$\tau_d := \{A \mid A \text{ is open in } X\} = \{A \subseteq X \mid \text{forall } x \text{ in } A \text{ there exists an } \epsilon \text{ such that } B_\epsilon(x) \subseteq A\}$

$$\begin{tikzcd}
 & X \arrow[ddl, "\sigma_1"'] \arrow[d, dashed, "\exists!\tau"] \arrow[ddr, "\sigma_2"] & \\
 & V \times W \arrow[dl, "\rho_1"] \arrow[dr, "\rho_2"'] & \\
V & & W
\end{tikzcd}$$

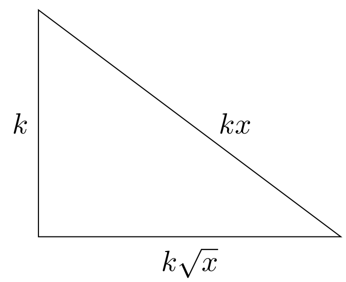
$A, B, S \in \mathcal{C}$ and $f : A \to B$

$$- \times S = \begin{cases} A \times S & \# \; A \in \mathcal{C} \\ f \times \mathrm{id}_S : A \times S \to B \times S & \# \; (a, s) \mapsto (f(a), s) \end{cases}$$

$$\begin{tikzcd}
A \arrow[r, shift left, "f_1"] \arrow[r, shift right, "f_2"'] & B \arrow[r, "g"] & C
\end{tikzcd}$$

For sets a mapping $g : B \to C$ is said to be *injective* if for $b_1, b_2 \in B$ we have $g(b_1) = g(b_2) \Rightarrow b_1 = b_2$.

Not a good definition because it looks inside the objects. Rather, in category theory we define a more general concept, *monomorphism*. A morphism $g : B \to C$ is said to be a monomorphism if for all $f_i : A \to B$ we have $gf_1 = gf_2 \Rightarrow f_1 = f_2$.



$$
\begin{tikzcd}
A \arrow[loop above] \arrow[loop below] \arrow[loop left] \arrow[loop right]
\end{tikzcd}
$$

$$
\begin{tikzcd}
A \arrow[r, "f"] \arrow[d, "g\circ f"'] & B \arrow[dl, "g"] \\
C &
\end{tikzcd}
$$

$$
\begin{tikzcd}
F(A) \arrow[r, "F(f)"] \arrow[d, "\eta_A"'] & F(B) \arrow[d, "\eta_B"] \\
G(A) \arrow[r, "G(f)"'] & G(B)
\end{tikzcd}
$$

$$
\begin{tikzcd}
F(A) \arrow[r, "F(f)"] \arrow[d, "\eta_A"'] & F(B) \arrow[d, "\eta_B"] \\
G(A) \arrow[r, "G(f)"'] & G(B)
\end{tikzcd}
$$

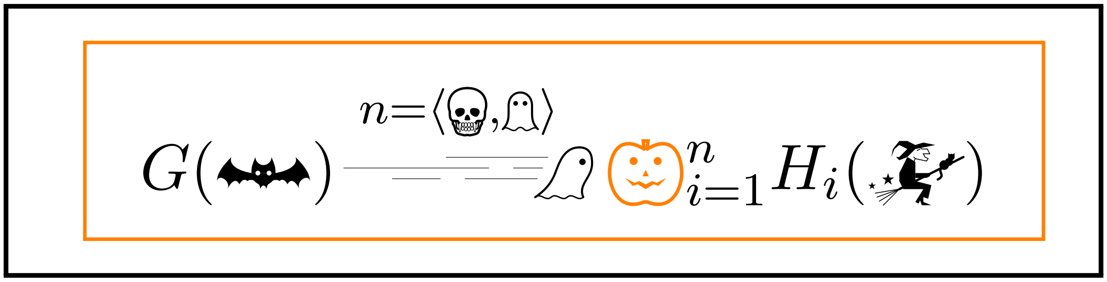


Figure 1: Happy Halloween!

