

对一段时间内的预测、实际发货与有效销售进行分析、衡量，从而指导我们未来的预测与计划管理工作。

这个衡量方法实际上就是统计学上的 MAPE (Mean Absolute Percent Error) 法，即平均绝对百分比误差法，如下表所示。

MAPE 法衡量预测数据准确性 (单位: 个)

时间	第1周	第2周	第3周	第4周	第5周	第6周	第7周	第8周	第9周	第10周	第11周	第12周
预测 - F	1200	1500	1600	2000	2300	2200	2500	2300	1500	1500	1000	1000
实际发货 - D	900	1300	1380	1950	2100	1900	1800	2100	1500	1400	950	800
有效销售 - S	660	900	1100	1600	1690	1600	1500	1300	1180	800	880	750
PE - FD = (F - D) / D	33%	15%	16%	3%	10%	16%	39%	10%	0	7%	5%	25%
ABS(PE - FD)	33%	15%	16%	3%	10%	16%	39%	10%	0	7%	5%	25%
PE - DS = (D - S) / S	36%	44%	25%	22%	24%	19%	20%	62%	27%	75%	8%	7%
ABS(PE - DS)	36%	44%	25%	22%	24%	19%	20%	62%	27%	75%	8%	7%
PE - FS = (F - S) / S	82%	67%	45%	25%	36%	38%	67%	77%	27%	88%	14%	33%
ABS(PE - FS)	82%	67%	45%	25%	36%	38%	67%	77%	27%	88%	14%	33%
MAPE - FD	33%	24%	22%	17%	15%	15%	19%	18%	16%	15%	14%	15%
MAPE - DS	36%	40%	35%	32%	30%	29%	27%	32%	31%	35%	33%	31%
MAPE - FS	82%	74%	65%	55%	51%	49%	51%	55%	51%	55%	51%	50%

譬如，我们知道了过去 12 周 (WK1 ~ WK12) 的原始预测情况，我们也统计出了过去 12 周的工厂实际发货情况，我们同时也得到了我们客户在对应时期的有效销售情况，那么根据 MAPE 的定义，我们就很容易算出：

预测对应实际发货的平均绝对百分比误差为：MAPE - FD = 15%；

实际发货对应有效销售的平均绝对百分比误差为：MAPE - DS = 31%；

预测对应有效销售的平均绝对百分比误差为：MAPE - FS = 50%。

相当于我们过去 12 周的预测数据准确性为：

对应工厂实际发货，准确性为 $1 - 15\% = 85\%$ ；

对应有效销售，我们的预测准确性为 $1 - 50\% = 50\%$ ；

实际发货对有效销售的差异率为 31%，相当于客户要货或者客户订单的准确性为 $1 - 31\% = 69\%$ 。

Definition:
MAPE is a measure of prediction accuracy of a forecasting method in statistics for example in trend estimation. It usually expresses accuracy as a percentage, and is defined by the formula:

$$M = \frac{1}{n} \sum_{t=1}^n \left| \frac{A_t - F_t}{A_t} \right|$$

where A_t is the actual value and F_t is the forecast value.

The problem:

对某一个点、周期的预测:

预测第 8 周出货 100 台，实发货 80 台 \Rightarrow 预测误差: $(100 - 80) / 80 = 25\%$
 准确性: $100\% - \text{ABS}(\text{预测误差}) = 75\%$
 100 台, 120 台 \Rightarrow 预测误差: $(100 - 120) / 120 = -17\%$
 准确性: $100\% - \text{ABS}(-17\%) = 83\%$

MAPE - FD (一段时间内预测对应实际发货的平均绝对百分比误差)

Week 1: $\Rightarrow n=1$

$$M = \frac{1}{n} \sum_{t=1}^n \left| \frac{D - F}{D} \right| = \left| \frac{900 - 1200}{900} \right| = \frac{1}{3} \approx 33\%$$

