20041023 Structuring the Second Order EMA

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Introduction

Now that we have a very simple formula to calculate the First Order EMA, this formula can be extended slightly to produce a Second Order EMA (SO_EMA), and with a little bit of fiddling with a few spreadsheets the SO_EMA can be engineered to have about a 2.3% overshoot and a rather smooth (almost linear transition from zero to 100% from a clinical Step excitation. Here are the formulae:

Temp = 1.2 * Today – 0.2 * SO_EMA(1)

SO_EMAInter(0) = (2 * Temp + (P – 1) * SO_EMAInter(1)) / (P + 1)

SO_EMA(0) = (2 * SO_EMAInter(0) + (P – 1) * SO_EMA(1)) / (P + 1)

Note that the period (P) is set to 0.8 the actual periods, so that if you want a 30CEDMA than the period setting is actually 24 and not 30. Again P (Period) does not have to be an integer!

These three above equations give the new intermediate and final values for SO_EMA and use the old ones concurrently, so moving from an EMA to a SO_EMA is no big deal!

For the SO_EMA, because it involves a cascading of results, you will need to store another variable – the old SO_EMA intermediate value.

This intermediate value is generated from the second equation above and used in two places; the next immediate equation, and the next sample after that. That is why it needs to be saved, along with the new SO_EMA value.

Programming Moving Averages

Now more than ever the transient response of the simple EMA needs to be revisited and adjustments made to correct the response.

Clinical tests have shown that in practice the SMA is difficult to set up and calculate, and the EMA is much easier to establish and calculate, far easier to establish and unfortunately has a response curve that is too responsive too early and too inactive much later, the DEMA and TEMA (in my opinion) are both mistakes, and the Triangular (weighted SMA) is difficult to set up but has a good (almost ideal) transient response shape.

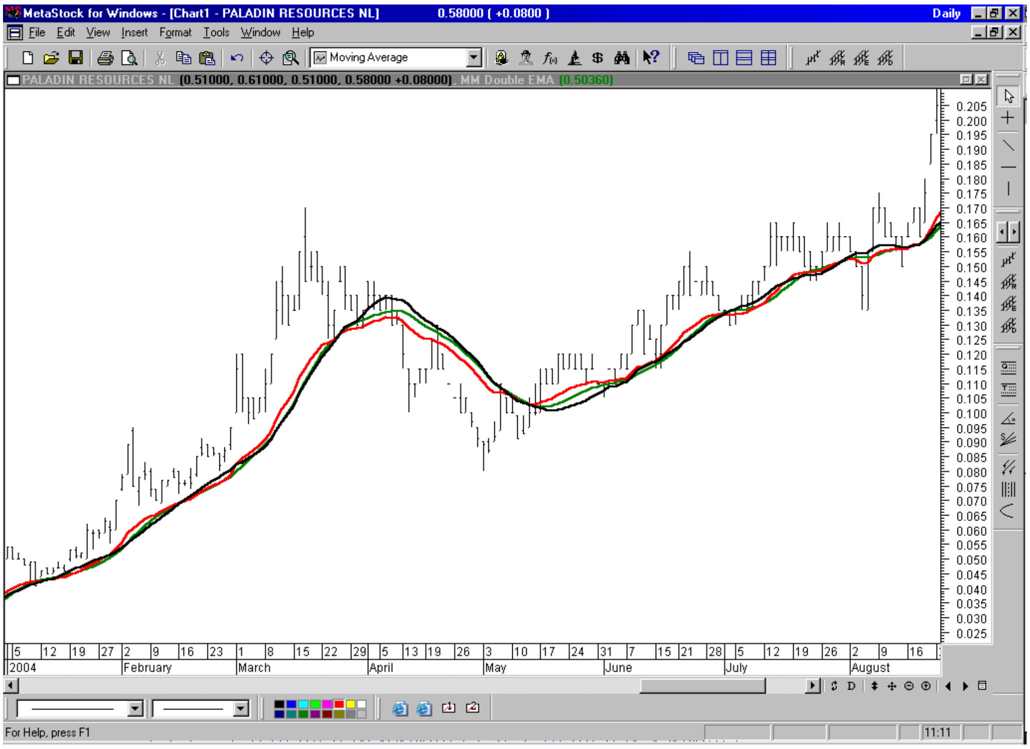
The Cascaded Truncated EMA (CT_EMA) is harder to set up but has an almost ideal response shape, and much better noise reduction than all the rest, and that means that my order of preference for response shape in descending order is SMA, CT_EMA, TSMA, SMA, EMA, DEMA, TEMA.

