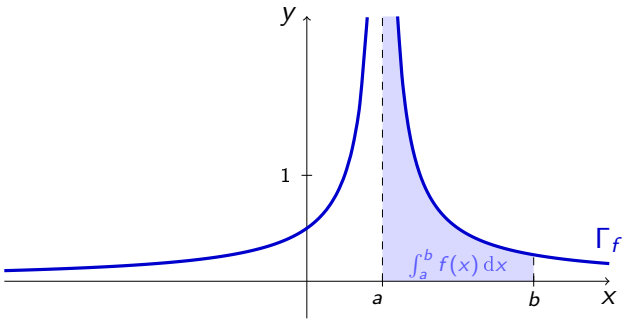
5.7.2. Nepravi integrali neograničenih funkcija

8. 1. 2020.

Fotografija: Kalen Emsley

Definicija 1(a)

Neka su $a, b \in \mathbb{R}$ takvi da je $a < b$.



Ako je pravac $x = a$ vertikalna asimptota funkcije $f : D \subseteq \mathbb{R} \to \mathbb{R}$, tada definiramo

$$\int_a^b f(x)\,\mathrm{d}x :=$$

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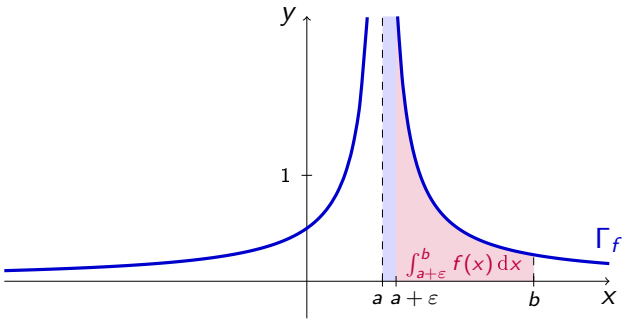

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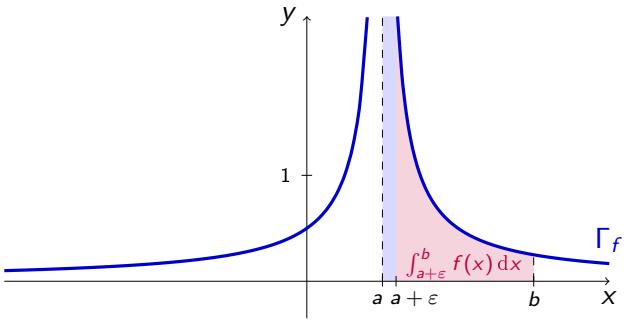


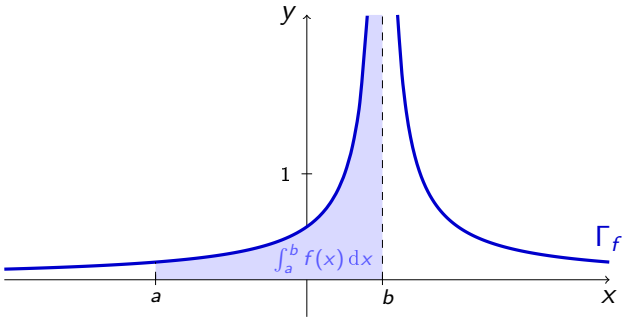
Ako je pravac $x = a$ vertikalna asimptota funkcije $f : D \subseteq \mathbb{R} \to \mathbb{R}$, tada definiramo

$$\int_a^b f(x)\,\mathrm{d}x := \lim_{\varepsilon \to 0+} \int_{a+\varepsilon}^{b} f(x)\,\mathrm{d}x,$$

kad god je desna strana ove formule definirana.

Definicija 1(b)

Neka su $a, b \in \mathbb{R}$ takvi da je $a < b$.



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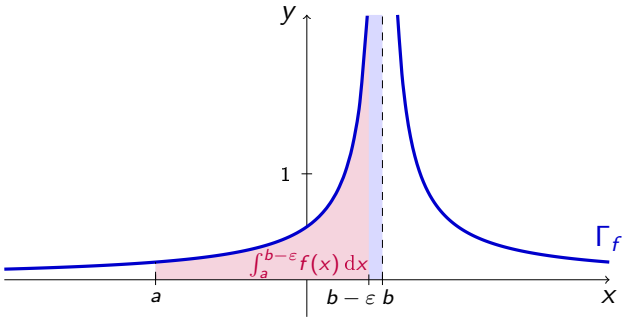

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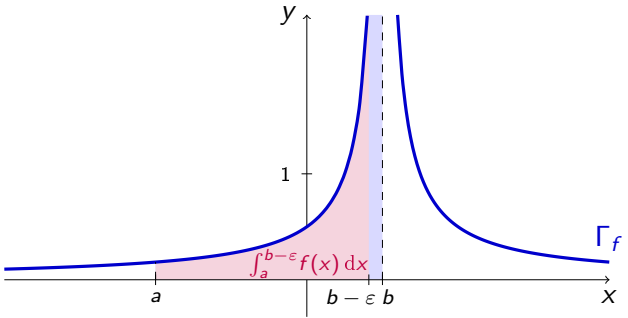


