The number N of locations of a popular coffeehouse chain is given in the table. (The numbers of locations as of October 1 are given.)[1]

Year	2004	2006	2008	2010	2012
N	8569	12,440	16,680	16,858	18,066

(a) *Find the average rate of growth*

(i) *from 2006 to 2008*

(ii) *from 2008 to 2010*

In each case, include the units. What can you conclude?

$$\begin{aligned}\text{AROC}_{2006\to2008} &= \frac{16680-12440}{2008-2006}\\ &= 2120\,\tfrac{\text{locations}}{\text{year}}\end{aligned}$$

$$\begin{aligned}\text{AROC}_{2008\to2010} &= \frac{16858-16680}{2010-2008}\\ &= 89\,\tfrac{\text{locations}}{\text{year}}\end{aligned}$$

The number of locations continues to increase (both AROCs are positive), but the growth was much slower from 2008 to 2010.

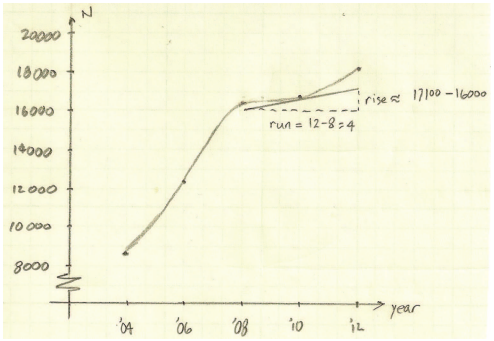
(b) *Estimate the instantaneous rate of growth in 2010 by taking the average of two average rates of change. What are its units?*

$$\begin{aligned}\text{AROC}_{2008\to2010} &= \frac{16858-16680}{2010-2008}\\ &= 89\,\tfrac{\text{locations}}{\text{year}}\end{aligned}$$

$$\begin{aligned}\text{AROC}_{2010\to2012} &= \frac{18066-16858}{2012-2010}\\ &= 604\,\tfrac{\text{locations}}{\text{year}}\end{aligned}$$

$$\text{IROC}_{2010} \approx \frac{89\,\frac{\text{locations}}{\text{year}} + 604\,\frac{\text{locations}}{\text{year}}}{2} = 346.5\,\tfrac{\text{locations}}{\text{year}}$$

(c) *Estimate the instantaneous rate of growth in 2010 by measuring the slope of a tangent.*



From the triangle on the diagram, $N'(10) \approx \frac{17100-16000}{2012-2008} = 275\,\frac{\text{locations}}{\text{year}}$.

[1] Stewart, *Calculus, Early Transcendentals*, p. 150, #48.