Forecasting Workshop: Intermittent Demand Forecasting

Software and Freeware for Intermittent Demand

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Research over the last years has developed multiple methods and innovations in intermittent/slow moving items forecasting. A **key barrier** to using these in practice is their **availability in mainstream software**.

In this presentation we will present some of the available options and potential solutions. We will look at two sides of the question:

- **Examples** of available commercial software;
- A *free* (GPL) toolbox for intermittent demand for R.

This is not a complete list and the purpose of this presentation is not to provide one, but rather to illustrate some of the options and issues to consider.
## Agenda

1. Commercial software
2. Non-commercial software
3. Demo
We will look at three aspects:

1. Availability of methods/models and transparency of implementation

2. Automation in terms of forecasting method selection and setup

3. Support for exploration and analysis of intermittent time series
Typically intermittent demand forecasting methods are included in demand planning and specialised forecasting software. We will look at the following examples:

- SAP: Advanced Planning and Optimisation (APO)
- ForecastPro (TRAC edition)
- SAS Forecast Server

A notable mention is *Smart Software: Intermittent Demand Planning and Service Parts Forecasting*, which is focused at using a bootstrapping based forecasting approach.
SAP APO offers limited intermittent demand forecasting. It offers a single method: **Croston’s method** (original):

- Fixed model initialisation (maybe rather problematic)
- Manual selection of (a single) method parameter
- Two ways to get a forecast out of the method: *constant* and *sporadic*

Sporadic takes the last interval and demand estimates and assumes some deterministic behaviour thereafter. Do not use!

Constant is the standard Croston’s forecast
SAP APO offers limited exploration and time series analysis facilities. This is true for the intermittent demand case.

SAP APO offers some model selection between continuous demand forecasting methods and Croston’s. Time series that have 66% or more of their history zero demand periods are assigned to Croston’s. This threshold can be adjusted, but SAP APO does not offer any analytics tools to help decide an appropriate threshold.

The details of the implementation are documented online:

ForecastPro is a dedicated forecasting software with limited demand planning support. It offers two options based on Croston’s method:

- Original Croston’s method
- Modification of Croston’s as suggested by Willemain et al. (assumes log-normal distribution of order sizes instead of normal)

ForecastPro always uses Willemain et al. modification, unless there are negative values in the history, when it reverts to Croston’s original.
ForecastPro automatically decides when to use Croston’s method over continuous demand methods/models. The choice rule is unknown.

The user can manually override the method selection → but there are no exploration tools to support the choice.

Method parameters are chosen automatically (unknown methodology). Demand size and intervals have separate smoothing parameters, giving more flexibility to the model in accordance to current research. No option for manual parameters.
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Intermittent Demand Software
Commercial: ForecastPro
SAS Forecast Server stands in the middle of pure forecasting software and demand planning/inventory management software. It does offer some support for intermittent time series forecasting.

Two methods are implemented:

- Croston’s method type
- Average demand forecast

SAS has implemented Croston’s time series decomposition, but within its suite there is no restriction to the model used to predict either demand intervals or size.
Although this raises the flexibility of the method it raises questions of model/parameter selection, thus complicating the model setup and automation.

SAS Forecast Server does not offer additional tools to explore the intermittent time series further to help decide on methods and parameter choice.

It is perhaps useful to keep in mind that SAS permits easily to code new functions and as such the current capabilities can be substantially extended in-house.
Some common themes for the various commercial software:

- Mostly focus on Croston’s method, typically ignore developments on bias, obsolesce corrections and lack of independence between demand events and demand size.
- Offer very limited tools to explore and understand intermittent data.
- Opaque parameter selection
- Nonetheless implemented within a forecasting system (hierarchies, adjustments, etc).

In no way an exhaustive list!
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The lack of thorough and standardised implementations of intermittent demand methods is not exclusive to commercial software. This has lead to develop a freely available and open source (GPL ≥2) intermittent demand package for R.

The motivation in developing this was to have a standardised implementation of methods, following current research findings, that is transparent and open source for others to use and build on.

The package is freely available at either CRAN R repository or my research blog

http://cran.r-project.org/web/packages/tsintermittent/index.html
Exploration and method selection

Conventional plots:
- Time series plots
- Histograms of demand

Intermittent demand specific plots:
- Non-zero demand size and interval plot (classification of demand)

Classification of demand into: erratic, lumpy, intermittent and smooth.

This classification has been beneficial for method selection, between Croston’s original method and the bias-corrected SBA.
Exploration and method selection

Multiple classification have been proposed, with an objective of method selection:

- **SBC classification**
  
  Syntetos et al., 2005

- **KHa classification**
  
  Kostenko and Hyndman, 2006

- **PKa classification**
  
  Petropoulos and Kourentzes, 2014

These model selection schemes have lead to improvements in forecasting performance.
Exploration and method selection

... but also permit a more detailed understanding of the intermittent items in the assortment:

![PK classification diagram](image)

- **High demand variance, low intermittence SKU.**
- **High intermittence, low variance SKU.**
Forecasting Methods

tsintermittent package offers a variety of methods (which is expanded over time):

- Croston’s and variants:
  - Croston’s original method
  - SBA and SBJ modifications
  - Croston decomposition based moving averages (with bias correction)
- TSB method for obsolescence
- Temporal aggregation methodologies:
  - Aggregate-Disaggregate Intermittent Demand Approach (ADIDA)
  - Intermittent Multiple Aggregation Prediction Algorithm (iMAPA)
- Single exponential smoothing
Forecasting Methods

Croston’s method options:
- Manual or automatic parameter selection based on latest research
- Single or independent smoothing parameters for demand size and intervals
- Modifications (SBA, SBJ)

Similar Croston based moving average and TSB method options.
Forecasting Methods

Single exponential smoothing:
  • Intermittent demand series consistent automatic parameter selection

Conventional parameter optimisation

Intermittent series specific optimisation
Forecasting Methods

Temporal aggregation methods: model the intermittent time series at larger time buckets to reduce intermittency:

- ADIDA
- iMAPA
Intermittent Demand Software

tsintermittent: Overview

• Free open source package for intermittent demand time series analysis and forecasting.

• Updated with latest research and continuously expanding list of methods and tools.

• Not implemented within a demand planning system, but several options to incorporate R modules in existing IT infrastructure.

Useful links:


• Online package demo: https://kourentzes.shinyapps.io/shinyIntermittent/
Intermittent Demand Software
Demonstration of tsintermittent

Simulated Time Series Setup
- Observations
- Demand level
- Inter-demand interval
- Demand CV squared

Model Setup
- Croston
  - Optimise
  - Select cost function
- MAR

Forecast

Info
Based on the tsintermittent package for R. Details about the optimisation of the methods can be found here

https://kourentzes.shinyapps.io/shinyIntermittent/
Thank you for your attention!
Questions?

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