2. EXPONENTIAL: LOG-LINEAR

$$\log(y) = \beta_0 + \beta_1 x + u$$

WHY IS THIS EXPONENTIAL?

RECALL THE EXPONENTIAL GROWTH/DECAY FORMULA:

$$y = \underbrace{a}_{\text{INITIAL AMOUNT}} (1 + \underbrace{r}_{\text{GROWTH RATE}})^{t}$$

t ← # TIME STEPS ELAPSED

TAKE LOGS:

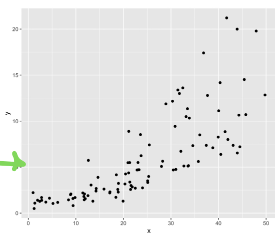
$$\log(y) = \underbrace{\log(a)}_{\beta_0} + \underbrace{t}_{x} \underbrace{\log(1+r)}_{\beta_1}$$

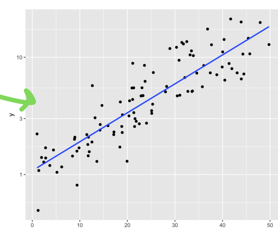
$$\log(y) = \beta_0 + \beta_1 x$$

```r
data_exponential %>%
  ggplot(aes(x = x, y = y)) +
  geom_point()

data_exponential %>%
  ggplot(aes(x = x, y = y)) +
  geom_point() +
  geom_smooth(method = lm, se = F) +
  scale_y_log10()

data_exponential %>%
  lm(log(y) ~ x, data = .) %>%
  broom::tidy()
```





term	estimate	std.error	statistic	p.value
<chr>	<dbl>	<dbl>	<dbl>	<dbl>
(Intercept)	0.0761	0.0855	0.891	3.75e- 1
x	0.0568	0.00315	18.0	6.61e-33

$\hat\beta_0 = .0761$: WHEN $x = 0$, $\log(y)$ IS EXPECTED TO BE .0761

$\hat\beta_1 = \log(1 + \hat r) = .0568$

$\exp(\log(1+\hat r)) = \exp(.0568)$

$1 + \hat r \approx 1.0568$

$\hat r = .0568$: GROWTH RATE

WHEN X INCREASES BY 1 UNIT, Y IS EXPECTED TO INCREASE BY 5.68%.