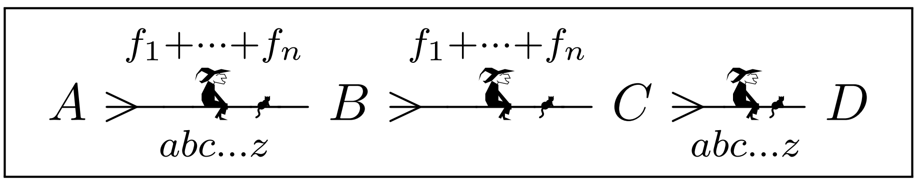


Figure 2: Happy Halloween!

0.6249999121401877

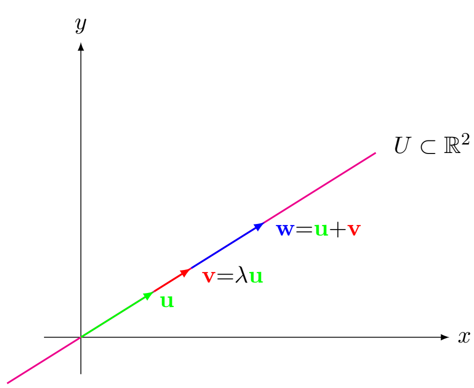


Figure 3: The line U is a linear subspace of $\mathbb{R}^2$

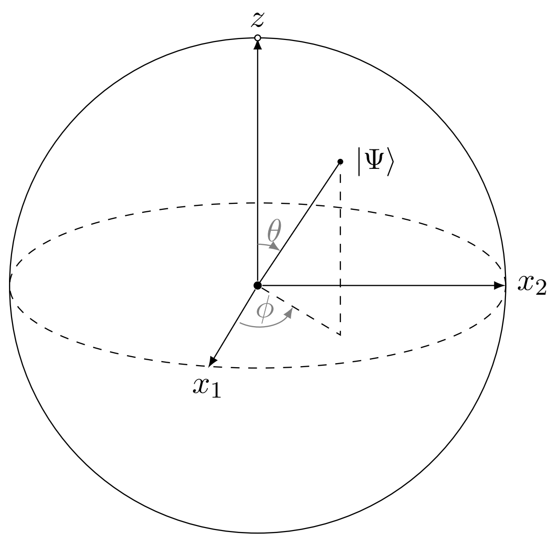


Figure 4: The Bloch Sphere

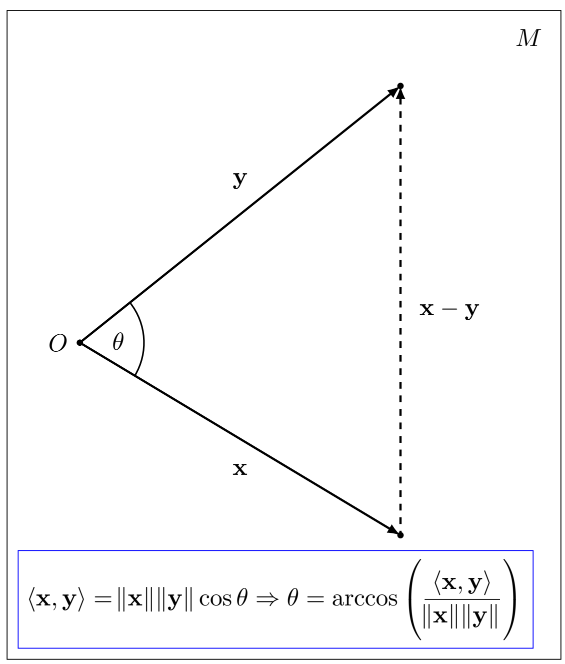


Figure 5: Geometric interpretation of $\langle \mathbf{x}, \mathbf{y} \rangle$