The ease for setting up for calculations (also in descending order) is EMA, DEMA, TEMA, SMA, TSMA, CT_EMA. In my opinion I consider the uselessness of TEMA and DEMA, and the weighting factors for the TSMA this leaves three moving average schools of thought being SMA, EMA and CT_EMA.

If the CT_EMA is to be realistically considered, as it has the best transient response; then an intermediate term needs to be saved in the database as well as the old CT_EMA value, and all future info bases need to be established with this in mind. So a first Order EMA uses the last value, a Second Order uses the last value and another temporary value, a Third Order EMA would have two temporary values etc

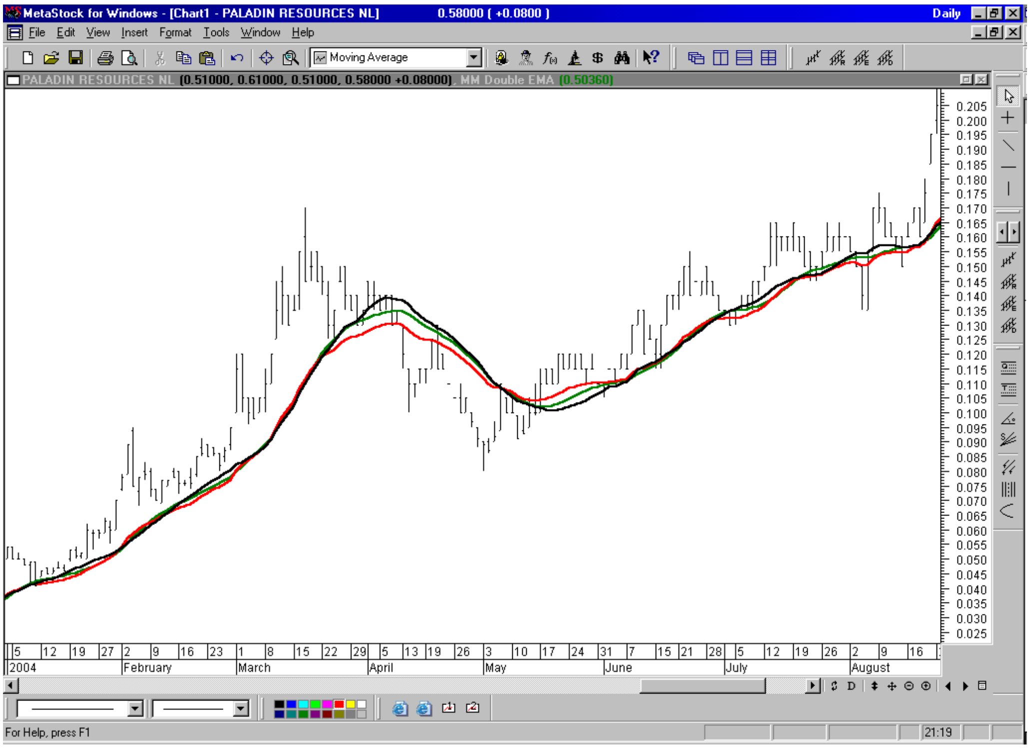
With this changed info base management structure in mind, this now greatly simplifies the calculation process for SO_EMA and the ease in setting up for calculation now becomes (in descending order); EMA, SO_EMA, SMA. Considering that SO_EMA gives a near ideal transient response; then the standard moving average should always be calculated using the SO_EMA.