Week 2: $\Rightarrow n=2$

$$M = \frac{1}{n} \sum_{t=1}^n \left| \frac{D - F}{D} \right| = \frac{1}{2} \left(\frac{900 - 1200}{900} + \frac{1300 - 1500}{1300} \right) = \frac{1}{2} \left(\frac{1}{3} + \frac{2}{13} \right) = 24\%$$

准确性为 1 - 31%，为 69%。

知道了我们预测数据的准确性，我们就有可能改进我们的预测处理水平，并可以根据过去的预测数据准确地调整未来的预测与计划。

具体如何处理预测以及如何预测未来的需求，相关的专家们已经给出了很多种方法。这些方法，从大类上讲分为定性处理与定量处理；定量处理又分为时间序列法、回归分析法等。我们下面简单地介绍几种常用的比较简单的预测分析与处理方法，供大家参考。需要注意的是：

- 这些方法在相关的书籍以及相关预测处理软件，如 i2、ForecastPro 中都可以找到。
- 没有任何一种预测处理方法或者计算机软件可以帮你把预测做得非常准确。道理很简单，任何方法或者软件都是基于一种假设：未来要发生的事情与过去已经发生的事情之间是有内在连续性的。也就是说，任何一种预测处理方法都是基于过去已经发生的历史数据来分析预测将来的需求。而这种假设本身的问题就是，将来要发生的需求可能会与过去已经发生的需求之间没有太多的关系。这也是为什么，即使那些已经使用了计算机预测处理软件的企业，他们的预测还有做不准的原因，但这并不是说，你就不需要运用预测处理方法、工具对历史数据进行分析处理了。这些工具如同 ERP 一样，你想用好了，还得靠人的经验。“垃圾进，垃圾出”的道理同样适应于预测处理软件——你收集的数据是不准确的，你的计算机输出就不可能是准确的。

我们先介绍 3 种常用的时间序列法：

第一种方法：平均值法预测。如图 9 - 2 所示：其中， F_{t+1} 为第 $t+1$ 期的预测， S_t 为第 t 期实际销售或者发货，以下同。

这种预测方法简单易懂，适合于需求波动不大的情况。

第二种方法：移动平均值法。

我们知道，平均值法是取过去发生的历史水平的平均值，它主要适应于需求比较平稳的情况。考虑到一个时效性的问题，我们为什么不去采用近期发生的数据来预测未来呢？这样是否可能更接近一些？如图 9 - 3 所示。

公式: $F_{t+1} = \text{average} (S_1: S_t)$

实际发货	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	预测	F18
	20	25	25	26	23	23	28	24	27	24	24	22	23	28	21	23	28		24

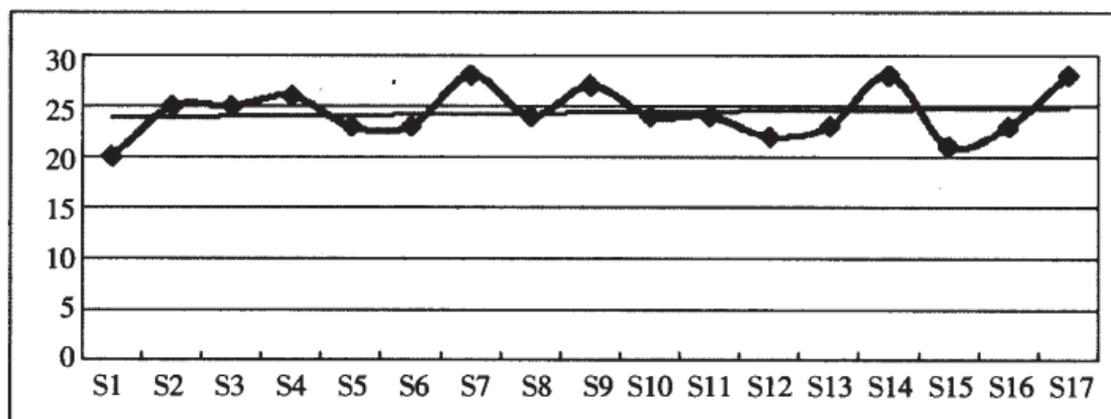


图 9-2 平均值法预测

公式: $F_{t+1} = (S_t + S_{t-1} + S_{t-2} + \dots + S_{t-n+1}) / n$

实际发货	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17
	21	22	26	23	20	26	29	23	22	20	22	19	26	30	17	22	20