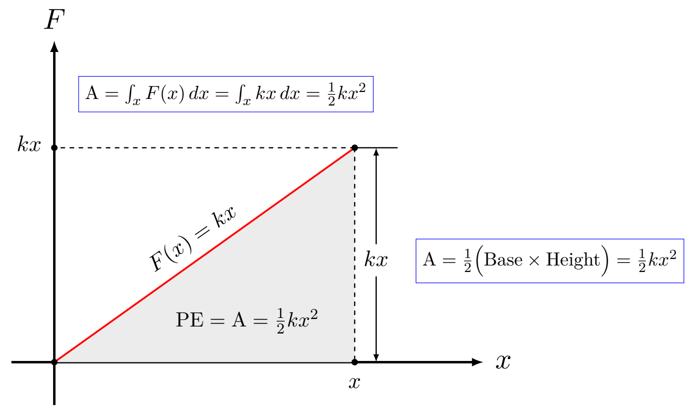


Figure 6: Potential Energy of a Simple Harmonic Oscillator

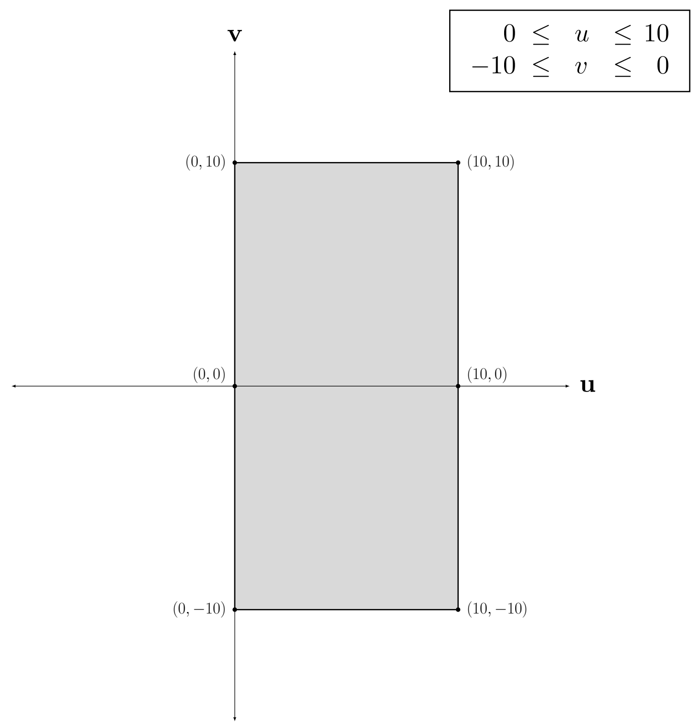


Figure 7: The transformed parallelogram is a rectangle in the uv-plane

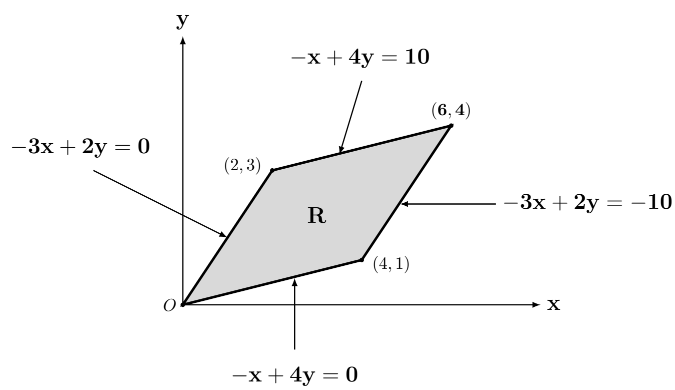


Figure 8: Equations of the Sides of the Parallelogram