For consistency, the transient response (with respect to a step input) has to be a virtually straight line from inception to completion and a First Order EMA fails this simple test hands down. A Second Order EMA (or Cascaded EMA) is considerably more consistent, and it is often a lot easier to construct than an SMA, but the Transient Responses need to be correlated to get consistency of purpose.



In practice the Second Order EMA (SO_EMA) works very well in that it is smoother (as expected) than a 1st order moving average. In the graph above, the **SMA20 is (in BLACK)** and peaks highest and tracks the best - and it should as it is consistent from its input. The **EMA20 (in RED)** wriggles about – peaking out lowest as expected as the EMA takes less notice of less recent input data due to its dragging tail.

The **SO_EMA20 (in GREEN)** aligns very closely with the SMA20. This SO_EMA20 recovers in line with the SMA. Meanwhile the EMA looks a little skewed as it rises too fast and comes up on the left hand side of the other two indicating that the EMA time constant (periods) is too short and that the equivalent time constant could be matched with an EMA23 or about 15% slower than it currently is compared to the SMA20. For comparison the EMA20 is changed to an EMA23 and shown on the right hand lower graph.



Here in the graph above, the **EMA23 (in RED)** more closely tracks the **SMA20 (in BLACK)** and the **SO_EMA20 (in GREEN)**, is again very smooth; but the **EMA23 (in RED)** wriggles about, showing that it is more trade noise affected than the **SMA20 (Black)** or the **SO_EMA20 (Green)**. If the **SO_EMA20 (CEMA20) in GREEN** had a slight overshoot in its time response, then not only would it be 'quieter' but it would also have a sharper transient response.

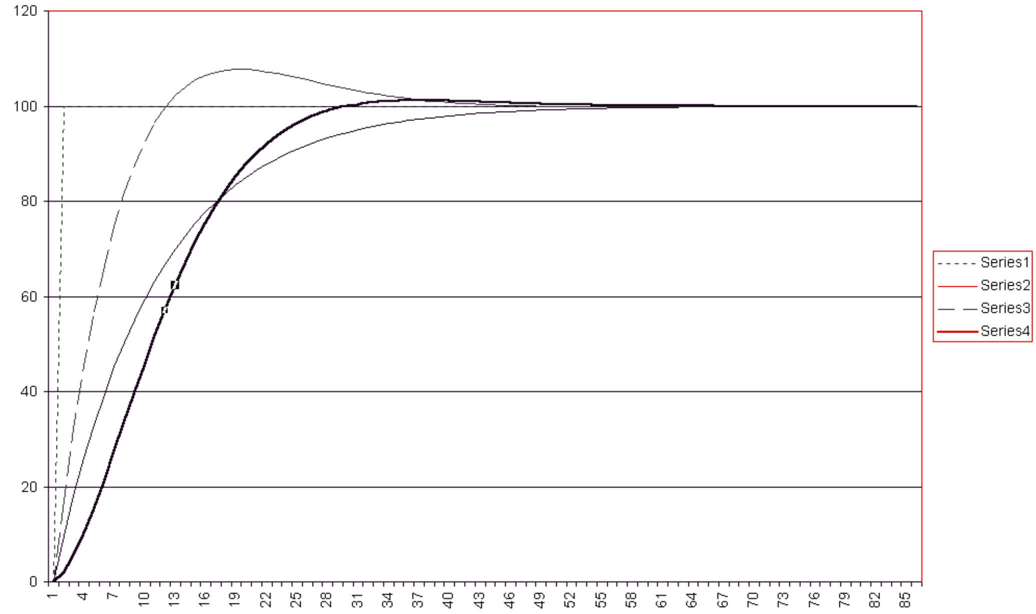
By applying some feedback to the overall filter and lengthening the time constants, the filter takes on a new dimension with a steeper transition and a very slight overshoot about 1% – but nothing like that of the DEMA or worse still the TEMA.

