House prices vary a great deal. They are influenced by many factors, including the region of the UK where the houses are and the time of year.

This activity introduces moving averages. These can be used to iron out seasonal fluctuations in price in order to look at the yearly trend.

Information sheet A Finding moving averages

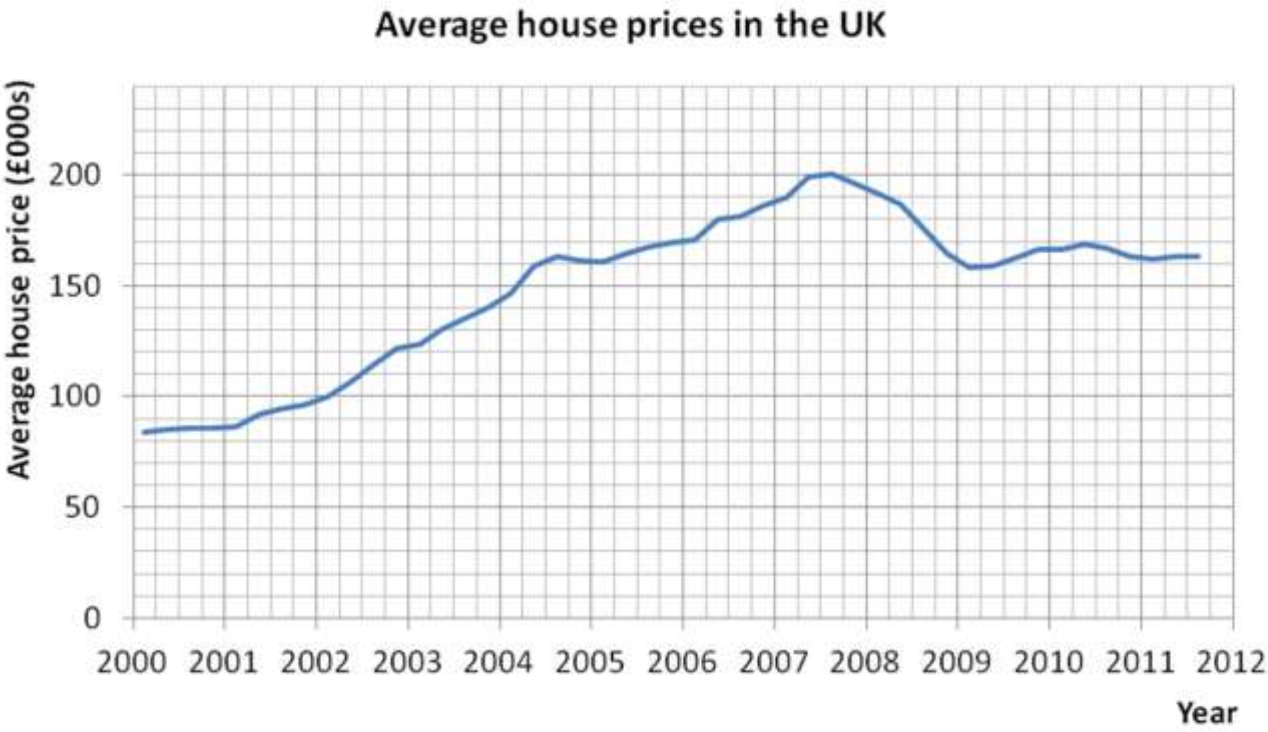
The table and graph below show how average house prices in the UK have changed since 2000.

Q1 represents the first quarter of the year from January to March,
Q2 the second quarter from April to June,
Q3 the third quarter from July to September, and
Q4 the fourth quarter from October to December.

