

This formula is more complicated than it needs to be. If we combine $C = C_1 - 2C_2$, and $5C_3$ into a single arbitrary constant $C = C_1 - 2C_2 + 5C_3$, the formula simplifies to
 这个公式比实际情况还要复杂。如果我们把 $C = C_1 - 2C_2$, 和 $5C_3$ 合并到一个任意常数的式子 $C = C_1 - 2C_2 + 5C_3$, 这个公式可以被简化成

$$y = \frac{x^3}{3} - x^2 + 5x + C$$

and *still* gives all the possible antiderivatives there are. For this reason, we recommend that you go right to the final form even if you elect to integrate term-by-term. Write
 并且依然给所有可能的不定积分。基于这个原因, 我们推荐你直接看最后的形式, 即使你需要逐项的整合。写

$$\begin{aligned}\int (x^2 - 2x + 5)dx &= \int x^2 dx - \int 2x dx + \int 5 dx \\ &= \frac{x^3}{3} - x^2 + 5x + C.\end{aligned}$$

Find the simplest antiderivative you can for each part and add the arbitrary constant of integration at the end.

为每个部分找出它最简形式的反导数, 然后在最后取一个任意的正常数。 ■

EXERCISES 4.7

Finding Antiderivatives

寻找反导数

In Exercises 1-16, find an antiderivative for each function. Do as many as you can mentally. Check your answer by differentiation.
 在练习 1-16 中, 为每个函数寻找一个不定积分。在你的能力范围内尽可能寻找。并且通过微分法验证你的答案。

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|--------------------------------------|----------------------------------|-------------|
| 1. a. $2x$ | b. x^2 | c. $y = 2x$ |
| 2. a. $6x$ | b. x^7 | c. $y = 2x$ |
| 3. a. $-3x^{-4}$ | b. x^{-4} | c. $y = 2x$ |
| 4. a. $2x^{-3}$ | b. $\frac{x^{-3}}{2} + x^2$ | c. $y = 2x$ |
| 5. a. $\frac{1}{x^2}$ | b. $\frac{5}{x^2}$ | c. $y = 2x$ |
| 6. a. $-\frac{2}{x^3}$ | b. $\frac{1}{2x^3}$ | c. $y = 2x$ |
| 7. a. $\frac{3}{2}\sqrt{x}$ | b. $\frac{1}{2\sqrt{x}}$ | c. $y = 2x$ |
| 8. a. $\frac{4}{3}\sqrt[3]{x}$ | b. $\frac{1}{3\sqrt[3]{x}}$ | c. $y = 2x$ |
| 9. a. $\frac{2}{3}x^{-\frac{1}{3}}$ | b. $\frac{1}{3}x^{-\frac{2}{3}}$ | c. $y = 2x$ |
| 10. a. $\frac{1}{2}x^{-\frac{1}{2}}$ | b. $y = 2x$ | c. $y = 2x$ |
| 11. a. $-\pi \sin \pi x$ | b. $y = 2x$ | c. $y = 2x$ |
| 12. a. $\pi \cos \pi x$ | b. $y = 2x$ | c. $y = 2x$ |
| 13. a. $\sec^2 x$ | b. $y = 2x$ | c. $y = 2x$ |
| 14. a. $\csc^2 x$ | b. $y = 2x$ | c. $y = 2x$ |
| 15. a. $\csc x \cot x$ | b. $y = 2x$ | c. $y = 2x$ |
| 16. a. $\sec x \tan x$ | b. $y = 2x$ | c. $y = 2x$ |

Finding Indefinite Integrals

寻找反导数

In Exercises 17-56, find the most general antiderivative or indefinite integral. You may need to try a solution and then adjust your guess. Check your answers by differentiation.