In this case, the MetaStock equation was

Mov(Mov(1.5*CLOSE - 0.5* PREV,16.5,E),16.5,E);

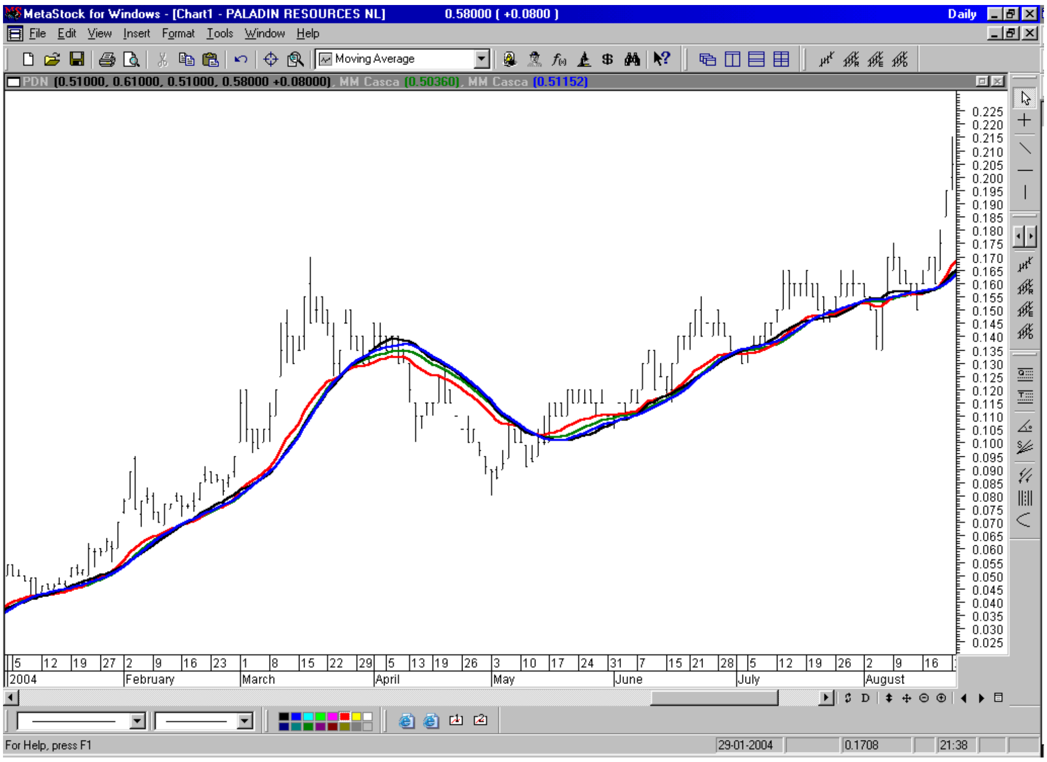
This results in an overall crossover at about the 16th step in a 20 EMA consideration.

The overall rise time of this second order filter with feedback is substantially faster and more symmetrical than a cascaded first order filters EMA without feedback.



By marginally increasing the overshoot to about 2.3% by altering the feedback constant and changing the exponential constants to 18.2 to re-align the curve with the standard crossover at 80%, this response then even looks better.

The dark line in the above graph shows the transient output response from a step input with about 2.3% overshoot, and the graph below shows the smooth, rounded and substantially quiet **SO_EMA20 (Royal Blue)** with feedback.



The SO_EMA20 with a little overshoot very closely tracks the SMA and the slight overshoot lets the transient track better than the critical transient with nominally no overshoot.

This SO_EMA with its characteristic slight delay in ‘kicking in’, and has a small overshoot that gives it a smoother peak and following trough, and, unlike the SMA, it lends itself to weighting on the fly by adjusting the time constants.