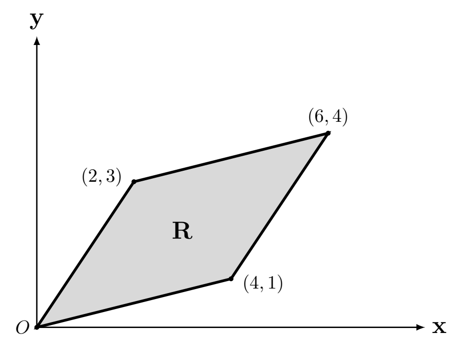


Figure 9: Parallelogram in the xy-plane

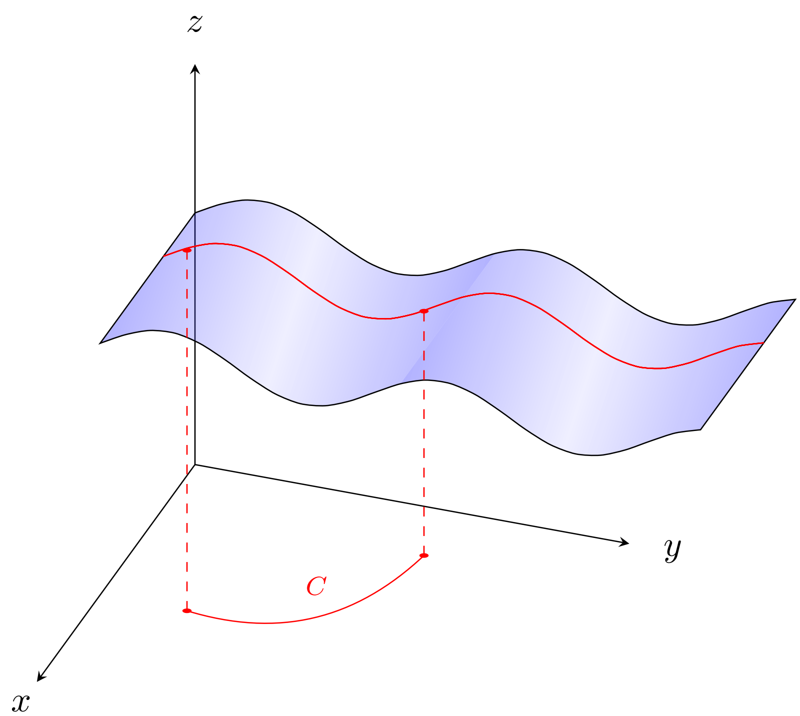


Figure 10: 3D

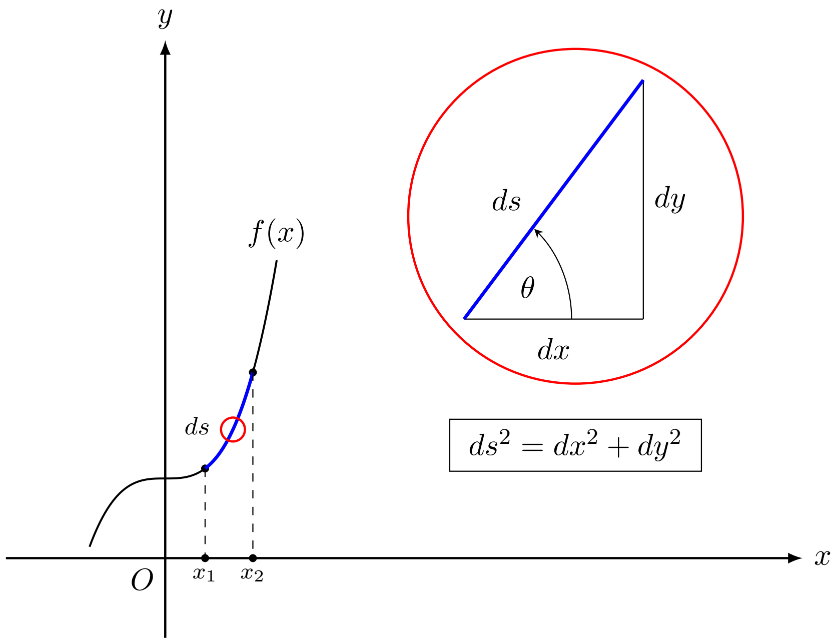


Figure 11: $f(x)$, ds and the Pythagorean Theorem

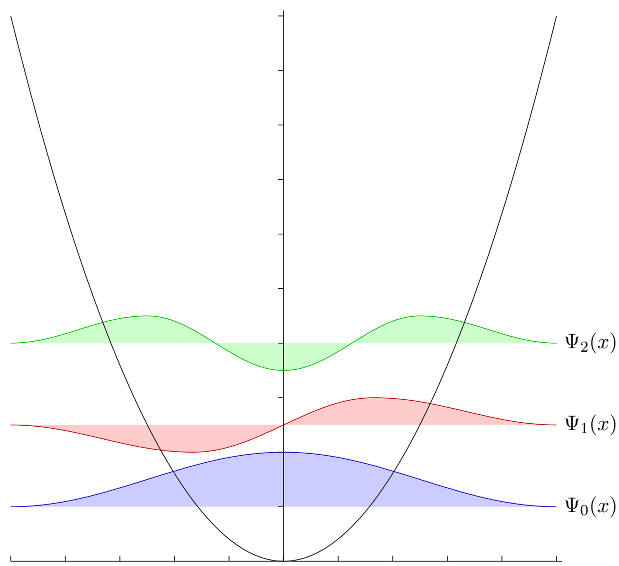


Figure 12: Wave Functions

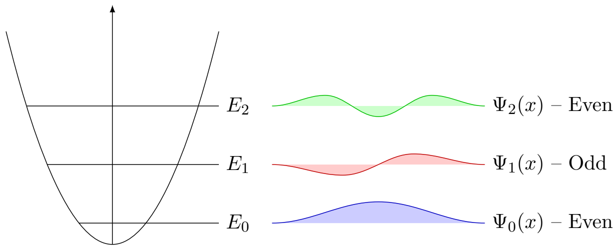


Figure 13: Wave Functions

$$\begin{array}{rcrcrcr}
9^2 & = & 81 & \longrightarrow & 8+1 & = & 9 \\
45^2 & = & 2025 & \longrightarrow & 20+25 & = & 45 \\
703^2 & = & 494209 & \longrightarrow & 494+209 & = & 703 \\
7777^2 & = & 60481729 & \longrightarrow & 6048+1729 & = & 7777 \\
857143^2 & = & 734694122449 & \longrightarrow & 734694+122449 & = & 857143
\end{array}$$