Average house prices in the UK since 2000

Period	Year	Average price (£)
Q1	2000	83 570
Q2	2000	85 162
Q3	2000	85 784
Q4	2000	85 999
Q1	2001	86 192
Q2	2001	91 754
Q3	2001	94 243
Q4	2001	96 076
Q1	2002	100 195
Q2	2002	107 079
Q3	2002	114 040
Q4	2002	121 426
Q1	2003	123 637
Q2	2003	130 545
Q3	2003	135 204
Q4	2003	140 130
Q1	2004	146 465
Q2	2004	158 580
Q3	2004	162 903
Q4	2004	161 288
Q1	2005	160 724
Q2	2005	164 413
Q3	2005	167 808
Q4	2005	169 445

Period	Year	Average price (£)
Q1	2006	170 748
Q2	2006	179 840
Q3	2006	181 278
Q4	2006	186 242
Q1	2007	189 681
Q2	2007	199 021
Q3	2007	200 623
Q4	2007	196 002
Q1	2008	191 852
Q2	2008	186 958
Q3	2008	175 764
Q4	2008	164 225
Q1	2009	158 359
Q2	2009	158 892
Q3	2009	162 689
Q4	2009	166 027
Q1	2010	166 540
Q2	2010	168 876
Q3	2010	166 961
Q4	2010	163 398
Q1	2011	161 666
Q2	2011	162 898
Q3	2011	163 154



Think about …

How have house prices in the UK changed since 2000?

Do the house prices change more in some quarters of the year than in others? What evidence does the table or graph give of this?

How could fluctuations due to seasonal factors be smoothed out?

Seasonally adjusted average house prices

Moving averages can be used to smooth out fluctuations due to seasonal factors. In this case combining the values for 4 quarters gives the moving averages shown below:

$$\overline{x_{2000Q4}} = \frac{85\,999 + 85\,784 + 85\,162 + 83\,570}{4} = £85\,129 \text{ (nearest £)}$$

where the symbol $\overline{x_{2000Q4}}$ means 'the mean of the 4 quarters up to and including the 4th quarter of 2000'. The calculation shows the most recent price first.

$$\overline{x_{2001Q1}} = \frac{86\,192 + 85\,999 + 85\,784 + 85\,162}{4} = £85\,784 \text{ (nearest £)}$$

$$\overline{x_{2001Q2}} = \frac{91\,754 + 86\,192 + 85\,999 + 85\,784}{4} = £87\,432 \text{ (nearest £)}$$

$$\overline{x_{2001Q3}} = \frac{94\,243 + 91\,754 + 86\,192 + 85\,999}{4} = £89\,547$$

$$\overline{x_{2001Q4}} = \frac{96\,076 + 94\,243 + 91\,754 + 86\,192}{4} = £92\,066 \text{ (nearest £)}$$

These have been entered into the table below.

Period	Year	Average price (£)	Moving average (£)
Q1	2000	83 570	
Q2	2000	85 162	
Q3	2000	85 784	
Q4	2000	85 999	85 129
Q1	2001	86 192	85 784
Q2	2001	91 754	87 432
Q3	2001	94 243	89 547
Q4	2001	96 076	92 066
Q1	2002	100 195	
Q2	2002	107 079	
Q3	2002	114 040	
Q4	2002	121 426	
Q1	2003	123 637	
Q2	2003	130 545	
Q3	2003	135 204	
Q4	2003	140 130	
Q1	2004	146 465	
Q2	2004	158 580	
Q3	2004	162 903	
Q4	2004	161 288	
Q1	2005	160 724	
Q2	2005	164 413	
Q3	2005	167 808	
Q4	2005	169 445	

Period	Year	Average price (£)	Moving average (£)
Q1	2006	170 748	
Q2	2006	179 840	
Q3	2006	181 278	
Q4	2006	186 242	
Q1	2007	189 681	
Q2	2007	199 021	
Q3	2007	200 623	
Q4	2007	196 002	
Q1	2008	191 852	
Q2	2008	186 958	
Q3	2008	175 764	
Q4	2008	164 225	
Q1	2009	158 359	
Q2	2009	158 892	
Q3	2009	162 689	
Q4	2009	166 027	
Q1	2010	166 540	
Q2	2010	168 876	
Q3	2010	166 961	
Q4	2010	163 398	
Q1	2011	161 666	
Q2	2011	162 898	
Q3	2011	163 154	

Try this A

Calculate the moving averages for 2002, 2003 and 2004.
Enter the values you find into the table above.

