Prove that SSTo=SSR+SSE.

L.H.S= $SSTo= \sum\_{i=1}^{n}\left(Y\_{i}-\overbar{Y}\right)^{2}=\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}+\hat{Y\_{i}}-\overbar{Y}\right)^{2}=\sum\_{i=1}^{n}\left(\left(Y\_{i}-\hat{Y\_{i}}\right)+\left(\hat{Y\_{i}}-\overbar{Y}\right)\right)^{2}=\sum\_{i=1}^{n}\left[\left(Y\_{i}-\hat{Y\_{i}}\right)^{2}+\left(\hat{Y\_{i}}-\overbar{Y}\right)^{2}+2\left(Y\_{i}-\hat{Y\_{i}}\right)\left(\hat{Y\_{i}}-\overbar{Y}\right)\right]$

$$=\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)^{2}+\sum\_{i=1}^{n}\left(\hat{Y\_{i}}-\overbar{Y}\right)^{2}+2\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)\left(\hat{Y\_{i}}-\overbar{Y}\right)$$

$$∵\left(Y\_{i}-\hat{Y\_{i}}\right)=e\_{i}$$

$$\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)\left(\hat{Y\_{i}}-\overbar{Y}\right)=\sum\_{i=1}^{n}e\_{i}\left(\hat{Y\_{i}}-\overbar{Y}\right)=\sum\_{i=1}^{n}e\_{i}\hat{Y\_{i}}-\overbar{Y}\sum\_{i=1}^{n}e\_{i}$$

$$∵\sum\_{i=1}^{n}e\_{i}\hat{Y\_{i}}=\sum\_{i=1}^{n}e\_{i}=0$$

Then

$$\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)\left(\hat{Y\_{i}}-\overbar{Y}\right)=0$$

Then

$$SSTo=\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)^{2}+\sum\_{i=1}^{n}\left(\hat{Y\_{i}}-\overbar{Y}\right)^{2}$$

$$\sum\_{i=1}^{n}\left(Y\_{i}-\hat{Y\_{i}}\right)^{2}=SSE \& \sum\_{i=1}^{n}\left(\hat{Y\_{i}}-\overbar{Y}\right)^{2}=SSR$$

$$SSTo=SSR+SSE=L.H.S$$