$$\frac{\bar{Y}_1 - \bar{Y}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \sim T_{\hat{df}}$$

$$\frac{\bar{Y}_1 - \bar{Y}_2 - (\mu_1 - \mu_2)}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim T_{n_1+n_2-2}$$

$$P - value = P(T_{13} \geq 0.8488 | \mu_1 = \mu_2) = 0.2057$$

$$H_0 : \mu_1 - \mu_2 = 0 \iff H_0 : \mu_1 = \mu_2$$

$$H_A : \mu_1 - \mu_2 > 0 \iff H_A : \mu_1 > \mu_2$$

$$t_{obs} = \frac{(1.679 - 1.520) - 0}{\sqrt{\frac{(8-1)0.3743^2 + (7-1)0.3469^2}{8+7-2}\left(\frac{1}{8} + \frac{1}{7}\right)}} = 0.8488$$

$$t_{obs} = \frac{(1.679 - 1.520) - 0}{\sqrt{0.3743^2/8 + 0.3469^2/7}} = 0.8535$$

$$\frac{\bar{V}_1 - \bar{V}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \sim T_{\hat{df}}$$

$$\frac{\bar{V}_1 - \bar{V}_2 - (\mu_1 - \mu_2)}{\sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim T_{n_1+n_2-2}$$

$$SE(\bar{V}_1 - \bar{V}_2) = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} = \sqrt{S_p^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

$$SE(\bar{V}_1 - \bar{V}_2) = \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}$$

$$SD(\bar{V}_1 - \bar{V}_2) = \sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}$$

$$\frac{(\bar{V}_1 - \bar{V}_2) - (\mu_1 - \mu_2)}{\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2}} \sim N(0, 1)$$

$$\bar{V}_1 - \bar{V}_2 \sim N(\mu_1 - \mu_2, \sigma_1^2/n_1 + \sigma_2^2/n_2)$$

$$\bar{V}_1 \sim N(\mu_1, \sigma_1^2/n_1) \qquad \bar{V}_2 \sim N(\mu_2, \sigma_2^2/n_2)$$

$$V_{11} = log_{10}(Y_{11}), V_{12} = log_{10}(Y_{12}), ..., V_{1n_1} = log_{10}(Y_{1n_1})$$

$$V_{21} = log_{10}(Y_{21}), V_{22} = log_{10}(Y_{22}), ..., V_{2n_1} = log_{10}(Y_{2n_2})$$

$$Var\left(\bar{Y}_1 - \bar{Y}_2\right) = \sigma_1^2/n_1 + \sigma_2^2/n_2$$

$$Y_{11}, Y_{12}, ..., Y_{1n_1}$$

$$Y_{21}, Y_{22}, ..., Y_{2n_2}$$

$$P\left(-t_{n-1,\alpha/2} < \frac{\bar{D}-\mu_D}{S_D/\sqrt{n}} < t_{n-1,\alpha/2}\right) = 1-\alpha$$

$$P\left(-t_{n-1,\alpha/2}S_D/\sqrt{n} < \bar{D}-\mu_D < t_{n-1,\alpha/2}S_D/\sqrt{n}\right) = 1-\alpha$$

$$P\left(-\bar{D}-t_{n-1,\alpha/2}S_D/\sqrt{n} < -\mu_D < -\bar{D}+t_{n-1,\alpha/2}S_D/\sqrt{n}\right) = 1-\alpha$$

$$P\left(\bar{D}+t_{n-1,\alpha/2}S_D/\sqrt{n} > \mu_D > \bar{D}-t_{n-1,\alpha/2}S_D/\sqrt{n}\right) = 1-\alpha$$

$$P\left(\bar{D}-t_{n-1,\alpha/2}S_D/\sqrt{n} < \mu_D < \bar{D}+t_{n-1,\alpha/2}S_D/\sqrt{n}\right) = 1-\alpha$$

$$t_{\nu,\alpha} \quad t_{\nu,0.1/2} \qquad -t_{\nu,0.1/2}$$

$$t_{\nu,\alpha} \quad t_{\nu,\alpha/2} \qquad -t_{\nu,\alpha/2}$$

$$\frac{\bar{D}-\mu_D}{S_D/\sqrt{n}} \sim t_{n-1}$$

$$\frac{\hat{p}-p}{\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}} \sim N(0,1)$$