Information sheet B Alternative method for finding moving averages

A moving average can also be found from the previous value as shown for $\overline{x_{2001Q4}}$ below.

$$\overline{x_{2001Q4}} = \overline{x_{2001Q3}} - \frac{85\,999}{4} + \frac{96\,076}{4}$$

= 89 547 – 21 499.75 + 24 019

= 92 066 (nearest £)

So $\overline{x_{2002Q1}} = \overline{x_{2001Q4}} - \frac{86\,192}{4} + \frac{100\,195}{4}$

= 92 066 – 21 548 + 25 048.75

= 95 567 (nearest £)

Check that this value agrees with the value you have entered into the table above.

Try this B

Use the alternative method to calculate the moving averages for 2005, 2006 and 2007. Enter the values you find into the table above.

Complete the table using either of the methods for finding moving averages.

Think about…

Both methods for finding moving averages are given in general terms below.

Which method do you prefer? Why?

Moving averages

For data points p_1, p_2, …
the simple moving average at interval m with n data points is:

$$\overline{x_m} = \frac{p_m + p_{m-1} + p_{m-2} + \dots p_{m-(n-1)}}{n}$$

Alternatively, calculate successive values using

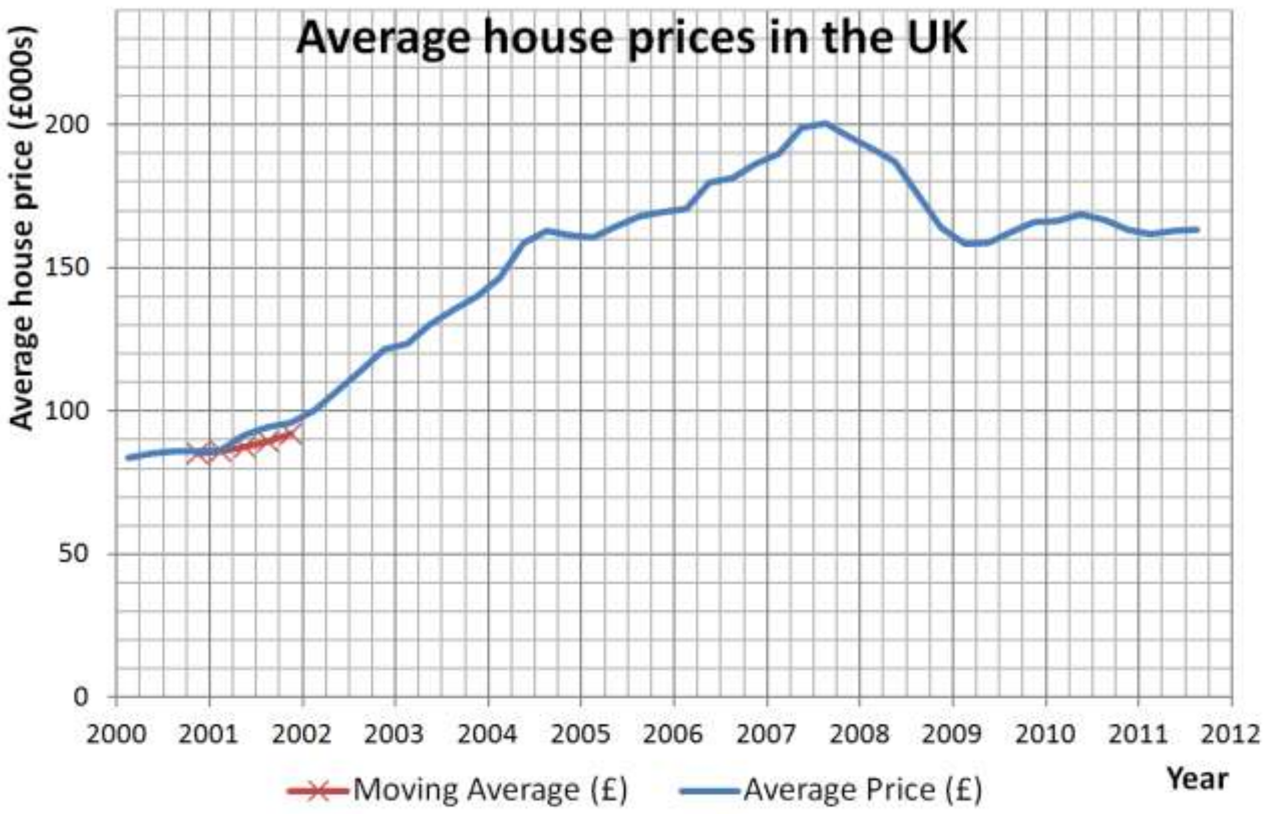
$$\overline{x_{m+1}} = \overline{x_m} - \frac{p_{m-(n-1)}}{n} + \frac{p_{m+1}}{n}$$

Information sheet C Graph showing moving averages

The 2000 and 2001 moving averages have been plotted on the 'House price' graph below.