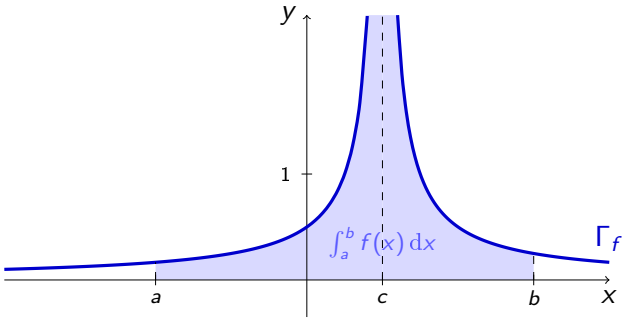
Ako je pravac $x = b$ vertikalna asimptota funkcije $f : D \subseteq \mathbb{R} \to \mathbb{R}$, tada definiramo

$$\int_a^b f(x)\,\mathrm{d}x := \lim_{\varepsilon \to 0+} \int_a^{b-\varepsilon} f(x)\,\mathrm{d}x,$$

kad god je desna strana ove formule definirana.

Definicija 1(c)

Neka su $a, b, c \in \mathbb{R}$ takvi da je $a < c < b$.



Ako je pravac $x = c$ vertikalna asimptota funkcije $f : D \subseteq \mathbb{R} \to \mathbb{R}$, tada definiramo

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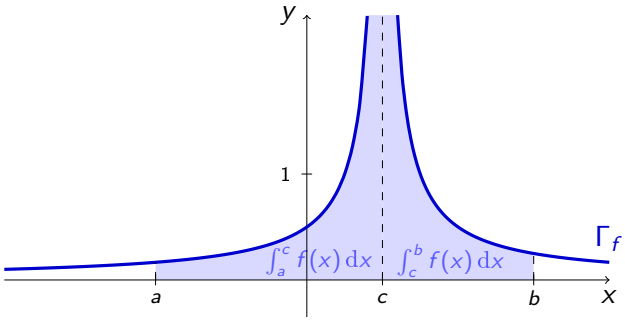

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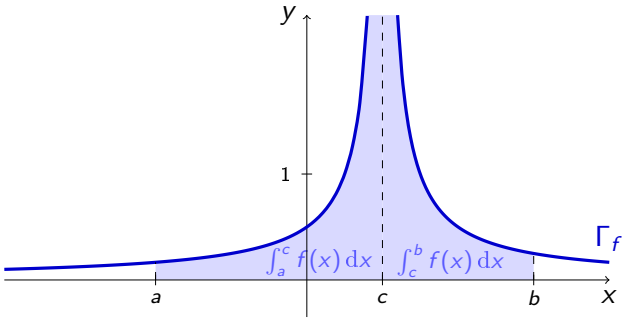

Ako je pravac $x = c$ vertikalna asimptota funkcije $f : D \subseteq \mathbb{R} \to \mathbb{R}$, tada definiramo

$$\int_a^b f(x)\,\mathrm{d}x := \underbrace{\int_a^c f(x)\,\mathrm{d}x}_{\text{Definicija 1(b)}} + \underbrace{\int_c^b f(x)\,\mathrm{d}x}_{\text{Definicija 1(a)}},$$

kad god je desna strana ove formule definirana.

Zadatak 54(a)

Izračunajte integral $\int_0^1 \frac{\mathrm{d}x}{\sqrt{x}}$.

$$\int \mathrm{d}x = x + C$$
$$\int x^a \,\mathrm{d}x = \frac{x^{a+1}}{a+1} + C \quad (a \neq -1)$$
$$\int \frac{\mathrm{d}x}{x} = \ln|x| + C$$
$$\int e^x \,\mathrm{d}x = e^x + C$$
$$\int a^x \,\mathrm{d}x = \frac{a^x}{\ln a} + C \quad (a > 0,\ a \neq 1)$$
$$\int \cos x \,\mathrm{d}x = \sin x + C$$
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Zadatak 54(b)

Izračunajte integral $\int_{-1}^{0} \frac{\mathrm{d}x}{x}$.

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Izračunajte integral $\int_{-1}^{0} \frac{\mathrm{d}x}{x}$.

