Forecasting Childcare Enrolment

John Telford
University of Melbourne

Background
The aim of this study was to develop and test methods of forecasting the enrolments in a childcare facility. The facility consists of four classes, determined by the age of the child enrolled; Nursery, Toddler, Kinder 1 and Kinder 2.
Children enrolled in the facility do not change classes during the year. Children returning from the year before go into the next class up (children can stay in Kinder2 for two years). This system means that the enrolments in a class next year are affected by the enrolment in the class below this year.
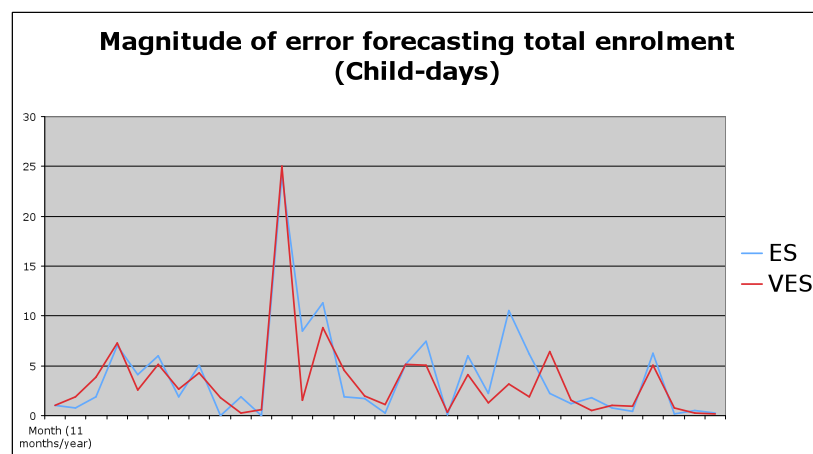Enrolment in the centre is recorded by days of the week for each month. The measure used for quantifying enrolment is total weekly enrolment in the class.

Exponential Smoothing
For the first method of forecasting, an Exponential Smoother (ES) was fitted to enrolment in each class. This gave us a baseline for forecasting, as ES is a relatively quick and easy method, treating enrolment in each class as independent.

Extending on the ES method, we next fitted a Vector Exponential Smoother (VES) to the enrolment in the four classes.
It was believed that the VES method, in which enrolment in different classes are allowed to influence each other, would have an advantage in picking up the migration of children from one class to the one above, from one year to the next.

Magnitude of error forecasting total enrolment (Child-days)

Postal Address: 111 Barry Street
c/- The University of Melbourne
Victoria 3010 Australia

Email: enquiries@amsi.org.au
Phone: +61 3 8344 1777
Fax: +61 3 9349 4106
Web: www.amsi.org.au

The graph above compares the size of the error in forecasting the total weekly enrolment for the centre (all four classes) with the ES method and the VES method. The results for VES are slightly better, so we conclude that there is something to be gained by including the interaction between enrolments in the different classes. The advantage is not great, but this is unsurprising, as the classes should only affect each other from one year to the next, not throughout the enrolment year.

Markov Model
The final forecasting technique examined uses a Markov model.
The model treats the classes as independent Markov birth-death processes throughout the enrolment year, and then for each class, the enrolment for the start of the next year is based on the sum of:
- A Binomial RV representing children from the lower class migrating up, each with independent probability ρ (can be different for the different classes)
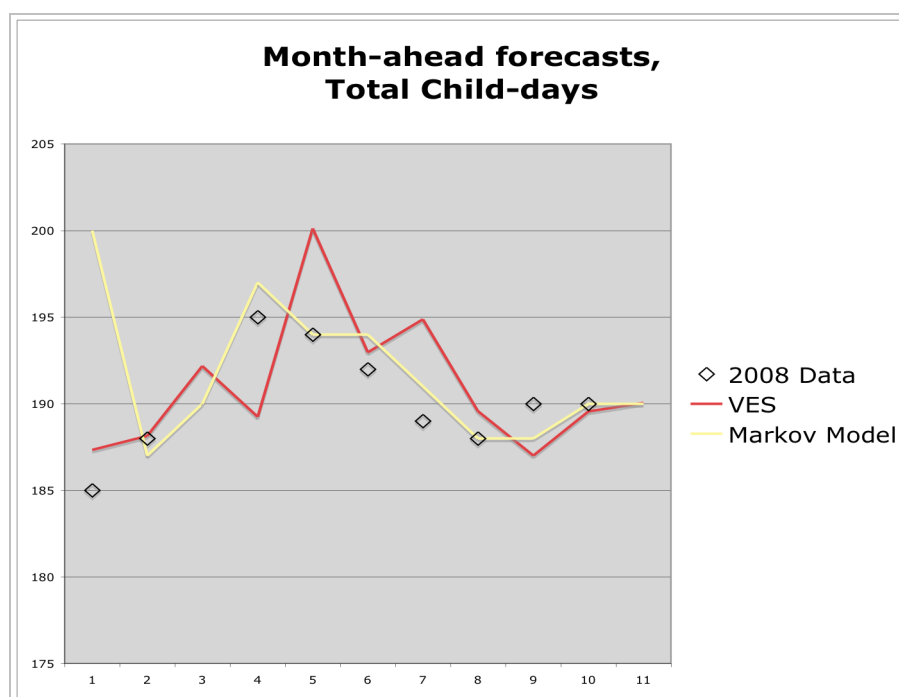- A Poisson RV (parameter λ, again, can vary between classes) representing the arrival of new children

The Nursery class has only the Poisson RV, as there is no lower class to move up from, and the Kinder 2 class has another Binomial RV (with a different probability) for children remaining in the class, as children can stay two years in Kinder 2.

Comparing Forecasts
All methods of forecasting where fitted using 4 years of data, 2004-2007, and then comparisons where made on their ability to forecast enrolment for 2008.

Comparisons were made between the models' forecasts for the entire year ahead, as well forecasts made one month ahead, based on current enrolment.
The graph below shows the results for forecasting the total weekly enrolment for the centre (all four classes). As can be seen, the Markov Model outperforms the VES method, except for the forecast for the first month.

Postal Address: 111 Barry Street
c/- The University of Melbourne
Victoria 3010 Australia

Email: enquiries@amsi.org.au
Phone: +61 3 8344 1777
Fax: +61 3 9349 4106
Web: www.amsi.org.au

I would like to thank the University of Melbourne and AMSI for their generous support in making this project possible; it has been a wonderfully interesting and fulfilling summer. I would also like to thank CSIRO for hosting the Big Day In conference at Macquarie University. Lastly I would like to thank my supervisor, Dr Owen Jones for all his insight and guidance throughout the project.

John received an AMSI Vacation Scholarship in December 2010 See: www.amsi.org.au/vs10.php