$$-3.52 \pm 1.968(13.60)/\sqrt{300} = (-5.06, -1.97)$$

$$\bar{d} \pm t_{n-1,0.025}s_D/\sqrt{n}$$

$$\bar{D} \pm t_{n-1,\alpha/2}S_D/\sqrt{n}$$

$$\alpha$$

$$\frac{\bar{Y}-\mu}{S/\sqrt{n}} \sim T_{n-1}$$

$$\frac{\bar{Y}-\mu}{S/\sqrt{n}} \sim ?$$

$$Z = \frac{\bar{Y}-\mu}{\sigma/\sqrt{n}} \sim N(0,1)$$

$$T \sim t_\nu \qquad E(T) = \nu \qquad Var(T) = 2\nu$$

$$\mu_1 \qquad \mu_2 \qquad \mu_D$$

$$\bar{Y}_1 - \bar{Y}_2$$

$$E\left(\bar{Y}_1-\bar{Y}_2\right) = E\left(\bar{Y}_1\right) - E\left(\bar{Y}_2\right) = \mu_1 - \mu_2 = \mu_D$$

$$Var\left(\bar{Y}_1-\bar{Y}_2\right) = \sigma_1^2/n + \sigma_2^2/n$$

$$\bar{D} = \frac{1}{n}\sum_{i=1}^{n} D_i = \frac{1}{n}\sum_{i=1}^{n}(Y_{1i}-Y_{2i})$$

$$E\left(\bar{D}\right)=E\left(\frac{1}{n}\sum_{i=1}^{n}(Y_{1i}-Y_{2i})\right)=\frac{1}{n}\sum_{i=1}^{n}\left(E\left(Y_{1i}\right)-E\left(Y_{2i}\right)\right)=\frac{1}{n}\sum_{i=1}^{n}(\mu_1-\mu_2)=\mu_D$$

$$E\left(\bar{Y}_1\right)=E\left(\frac{1}{n}\sum_{i=1}^{n}Y_{1i}\right)=\frac{1}{n}\sum_{i=1}^{n}E(Y_{1i})=\frac{1}{n}\sum_{i=1}^{n}\mu_1=\mu_1$$

$$Var\left(\bar{Y}_1\right)=Var\left(\frac{1}{n}\sum_{i=1}^{n}Y_{1i}\right)=\frac{1}{n^2}Var\left(\sum_{i=1}^{n}Y_{1i}\right)$$

$$=\frac{1}{n^2}\left(\sum_{i=1}^{n}Var(Y_{1i})+\sum_{i\neq j}Cov(Y_{1i},Y_{1j})\right)=\frac{1}{n^2}\sum_{i=1}^{n}\sigma_1^2=\sigma_1^2/n$$

$$Var(aX)=a^2Var(X)$$

$$Var(X-Y)=Var(X)+Var(Y)-2Cov(X,Y)$$

$$Var\left(\bar{Y}_1-\bar{Y}_2\right)=Var\left(\bar{Y}_1\right)+Var\left(\bar{Y}_2\right)$$

$$Var\left(\bar{D}\right)=Var\left(\frac{1}{n}\sum_{i=1}^{n}D_i\right)+\frac{1}{n^2}Var\left(\sum_{i=1}^{n}D_i\right)=\frac{1}{n^2}\sum_{i=1}^{n}Var(D_i)$$

$$=\frac{1}{n}Var(D_1)=\frac{1}{n}Var(Y_{11}-Y_{21})=\frac{1}{n}\left(Var(Y_{11})+Var(Y_{21})-2Cov(Y_{11},Y_{21})\right)$$

$$=\sigma_1^2/n+\sigma_2^2/n-2Cov(Y_{11},Y_{21})/n=\sigma_D^2/n$$

$$Var\left(\bar{D}\right)=\sigma_1^2/n+\sigma_2^2/n-2Cov(Y_{11},Y_{21})$$

$$E\left(\bar{D}\right)=\mu_D$$

$$E\left(\bar{Y}_1-\bar{Y}_2\right)=\mu_D$$

$$Z=\frac{\bar{Y}-\mu}{\sigma/\sqrt{n}}\xrightarrow{d}N(0,1)$$

$$\bar{Y}\sim N(\mu,\sigma^2/n)$$

$$\sigma_D^2$$

$$\bar{D}\sim N(\mu_D,\sigma_D^2/n)$$

$$T=\frac{\bar{D}-\mu_D}{S_D/\sqrt{n}}\sim t_{n-1}$$