Try this C

Plot the other moving averages from the table onto the graph and join them with a smooth curve.



Think about…

What effect has using moving averages had on the trend line?

Can you think of a way to adjust the lag which has occurred?

Information sheet D   Weighted moving averages

The problem of lag can be alleviated by using a **weighted** moving average.

Here are calculations for the 2000 and 2001 weighted moving averages for house prices:

$$\overline{x_{2000Q4}} = \frac{4\times 85\,999+3\times 85\,784+2\times 85\,162+83\,570}{4+3+2+1} = \frac{855\,242}{10} = \text{£}85\,524 \text{ (nearest £)}$$

$$\overline{x_{2001Q1}} = \frac{4\times 86\,192+3\times 85\,999+2\times 85\,784+85\,162}{4+3+2+1} = \frac{859\,495}{10} = \text{£}85\,950 \text{ (nearest £)}$$

$$\overline{x_{2001Q2}} = \frac{4\times 91\,754+3\times 86\,192+2\times 85\,999+85\,784}{4+3+2+1} = \frac{883\,374}{10} = \text{£}88\,337 \text{ (nearest £)}$$

$$\overline{x_{2001Q3}} = \frac{4\times 94\,243+3\times 91\,754+2\times 86\,192+85\,999}{4+3+2+1} = \frac{910\,617}{10} = \text{£}91\,062 \text{ (nearest £)}$$

$$\overline{x_{2001Q4}} = \frac{4\times 96\,076+3\times 94\,243+2\times 91\,754+86\,192}{4+3+2+1} = \frac{936\,733}{10} = \text{£}93\,673 \text{ (nearest £)}$$

The method for finding the linear weighted moving average is given in general terms in the box below. Note the formula $\frac{n(n+1)}{2}$ given for finding the sum of values in the denominator.

When n = 4, $\frac{n(n+1)}{2} = \frac{4(4+1)}{2}$ = 10 as used above.

In this example this is no quicker than adding 4, 3, 2 and 1. However, in cases where n is large, the formula $\frac{n(n+1)}{2}$ is much quicker than adding the individual values.

Weighted moving averages

The linear weighted moving average is

$$\overline{x_m} = \frac{np_m + (n-1)p_{m-1} + (n-2)p_{m-2} + \ldots + p_{m-(n-1)}}{n + (n-1) + (n-2) + \ldots + 2 + 1}$$

where the denominator is the triangular number with sum $\frac{n(n+1)}{2}$.

The values calculated above have been entered into the table below.

