## antiderivatives

$$
F(x)
$$

$$
\begin{gathered}
F(x) \\
\quad \mid
\end{gathered}
$$

"rate of change" $\frac{\mathrm{d}}{\mathrm{d} x}$

$$
\stackrel{\downarrow}{f(x)}
$$

$$
\begin{gathered}
F(x) \\
\quad \mid
\end{gathered}
$$

"rate of change" $\frac{\mathrm{d}}{\mathrm{d} x}$

$$
\stackrel{\downarrow}{f(x)}
$$

$$
g(x)
$$

$$
\begin{aligned}
& F(x) \quad G(x) \\
& 1 \\
& f(x)
\end{aligned}
$$

"rate of change" $\frac{d}{d x}$

$$
\begin{gathered}
F(x) \\
\hline
\end{gathered}
$$

"rate of change" $\frac{\mathrm{d}}{\mathrm{d} x}$

$f(x)$
$G(x)$

anti-derivative!

$$
\underset{g(x)}{\mid}
$$

## $F(x)$ <br>  <br> $G(x)$ <br> 

"rate of change" $\frac{\mathrm{d}}{\mathrm{d} x}$


$$
f(x)
$$

$\int \mathrm{d} x$ "sum of change over time" $\frac{1}{1}(\underset{C}{l})$
we're going to label the sum-of-change-over-time operator
f
given a function $g(x)$, its anti-derivative or indefinite integral is

$$
\int g(x) \mathrm{d} x
$$


initial value problems
a differential equation is an equation that relates a function to one (or more!) of its derivatives.

$$
\frac{\mathrm{d} y}{\mathrm{~d} x}=f(x)
$$

$$
\frac{\mathrm{d} y}{\mathrm{~d} x}=f(x)
$$

"what function $y(x)$ has $f(x)$ as its derivative?"

$$
\frac{\mathrm{d} y}{\mathrm{~d} x}=y(x)
$$

"what function $y(x)$ has itself as its derivative?"
an initial value problem is a differential equation paired with an initial condition, often written as

$$
y\left(x_{0}\right)=y_{0},
$$

a solution to the initial value problem is a function $y(x)$ where both the differential equation and the initial condition hold true.

