} \sim N(\mu, \sigma^2/n)$
- **μ 的 95% 置信區間：** $\bar{x} \pm 1.96\ \sigma/\sqrt{n}$
- **μ 的 99% 置信區間：** $\bar{x} \pm 2.575\ \sigma/\sqrt{n}$

1.96 及 2.575 兩個數值來自分佈表：$A(1.96) = 0.4750$，$A(2.575) = 0.4950$。

- **Standardisation:** $Z = (X - \mu)/\sigma$, where $X \sim N(\mu, \sigma^2)$
- **Table:** $A(z) = P(0 \le Z \le z)$; $P(Z > z) = 0.5 - A(z)$ for $z > 0$

- **Sample mean:** $\bar{X} \sim N(\mu, \sigma^2/n)$
- **95% confidence interval for μ:** $\bar{x} \pm 1.96\ \sigma/\sqrt{n}$
- **99% confidence interval for μ:** $\bar{x} \pm 2.575\ \sigma/\sqrt{n}$

The values 1.96 and 2.575 come from the table: $A(1.96) = 0.4750$ and $A(2.575) = 0.4950$.

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M1 公式表例題詳解 Worked Examples

例題 1 Example 1：為甚麼 1.96 對應 95% 的區間 Why 1.96 gives a 95% interval

利用 $A(1.96) = 0.4750$，求 $P(-1.96 < Z < 1.96)$。Using $A(1.96) = 0.4750$, find $P(-1.96 < Z < 1.96)$.

1. 曲線以 0 為對稱軸The curve is symmetric about 0
2. $P(-1.96 < Z < 1.96) = 2A(1.96)$
3. $= 2 \times 0.4750 = 0.95$

答案： Answer: 0.95

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