In MetaStock terms the equation for a cascaded EMA looking like a SMA 20 is:

Mov(Mov(1.7*CLOSE - 0.7* PREV,18.2,E),18.2,E);

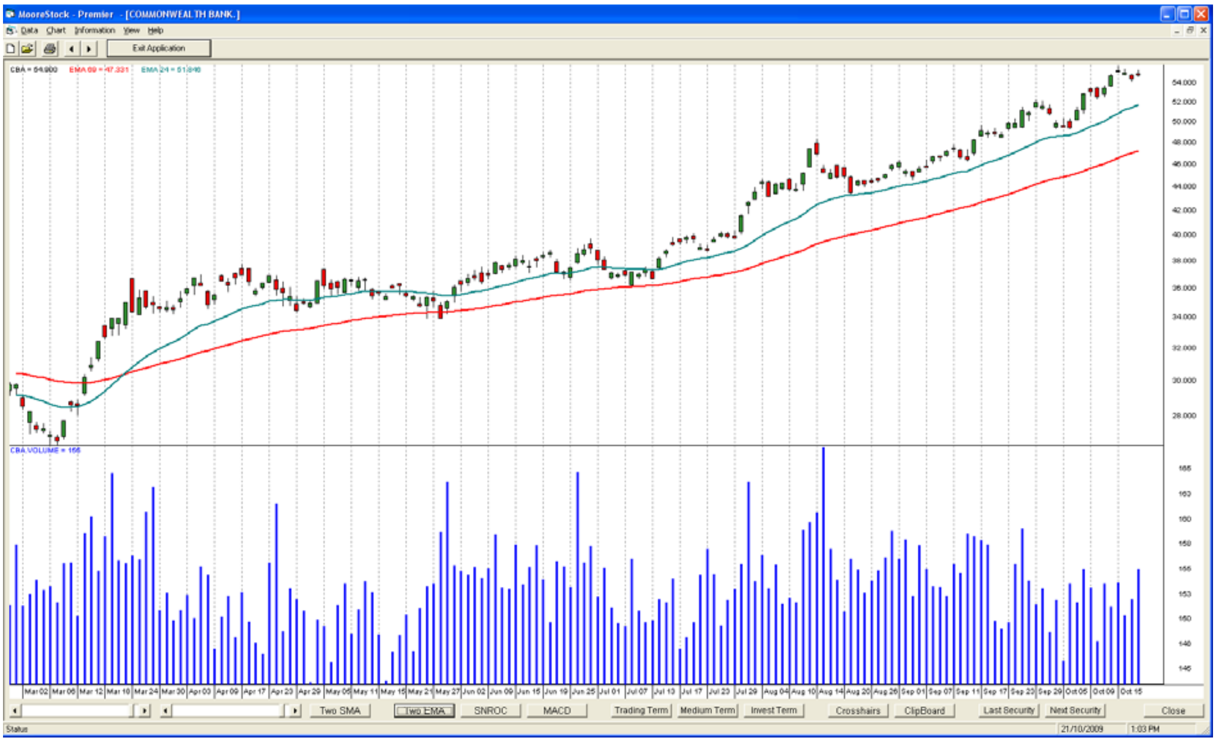
Of course this will not work as MetaStock requires integers as periods, but with a little lateral thinking and normalising this cannot be too difficult to make into a practical filter.

The other issue is that the tail should be a damped oscillation and it is not, indicating that the structure of this is not quite right, but is much better than an EMA for attenuating EOD noise.

