

Predicting the Dow Jones Industrial Average Using MLAB

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This paper will show how the MLAB mathematical modeling computer program can be used to estimate the January, 2001, Dow Jones Industrial Average (DJIA).

The Dow Jones Industrial Average is a widely quoted New York Stock Exchange market indicator that has been reported by Dow Jones and Company for more than seventy years. It is computed by adding together the share prices of 30 composite stocks at a given time, and dividing the total by a number known as the *divisor*.

Since March, 1997, the 30 companies comprising the DJIA have included:

AT&T	Eastman Kodak	Merck
Allied Signal	Exxon	3M
Alcoa	General Electric	JP Morgan
American Express	General Motors	Phillip Morris
Boeing	Goodyear	Proctor and Gamble
Caterpillar	Hewlett Packard	Sears
Chevron	IBM	Travelers
Coca Cola	International Paper	Union Carbide
Disney	Johnson & Johnson	United Technologies
DuPont	McDonalds	Wal Mart

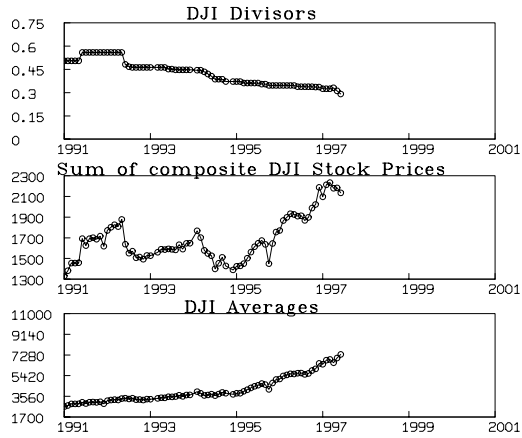
As of February 17, 1998, the divisor was 0.25089315. At this value, a single point change in the net price of the constituent stocks results in roughly a four point change in the DJI Average.

The divisor has not always had this value. The divisor is occasionally modified so that the resulting DJI Average reflects only stock price fluctuations due to trading conditions. When an extraordinary stock price-change event occurs, such as when a constituent company has a stock split or when Dow Jones and Company replaces a constituent corporation with another one, the divisor is recomputed so that the DJI average is unchanged by the event. For example, when McDonald's made a two-for-one stock split on June 30, 1994, the divisor dropped from 0.40625989 to 0.38610730 so that there would be no change in the Dow Jones Industrial Average due to the half-ing of MacDonal'd's stock price; and on March 17, 1997, when Hewlett Packard, Johnson and Johnson, Travelers, and Wal Mart were substituted for Bethlehem Steel, Texaco, Westinghouse, and Woolworth, the divisor was raised from 0.32481605 to 0.33098002 so that there would be no change in the average due to the difference in new and old companies' stock prices.

Assuming dates, divisors, and Dow Jones Industrial averages at the close of trading on the last trading day of each month, from December 1991, to May 1997, are stored in a file called *divisor.dat*, it is straightforward to graph the divisor and DJI Average, and to compute and graph the sum of the composite stock prices over the same period with MLAB. Typing

```
m1 = read("divisor.dat",1000,3)
draw m1 col 1:2 pt circle ptsize .01
top title "DJI Divisors" font 7
frame 0 to 1, .67 to 1
w1 = w
m3 = (m1 col 1) &' ((m1 col 3)*'(m1 col 2))
draw m3 pt circle ptsize .01
top title "Sum of composite DJI Stock Prices" font 7
frame 0 to 1, .33 to .67
w2 = w
draw m1 col (1,3) pt circle ptsize .01
top title "DJI Averages" font 7
frame 0 to 1, 0 to .33
view
```

leads to the following graphs:



The top graph shows that in the last seven years, the divisor has remained the same or declined from month to month, with only two exceptions: when Dow Jones and Company substituted corporations in May, 1991, and, again, in March, 1997. Since the divisor can never be zero, it seems reasonable to extrapolate the divisor data with a best-fitting (in the least-squares sense), exponentially decreasing curve. This is done in MLAB with the following commands:

```
fct df(t) = a*exp(-b*(t-m1[1,1]))
a = 1
b = 1
fit (a,b), df to (m1 col 1:2)
m2 = points(df,1991:2001!100)
draw m2 color green in w1
```

The middle graph, which was obtained by multiplying each divisor in the top graph by the corresponding DJI average in the bottom graph, shows that the sum of composite stock prices has fluctuated over a 1000 point range in the last seven years. Its difficult to say exactly what mathematical function would best predict the sum of DJI composite stock prices, but for the purposes of this paper, we extrapolate the sum of the composite stock prices with a best-fitting (in the least squares sense), straight line. This is done in MLAB with the following commands:

```

fct pf(t) = c*t+d
c = 1; d = 1
fit (c,d), pf to m3
m4 = points(pf,1991:2001!100)
draw m4 color green in w2

```

The slope of the best-fitting line corresponds to an annual growth rate of roughly 4 per cent.