Rješenje. Kako je pravac $x = 0$ vertikalna asimptota podintegralne funkcije $\frac{1}{x}$, imamo

$$\int_{-1}^{0} \frac{\mathrm{d}x}{x} = \lim_{\varepsilon \to 0+} \int_{-1}^{-\varepsilon} \frac{\mathrm{d}x}{x}$$

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$$\begin{aligned}
\int_{-1}^{0} \frac{\mathrm{d}x}{x} &= \lim_{\varepsilon \to 0+} \int_{-1}^{-\varepsilon} \frac{\mathrm{d}x}{x} \\
&= \lim_{\varepsilon \to 0+} \ln|x| \Big|_{-1}^{-\varepsilon} \\
&= \lim_{\varepsilon \to 0+} \left(\ln|-\varepsilon| - \ln|-1|\right) \\
&= \lim_{\varepsilon \to 0+} \ln \varepsilon \\
&= -\infty.
\end{aligned}$$

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$$\int \frac{\mathrm{d}x}{a^2+x^2} = \frac{1}{a} \operatorname{arctg} \frac{x}{a} + C \quad (a > 0)$$

Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

$$\int \mathrm{d}x = x + C$$
$$\int x^a \,\mathrm{d}x = \frac{x^{a+1}}{a+1} + C \quad (a \neq -1)$$
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Rješenje. Kako je pravac $x = 0$ vertikalna asimptota podintegralne funkcije $\frac{1}{x^2}$ i vrijedi $0 \in [-1, 1]$, imamo

$$\int_{-1}^{1} \frac{\mathrm{d}x}{x^2} = \int_{-1}^{0} \frac{\mathrm{d}x}{x^2} + \int_{0}^{1} \frac{\mathrm{d}x}{x^2}$$

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&= \lim_{\varepsilon \to 0+} \left(-\frac{1}{x} \right) \Big|_{-1}^{-\varepsilon} + \lim_{\varepsilon \to 0+} \left(-\frac{1}{x} \right) \Big|_{\varepsilon}^{1} \\
&= \lim_{\varepsilon \to 0+} \left(\frac{1}{\varepsilon} - 1 \right) + \lim_{\varepsilon \to 0+} \left(-1 + \frac{1}{\varepsilon} \right)
\end{aligned}$$

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&= \lim_{\varepsilon \to 0+} \left(\frac{1}{\varepsilon} - 1 \right) + \lim_{\varepsilon \to 0+} \left(-1 + \frac{1}{\varepsilon} \right) \\
&= (+\infty + (+\infty))
\end{aligned}$$

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&= \lim_{\varepsilon \to 0+} \left(\frac{1}{\varepsilon} - 1 \right) + \lim_{\varepsilon \to 0+} \left(-1 + \frac{1}{\varepsilon} \right) \\
&= (+\infty + (+\infty)) = +\infty.
\end{aligned}$$

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Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

Krivo rješenje.

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Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

Krivo rješenje. Imamo $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2} = -\frac{1}{x}\Big|_{-1}^{1}$

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Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

Krivo rješenje. Imamo

$$\int_{-1}^{1} \frac{\mathrm{d}x}{x^2} = -\frac{1}{x}\Big|_{-1}^{1} = -\frac{1}{1} - \left(-\frac{1}{-1}\right)$$

$$\int \mathrm{d}x = x + C$$

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Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

Krivo rješenje. Imamo

$$\begin{aligned}\int_{-1}^{1} \frac{\mathrm{d}x}{x^2} &= -\frac{1}{x}\Big|_{-1}^{1} \\ &= -\frac{1}{1} - \left(-\frac{1}{-1}\right) \\ &= -2.\end{aligned}$$

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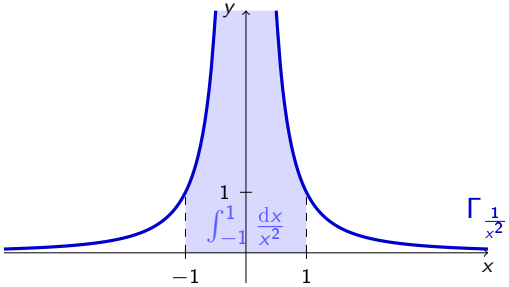

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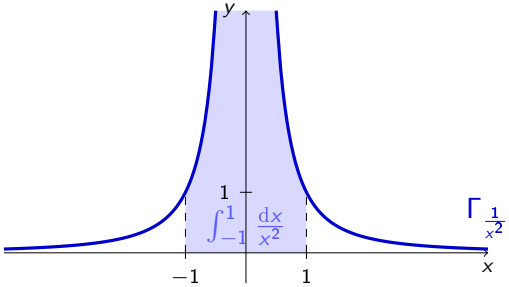
Zadatak 54(c)

Izračunajte integral $\int_{-1}^{1} \frac{\mathrm{d}x}{x^2}$.

Krivo rješenje. Imamo

$$\int_{-1}^{1} \frac{\mathrm{d}x}{x^2} \neq -\frac{1}{x}\Big|_{-1}^{1}$$
$$= -\frac{1}{1} - \left(-\frac{1}{-1}\right)$$
$$= -2.$$



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