$$F_{18} = 21 \quad n = 2$$

$$F_{18} = 20 \quad n = 3$$

$$F_{18} = 22 \quad n = 4$$

$$F_{18} = 23 \quad n = 5$$

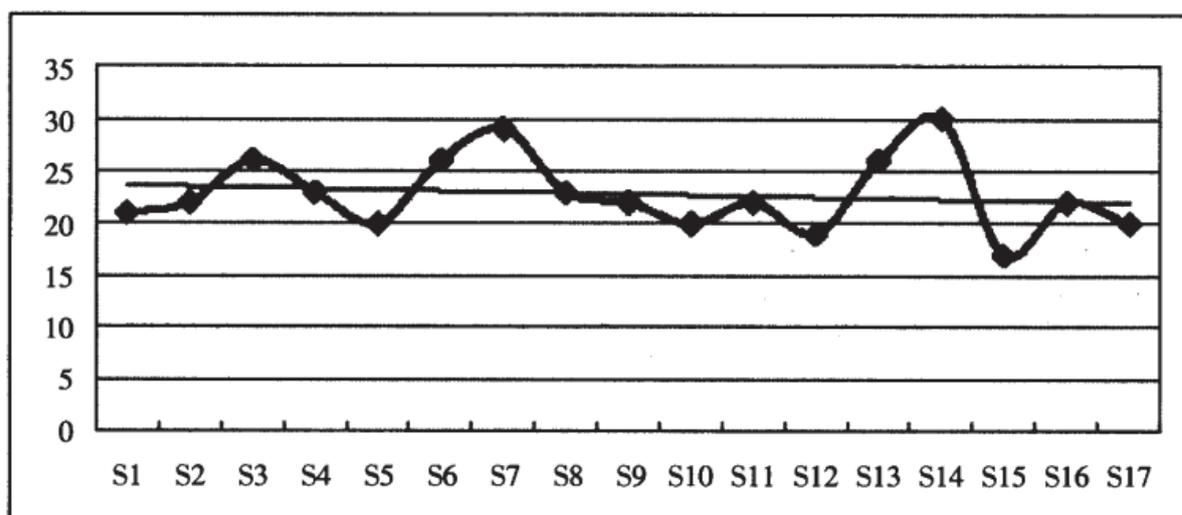


图 9-3 移动平均值法

由图 9-3 可以看出, 取不同的 n 值, 表示不同的“近期”数量, 你得出

的同一期的预测值可能是不一样的。实际工作中，你到底应该取几期的数据完全取决于你的实际发生以及你的经验。

第三种方法：指数平滑法。如图9-4所示。

指数平滑法也称为“指数权重移动平均”技术，其根本原理是下期的预测值是本期的实际销售值与本期的预测值的函数， α 就是我们所需要确定的系数，它是介于0~1之间的一个值；根据公式 $F_{t+1} = \alpha \times S_t + (1 - \alpha) \times F_t$ ， α 越大，说明你赋予本期的实际销售值的权重就越大。我们在图9-4的例子中分别赋予 α 的值为：0.1、0.3、0.5、0.7、0.9，它们得出了不同的预测。

经计算，它们分别对应的MAPE值（不同的预测对应相同的实际发货的平均绝对百分比误差）为：14%、16%、22%、19%、14%。说明，在本例中， α 的值取0.1或者0.9，得出的预测结果可能是比较准确的，因为它们的MAPE值最小。