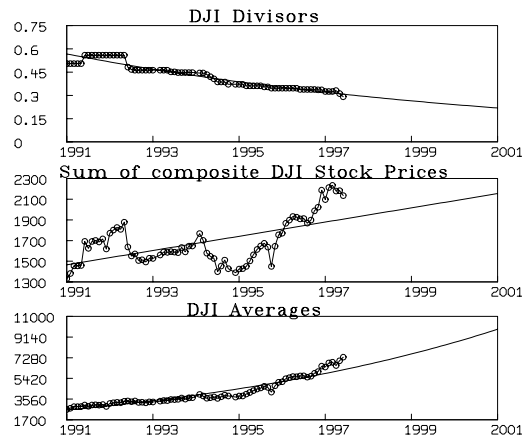
Having extrapolated the divisor and composite stock prices to 2001, it is a simple matter to compute the DJI average with the extrapolated points:

```

m5 = m4 col 1 &' ((m4 col 2) / (m2 col 2))
draw m5 color green in w
view

```

The extrapolated graphs follow:



From this dual linear-exponential model, it appears that the Dow Jones Industrial Average will reach 9844 by January 1, 2001.

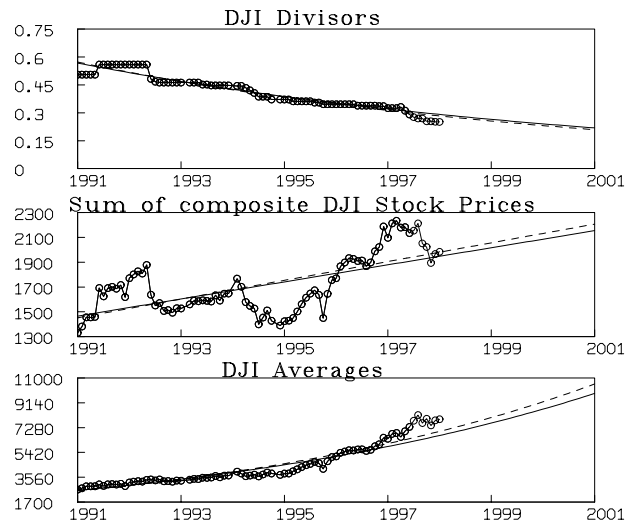
The above estimate was based on the month-end DJI averages and divisors from December 1990 to May 1997. If the month-end Dow Jones Industrial divisors and averages from June 1997 to January 1998 are stored in the file *divisor2.dat*, we can update the projected Dow Jones Industrial Average for January 2001 with the latest data as follows:

```

m8 = read("divisor2.dat",1000,3)
m1 = m1 & m8
draw m1 col 1:2 pt circle ptsize .01 in w1
fit (a,b), df to (m1 col 1:2)
m2 = points(df,1991:2001!100)
draw m2 lt dashed in w1
m3 = (m1 col 1) &' ((m1 col 3)*'(m1 col 2))
draw m3 pt circle ptsize .01 in w2
fit (c,d), pf to m3
m4 = points(pf,1991:2001!100)
draw m4 lt dashed in w2
m5 = m4 col 1 &' ((m4 col 2)/'(m2 col 2))
draw m5 lt dashed
draw m1 col (1,3) pt circle ptsize .01
view

```

In the resulting graphs, the dashed lines represent extrapolations based on the latest data.



Note that by including the seven most recent months of data, we find

10550 as the estimate for the January 2001 DJI Average. This is 706 points higher than the previous estimate.

Long-Term Equity Anticipation Securities (*LEAPS*) for the Dow Jones Industrial average are traded on the Chicago Board Options Exchange and reported in *The Wall Street Journal*. The following table summarizes results of LEAPS trading on February 17, 1998, for options based on the Dow Jones Industrial average expiring in December of 2000.

Option Type	Strike	Last	Open Interest	no loss if DJI average is
Call	7200	2362.5	1063	more than 9562.5
Put	7200	462.5	42021	less than 7662.5
Put	8000	650	15510	less than 8650
Put	8400	800	2084	less than 9200
Put	8800	932.5	3147	less than 9732.5
Put	9800	1232.5	20	less than 11032.5
Call	10000	912.5	186	more than 10912.5
Put	10000	1425	493	less than 11425

Each option represents a prediction of the DJI average on December 31, 2000. Our best current prediction for the end of trading on December 31, 2000, is 10550. According to our prediction, only 3 of the above bets will at least break even.