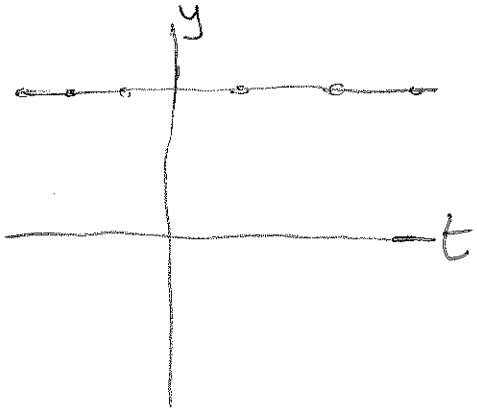
Announcements

- Quiz #5 due Tuesday;
- HW #6 out Today; due Thursday (3.1–3.3)
- Midterm grades ~~grades~~ soon; drop deadline Thurs.

Ex: Warmup: $\frac{d}{dt}\left[42^{\pi} + \frac{e^{6.1}}{\pi^2 + \ln(\pi-1)}\right] = 0$

↑ by constant rule



Ex (from 3.2)

- Pop. of Nevada P, in millions, is $P = 2.02(1.036)^t$ where t is in years since the start of 2000. At what rate is the pop. growing at the start of 2009?

Soln: Rate of pop. growth at the start of 2009 is $P'(9)$.

- $P'(t) = \frac{d}{dt}\left[2.02(1.036)^t\right]$

(const. mult. rule) $= 2.02\frac{d}{dt}\left[(1.036)^t\right]$

$= 2.02\left(\ln(1.036)\cdot(1.036)^t\right)$

$= (2.02)(\ln(1.036))\cdot(1.036)^t$

Recall:
- $\frac{d}{dt}\left[a^t\right] = \ln(a)\cdot a^t$

- WANT: $P'(9) = \left[(2.02)(\ln(1.036))\right](1.036)^9$

$= (0.07144)(1.3748)$

$= 0.0982$ millions people/year

$\Rightarrow$ Pop. of Nevada is growing at a rate of 98,200 people per year at the start of 2009.

Section 3.3

- Chain rule tells us how to differentiate the composition of two functions $f(g(t))$.

- **Chain Rule:** $\frac{d}{dt}\left[f(g(t))\right] = f'(g(t)) \cdot g'(t)$

- If $y = f(z)$ and $z = g(t)$, then

$$\frac{dy}{dt} = \frac{dy}{dz} \cdot \frac{dz}{dt}$$

- **Ex:** $\frac{d}{dt}\left[(2t+1)^6\right]$

Soln: Function: $y = (2t+1)^6$.

- Let $\underbrace{z = 2t+1}_{\text{inner function}}$, so that $\underbrace{y = z^6}_{\text{outer function}}$.

- $\frac{dy}{dt} = \frac{dy}{dz} \cdot \frac{dz}{dt}$

$$= \frac{d}{dz}[z^6] \cdot \frac{d}{dt}[2t+1]$$

$$= (6z^5) \cdot (2)$$

$$= 12z^5$$

Subst. for z = $\boxed{12(2t+1)^5}$

- Ex: $\frac{d}{dt}\left[e^{t^2+t}\right]$

- $z = t^2+t, \quad y = e^z$

- $\frac{d}{dt}\left[e^{t^2+t}\right] = \frac{dy}{dt} = \frac{dy}{dz} \cdot \frac{dz}{dt}$

$$= \frac{d}{dz}[e^z] \cdot \frac{d}{dt}[t^2+t]$$

$$= e^z \cdot (2t+1)$$

$$= \boxed{e^{t^2+t} \cdot (2t+1)}$$

- Ex: $\frac{d}{dt}\left[\sqrt{2+e^t}\right]$

- $z = 2 + e^t$, $y = z^{1/2}$

- $$\frac{dy}{dt} = \frac{dy}{dz} \cdot \frac{dz}{dt} = \frac{d}{dz}\left[z^{1/2}\right] \cdot \frac{d}{dt}\left[2 + e^t\right]$$

$$= \left(\frac{1}{2} z^{-\frac{1}{2}}\right) \cdot \left(\frac{d}{dt}[2] + \frac{d}{dt}[e^t]\right)$$

$$= \left(\frac{1}{2 z^{\frac{1}{2}}}\right) \cdot \left(0 + e^t\right)$$

$$= \frac{1}{2\sqrt{z}}\left(e^t\right)$$

$$= \boxed{\frac{e^t}{2\sqrt{2 + e^t}}}$$