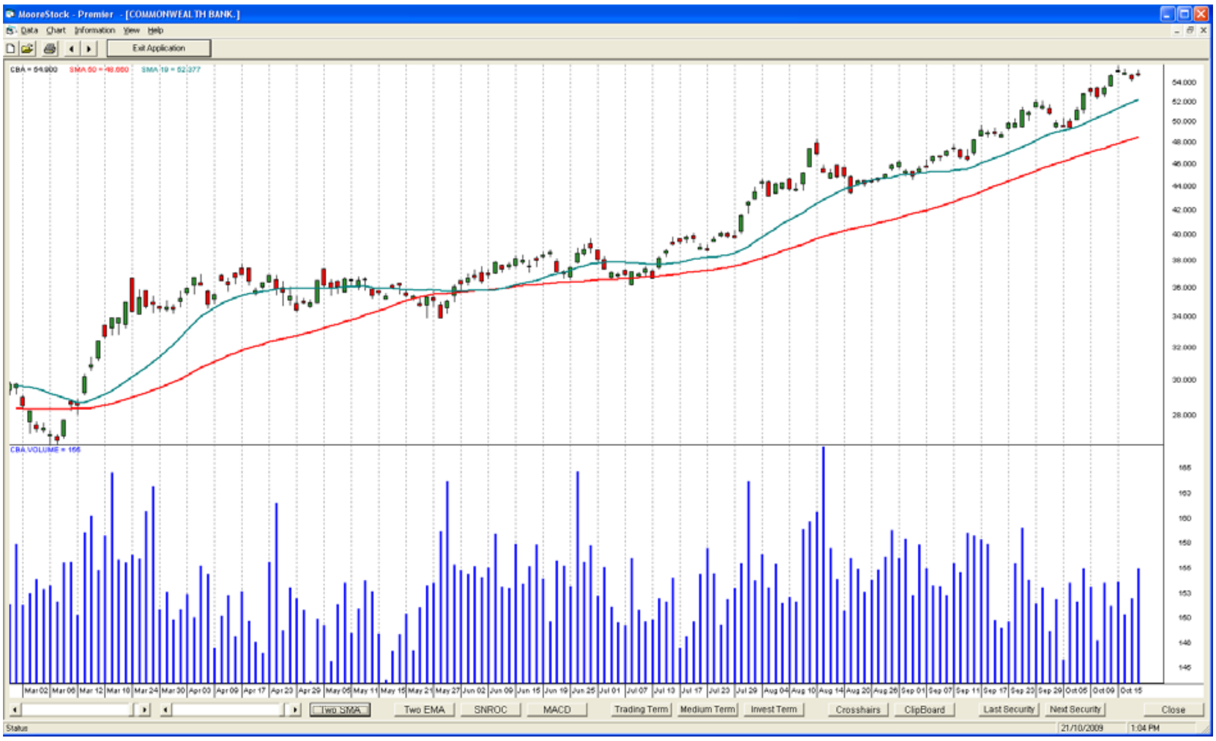
Comparing Simple and Exponential Moving Averages (2009)

Now that we have realised that it is the transient that is all important when we use moving averages to smooth the trade noise, and that the (first order) EMA has a very different step excited transient shape than the SMA, and that the periodicity for (first order) EMAs is not in alignment with SMAs because if the thick heavy tail in the (first order) EMAs.

To get a handle on this, the two graphs below have the same EOD data over the same time, but the two sets of moving averages spell a very different tune:



This is the old favourite Two EMA, and see how after the initial rise the EMAs cross and stay that way, so you would be thinking to stay in the trade, but have a look below and realise that the two SMAs below have virtually the same transient response, and no great big thick trailing tail that actually compromises the ability for the moving average to follow the trend:



Here is the same graph with a two SMA of equivalent transient response following the same EOD data over the same period. Notice that the Green SMA actually follows the price, and yes the two moving averages do collide (and momentarily cross) while the security price has plateaued, but picks up again and kicks in much like the two EMA before. The EMA trace actually does kick in faster, but this is usually swamped by earlier movement so the end result is that the EMA does not in reality kick in faster, and the exponential tail makes the (first order) EMA a very poor cousin to the SMA.

It may not be obvious, but if you are using (first order) EMAs as the indicator smoothing tool (like in an MACD), then by using EMAs there is an inherent problem as the resultant trigger will be far more compromised by an (first order) EMA than an SMA, and guess what; the Technical Analysts en-masse use EMAs in their MACDs, so systematically this indicator (and many others) will also be somewhat flawed!

Comments and Corrections are welcome