Period	Year	Average price (£)	Weighted moving average (£)
Q1	2000	83 570	
Q2	2000	85 162	
Q3	2000	85 784	
Q4	2000	85 999	85 524
Q1	2001	86 192	85 950
Q2	2001	91 754	88 337
Q3	2001	94 243	91 062
Q4	2001	96 076	93 673
Q1	2002	100 195	
Q2	2002	107 079	
Q3	2002	114 040	
Q4	2002	121 426	
Q1	2003	123 637	
Q2	2003	130 545	
Q3	2003	135 204	
Q4	2003	140 130	
Q1	2004	146 465	
Q2	2004	158 580	
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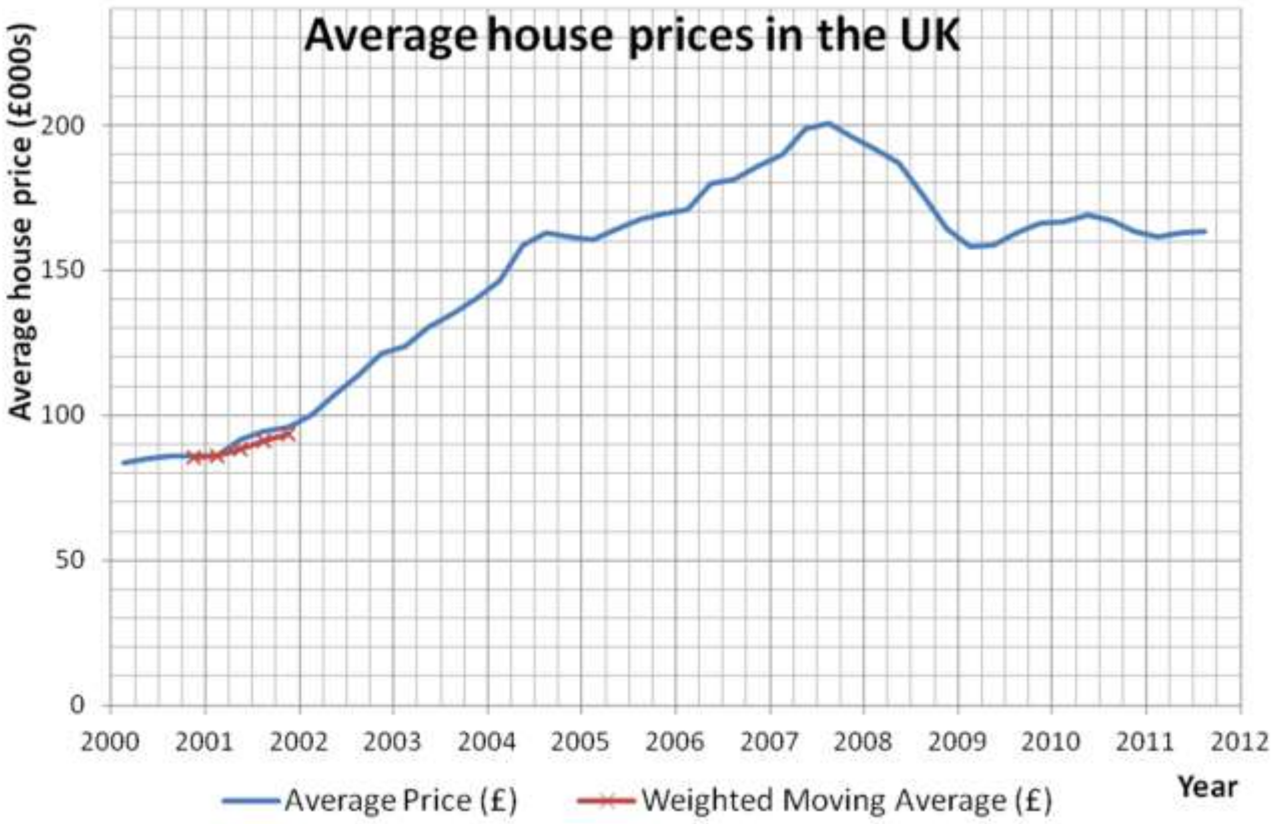
Q3	2008	175 764	
Q4	2008	164 225	
Q1	2009	158 359	
Q2	2009	158 892	
Q3	2009	162 689	
Q4	2009	166 027	
Q1	2010	166 540	
Q2	2010	168 876	
Q3	2010	166 961	
Q4	2010	163 398	
Q1	2011	161 666	
Q2	2011	162 898	
Q3	2011	163 154	

Try this D

Complete the rest of the table.

The graph on the following page shows the weighted moving averages for 2000 and 2001.

Plot the other weighted moving averages from the table onto the graph, and join them with a smooth curve. You should find that the lag is less severe than on the previous graph.



Reflect on your work

- What is a moving average? Why are they used?
- Describe two methods of calculating a moving average.
- Describe how to find a weighted moving average.
- Why does a weighted moving average help to overcome the problem of lag?

Notes on the data

The data are adapted from
The Halifax House Price Index spreadsheet at
http://www.lloydsbankinggroup.com/media1/research/halifax_hpi.asp

This website gives data for years before 2000 which could be used for finding moving averages over longer periods.

Please note that any use of the data for an individual's own or third party commercial purposes is done entirely at the risk of the person or persons making such reliance.