公式： $F_{t+1} = \alpha \times S_t + (1 - \alpha) \times F_t$

周期	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S	21	22	18	23	22	26	16	15	22	20	22	19	26	17	30	22	20	预测
Fa $\alpha=0.1$	21	21	21	21	21	21	22	21	20	21	21	21	21	21	21	22	22	21
Fb $\alpha=0.3$	21	21	21	20	21	21	23	21	19	20	20	21	20	22	20	23	23	22
Fc $\alpha=0.5$	21	21	22	18	23	22	26	16	15	22	20	22	19	26	17	30	22	20
Fd $\alpha=0.7$	21	21	22	19	22	22	25	19	16	20	20	21	20	24	19	27	23	21
Fe $\alpha=0.9$	21	21	21	21	21	21	21	22	21	21	21	21	21	21	21	21	21	22

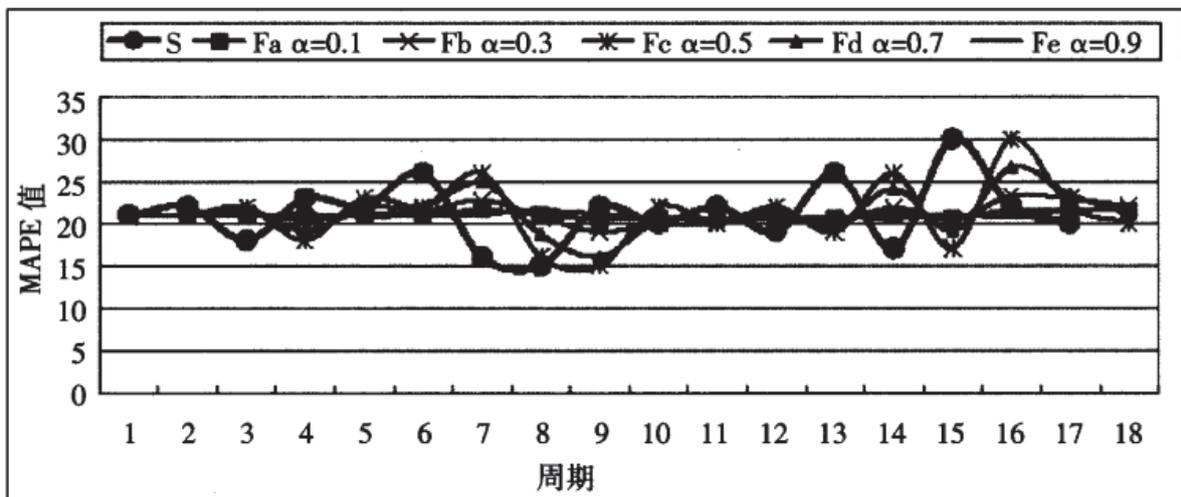


图9-4 指数平滑法

以上三种方法都是时间序列法中最基本也是最简单的预测方法。其实，时间序列法还包括自适应指数平滑法、带有趋势的指数平滑、带有趋势与季节性的指数平滑以及带有趋势与季节性的自适应指数平滑法等方法。但这些方法实际使用起来比较麻烦，手工模拟也是比较复杂的。如果大家感兴趣，可以参考相关书籍；如果你已经使用了相关预测软件，这些方法基本上都可以查到并测试。