Figure 14: A Few Example Kaprekar Numbers

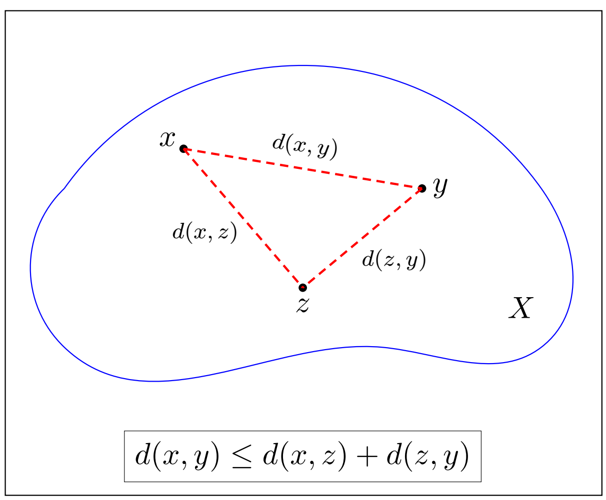


Figure 15: The Triangle Inequality

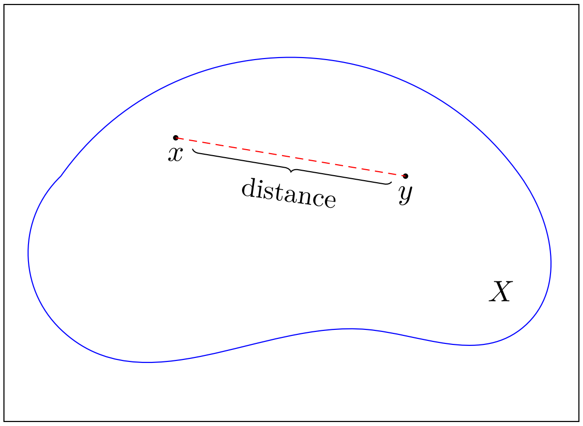


Figure 16: X, x and y

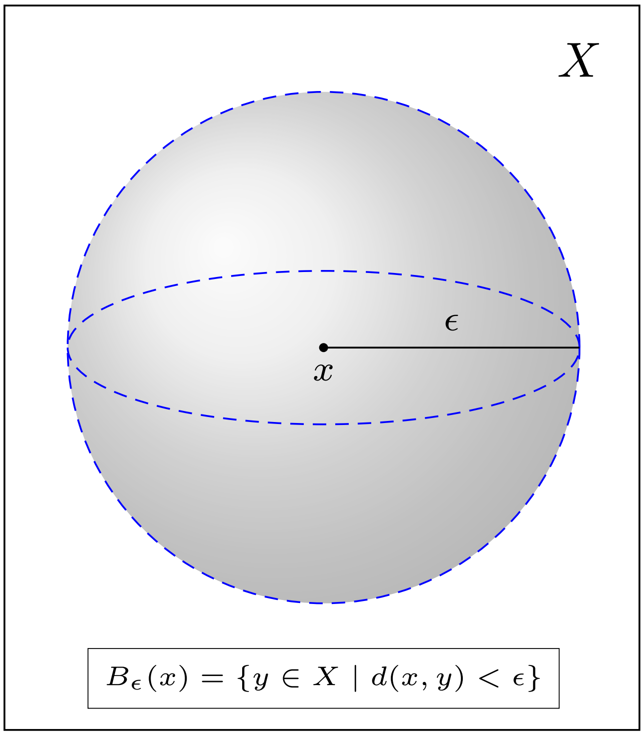


Figure 17: $B_\epsilon(x)$ is an open epsilon ball centered at x with radius ϵ