在练习 17-56 中, 为每个函数寻找一个不定积分。在你的能力范围内尽可能寻找。并且通过微分法验证你的答案。

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|--|--|
| 17. $\int (\sin 2x - \csc^2 x) dx$ | 18. $\int 3x^{\sqrt{3}} dx$ |
| 19. $\int \frac{1+\cos 4t}{2} dt$ | 20. $\int (1 + \tan^2 \theta) d\theta$ |
| 21. $\int 3x^{\sqrt{3}} dx$ | 22. $\int \cot^2 x dx$ |
| 23. $\int (1 + \tan^2 \theta) d\theta$ | 24. $\int \cos \theta (\tan \theta + \sec \theta) d\theta$ |
| 25. $\int \cot^2 x dx$ | 26. $\int (2 \cos 2x - 3 \sin 3x) dx$ |
| 27. $\int \cos \theta (\tan \theta + \sec \theta) d\theta$ | 28. $\int \frac{1-\cos 6t}{2} dt$ |
| 29. $\int (2 \cos 2x - 3 \sin 3x) dx$ | 30. $\int x^{\sqrt{2}-1} dx$ |
| 31. $\int \frac{1-\cos 6t}{2} dt$ | 32. $\int (2 + \tan^2 \theta) d\theta$ |
| 33. $\int x^{\sqrt{2}-1} dx$ | 34. $\int (1 - \cot^2 x) dx$ |
| 35. $\int (2 + \tan^2 \theta) d\theta$ | 36. $\int \frac{\csc \theta}{\csc \theta - \sin \theta}$ |
| 37. $\int (1 - \cot^2 x) dx$ | 38. $\int (1 - \cot^2 x) dx$ |
| 39. $\int \frac{\csc \theta}{\csc \theta - \sin \theta}$ | 40. $\int \frac{\csc \theta}{\csc \theta - \sin \theta}$ |
| 41. $\int (\sin 2x - \csc^2 x) dx$ | 42. $\int \frac{\csc \theta}{\csc \theta - \sin \theta}$ |
| 43. $\int (4 \sec x \tan x - 2 \sec^2 x) dx$ | |

$$44. \int \frac{1}{2}(\csc^2 x - \csc x \cot x) dx$$

$$45. \int (\sin 2x - \csc^2 x) dx \quad 46. \int (2 \cos 2x - 3 \sin 3x) dx$$

$$47. \int \frac{1+\cos 4t}{2} dt \quad 48. \int \frac{1-\cos 6t}{2} dt$$

$$49. \int 3x^{\sqrt{3}} dx \quad 50. \int x^{\sqrt{2}-1} dx$$

$$51. \int (1 + \tan^2 \theta) d\theta \quad 52. \int (2 = \tan^2 \theta) d\theta$$

(Hint : $1 + \tan^2 \theta = \sec^2 \theta$)

$$53. \int \cot^2 x dx \quad 54. \int (1 - \cot^2 x) dx$$

(Hint : $1 + \cot^2 x = \csc^2 x$)

$$55. \int \cos \theta (\tan \theta + \sec \theta) d\theta \quad 56. \int \frac{\csc \theta}{\csc \theta - \sin \theta}$$

在提取过程中, MFCC 首先对语音进行预处理, 即**预加重、分帧和加窗**三个部分; 然后对预处理的语音做快速傅里叶变换 (Fast Fourier transform, FFT), 再用 Mel 滤波器组滤波并对其取对数, 最后做离散余弦变换求倒谱 (Discrete cosine transform, DCT), 去除各维度信号之间的相关性, 从而将信号映射到低维空间。在提取 MFCC 的基础上, 还可求取其一阶、二阶差分, 共同组成 Mel 倒谱特性。在提取过程中, MFCC 首先对语音进行预处理, 即**预加重、分帧和加窗**三个部分; 然后对预处理的语音做快速傅里叶变换 (Fast Fourier transform, FFT), 再用 Mel 滤波器组滤波并对其取对数, 最后做离散余弦变换求倒谱 (Discrete cosine transform, DCT), 去除各维度信号之间的相关性, 从而将信号映射到低维空间。在提取 MFCC 的基础上, 还可求取其一阶、二阶差分, 共同组成 Mel 倒谱特性。

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