下面我们再给大家介绍几种常用的比较简单的回归分析模型，供大家参考。

第一种方法：对线性数据进行简单回归分析。

如图9-5所示，某公司2005年每周的历史销售数据。我们发现这些数据呈现出一个简单的线性规律，于是我们可以：

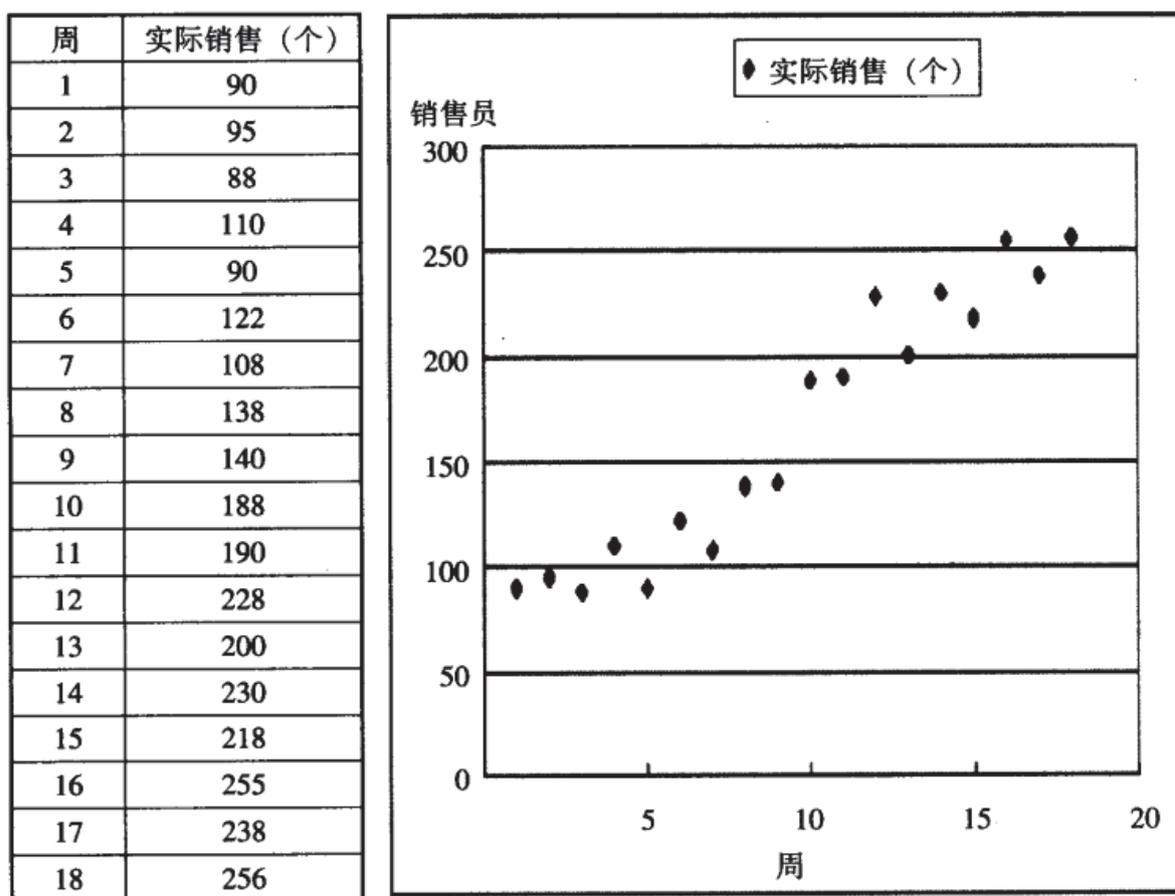


图9-5 某公司历史销售数据

Forecasting using Excel

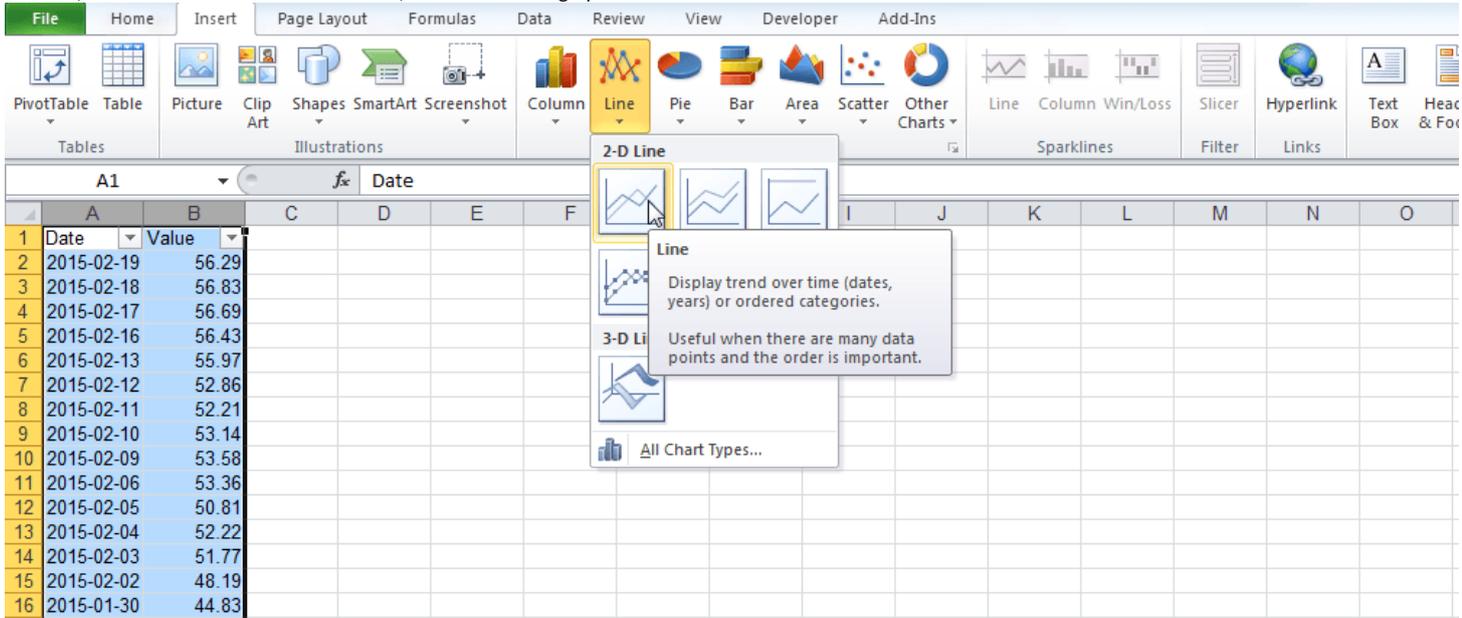
Saturday, December 05, 2015 6:38 PM

Intro to Forecasting

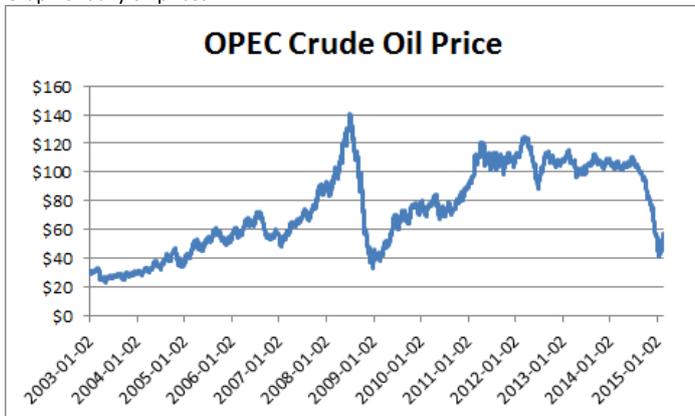
Forecasting can be defined as, "is about predicting the future as accurately as possible, given all of the information available, including historical data and knowledge of any future events that might impact the forecast" [source](#). It should be clear from the definition that forecasting can involve an almost limitless set of skills: for example, a bookie is forecasting when he decides to bet against a team based on based on a hunch he has about a key player's injury. Organizations often forecast based on expert consensus, but statistical techniques can improve accuracy. Excel's data analysis toolpak provides two forecasting techniques - moving averages and simple exponential smoothing. We'll take a look at how these work using some oil price data.

Graphic Oil Price data

Let's look at [crude oil price data](#) available from [Quandl](#), showing the daily price of crude oil since 2003. Highlight the columns, select the "Insert" tab on the ribbon, and create a line graph:



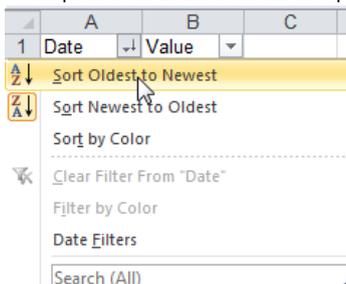
Graph of daily oil prices:



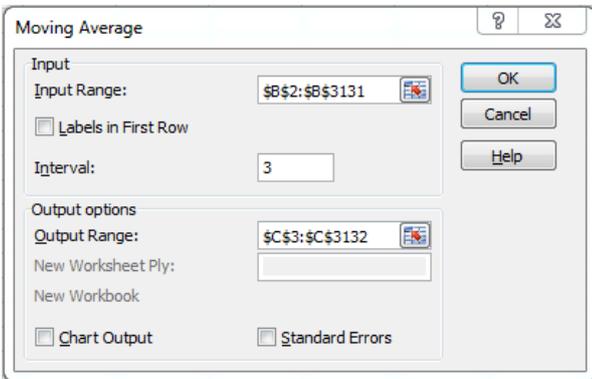
Moving Average

Forecasting with a moving average means we **predict that what is coming next will be the average of the past several measurements**.

To create moving average forecasts, first sort the data from oldest to newest, so that the data starts in 2003 and moves to the present as we move down the spreadsheet:



select the **data tab on the ribbon**, then select **data analysis**. This will bring up a list of analysis tools. Select Moving Average.



Choosing an interval of three means that we predict the oil price for the next day will be the average of the three previous days. The output range is shifted down by one row because we want to use the rows one, two and three to predict the value for row 4. We get the following output:

C5		fx		=AVERAGE(B2:B4)	
	A	B	C	D	E
1	Date	Value			
2	2003-01-02	30.05			
3	2003-01-03	30.83	#N/A		
4	2003-01-06	30.71	#N/A		
5	2003-01-07	29.72	30.53		
6	2003-01-08	28.86	30.42		
7	2003-01-09	29.51	29.763333		
8	2003-01-10	29.82	29.363333		
9	2003-01-13	29.82	29.396667		
10	2003-01-14	30.21	29.716667		
11	2003-01-15	30.66	29.95		
12	2003-01-16	30.87	30.23		

Cell C5, for example, predicts the price of oil on January 7th 2003 will be \$30.53, the average of the prices on the 2nd, 3rd, and 6th.

Evaluating Forecast Accuracy with Mean Average Percent Error (MAPE)

The next question is obvious - **how good is this forecast?** Forecasting errors are often measured using MAPE - mean absolute percentage error. To calculate the MAPE, **first calculate the absolute percentage error for each row.** Use the formulas shown below, dragging down column D:

SUM		fx		=abs(C5-B5)/B5	
	A	B	C	D	E
1	Date	Value			
2	2003-01-02	30.05			
3	2003-01-03	30.83	#N/A		
4	2003-01-06	30.71	#N/A		
5	2003-01-07	29.72	30.53	=abs(C5-B5)/B5	
6	2003-01-08	28.86	30.42		

$$\frac{A_t - F_t}{A_t}$$

Some of our predictions are very accurate, but there are some that are off by more than 18 percent! I found a mean absolute percentage error of 1.64%, though yours will be different since the OPEC data is updated daily.

	A	B	C	D
1	Date	Value	Moving Average Interval = 3	Absolute Percent Error
2	2003-01-02	30.05		
3	2003-01-03	30.83	#N/A	
4	2003-01-06	30.71	#N/A	
5	2003-01-07	29.72	30.53	0.027254374
6	2003-01-08	28.86	30.42	0.054054054
7	2003-01-09	29.51	29.76333333	0.008584661
8	2003-01-10	29.82	29.36333333	0.015314107
9	2003-01-13	29.82	29.39666667	0.014196289
10	2003-01-14	30.21	29.71666667	0.016330134
11	2003-01-15	30.66	29.95	0.023157208

I adjusted the formula to use the average of the six prior values. The MAPE was actually worse - 2.2% rather than 1.6%. Next I tried just using an interval of 1 - in other words, predicting that tomorrow's price will be the same as today. The MAPE for this was 1.1%. So, it turns out the naive assumption that tomorrow will be like today is actually better in this case than a moving average:

H191		fx		=ABS(G191-B191)/B191				
	A	B	C	D	E	F	G	H
	Date	Value	Moving Average Interval = 3	Absolute Percent Error Interval = 3	Moving Average Interval = 6	Absolute Percentage Error Interval = 6	Moving Average Interval = 1	Absolute Percent Error Interval = 1
3124	2015-02-10	53.14	52.58333333	1.0%	51.655	2.8%	53.58	0.8%
3125	2015-02-11	52.21	53.36	2.2%	52.48	0.5%	53.14	1.8%
3126	2015-02-12	52.86	52.97666667	0.2%	52.55333333	0.6%	52.21	1.2%
3127	2015-02-13	55.97	52.73666667	5.8%	52.66	5.9%	52.86	5.6%
3128	2015-02-16	56.43	53.68	4.9%	53.52	5.2%	55.97	0.8%
3129	2015-02-17	56.69	55.08666667	2.8%	54.03166667	4.7%	56.43	0.5%
3130	2015-02-18	56.83	56.36333333	0.8%	54.55	4.0%	56.69	0.2%
3131	2015-02-19	56.29	56.65	0.6%	55.165	2.0%	56.83	1.0%
3132	MAPE:			1.6%		2.3%		1.1%
3133								

3130	2015-02-18	56.83	56.36333333	0.8%	54.55	4.0%	56.69	0.2%
3131	2015-02-19	56.29	56.65	0.6%	55.165	2.0%	56.83	1.0%
3132	MAPE:			1.6%		2.3%		1.1%
3133								

From <http://data-analysis-excel.com/intro-to-forecasting/>

According to the formula of MAPE:

formula:

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{A_t - E_t}{A_t} \right|$$

Thus the MAPE=(SUM(D5:D3335)/(3335-5+1))

Load the Analysis ToolPak

Important This feature isn't available in Office on a Windows RT PC. Want to see what version of Office you're using?

The Analysis ToolPak is a Microsoft Excel add-in program that is available when you install Microsoft Office or Excel. To use it in Excel, however, you need to load it first.

Click the File tab, and then click Options.

Click Add-Ins, and then in the Manage box, select Excel Add-ins.

Click Go.

In the Add-Ins available box, select the Analysis ToolPak check box, and then click OK.

If Analysis ToolPak is not listed in the Add-Ins available box, click Browse to locate it.

If you get prompted that the Analysis ToolPak is not currently installed on your computer, click Yes to install it.

After you load the Analysis ToolPak, the **Data Analysis command is available in the Analysis group on the Data tab.**

Note To include Visual Basic for Application (VBA) functions for the Analysis ToolPak, you load the Analysis ToolPak - VBA add-in the same way that you load the Analysis ToolPak. In the Add-ins available box, select the Analysis ToolPak - VBA check box, and then click OK.

<https://support.office.com/en-us/article/Load-the-Analysis-ToolPak-305c260e-224f-4739-9777-2d86f1a5bd89>

Insert a module in your workbook and paste the following code:

Code:

```
Function MAPE(Original As Range, Revised As Range)
    Dim Divisor As Long
    Dim x As Long
    Dim Change As Double
    Dim TotalChange As Double
    Divisor = Original.Rows.Count
    Change = 0
    TotalChange = 0
    For x = 1 To Divisor
        Change = Abs(((Revised.Cells(x, 1) / Original.Cells(x, 1)) - 1) * 100)
        TotalChange = TotalChange + Change
    Next x
    MAPE = TotalChange / Divisor
End Function
```

Assuming your X data is in cells A1:A3 and your Y data is in cells B1:B3, enter the following formula in any other cell:

=MAPE(A1:A3,B1:B3)

***100 makes the result is in percentage**

From <http://www.mrexcel.com/forum/excel-questions/20193-function-calculate-mape.html>

How to insert a module:

To copy that code, and add it to one of your workbooks, follow these steps:

Copy the sample code that you want to use.

Open the workbook in which you want to add the code.

Hold the Alt key, and press the F11 key, to open the Visual Basic Editor.

Choose Insert. | Module.

Where the cursor is flashing, choose Edit. | Paste.