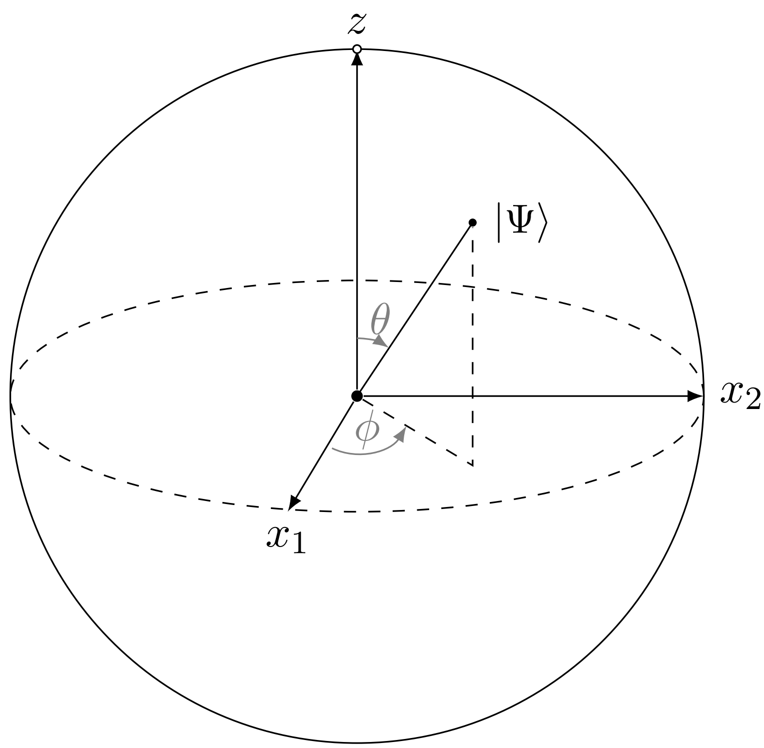


Figure 18: The Bloch Sphere

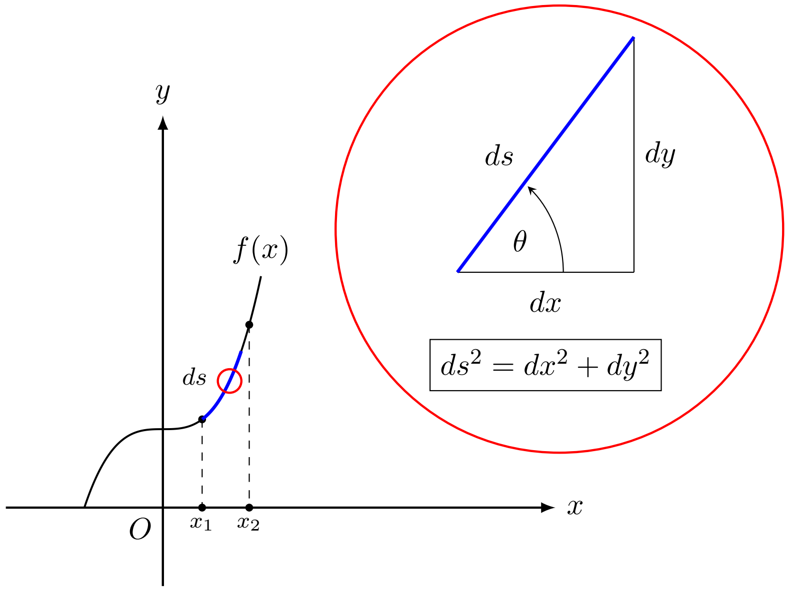


Figure 19: $f(x)$, ds and the Pythagorean Theorem

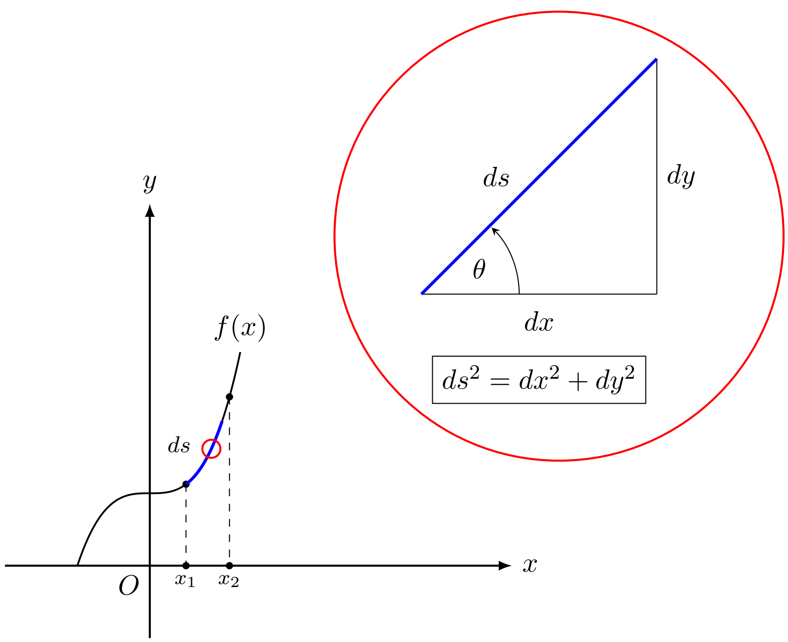


Figure 20: $f(x)$, ds and the Pythagorean Theorem