



JDemetra+:
From version 2 to version 3 how has the software evolved ?

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Presentation Outline

- JDemetra+ software overview
- Seasonal Adjustment algorithms
- New acceptable data frequencies
- Time series tools
- Enhanced SA production capabilities

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JDemetra+ software overview

JDemetra+ is an open source software for time series analysis developed in the framework of Eurostat's "Centre of Excellence on Statistical Methods and Tools (TSACE)" by the National Bank of Belgium with the support of the Bundesbank and Insee.

It provides algorithms for:

- Seasonal Adjustment
- Trend estimation
- Benchmarking and temporal disaggregation
- Nowcasting
- Business Cycle Estimation
- Revision analysis

These algorithms (implemented in Java) can be accessed with a graphical user-interface (GUI) and/or directly in R (packages).

Expansion from version 2 to version 3

Why a version 3 in the first place ?

- re-engineering
- adding seasonal adjustment high frequency (infra-monthly) data

Once started, the new version developed in several directions:

- Additional Algorithms for SA, Benchmarking, Nowcasting. . .
- More stand alone time series tools
- More “acceptable” frequencies in SA
- New SA (mass) production possibilities

Consequence: Expanded R ecosystem and Graphical user Interface

Goal of this presentation: give an overview of these evolutions, focusing on the SA domain

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Seasonal Adjustment Algorithms in JDemetra+

| Algorithm | Version 2.x | | Version 3.x | |
|-------------|---------------|-------------|---------------|----------------|
| | Access in GUI | Access in R | Access in GUI | Access in R |
| X-13 Arima | yes | RJDemetra | yes | rjd3x13 |
| Tramo-Seats | yes | RJDemetra | yes | rjd3tramoseats |
| X12plus | | | yes | rjd3x11plus |
| STL | | | yes | rjd3stl |
| BSM | | | yes | rjd3sts |
| SEATS+ | | | upcoming | upcoming |

(Packages names and perimeters are still provisional)

Two categories of algorithms :

- historical core (main): X-13-Arima and Tramo-Seats (improved)
- version 3 additional algorithms

Improvements on historical algorithms

Improvements X-13-Arima and Tramo-Seats (historical JD+)

- outlier correction taken into account when selecting decomposition scheme
- ex-ante leap year correction added to Tramo-Seats (like in X13)
- automatic trading day regressors selection from pre-defined sets built according to groups of days
- specification: split into two distinct concepts, which can be directly manipulated by the user:
 - reference (or domain) specification: a global set of constraints inside of which estimation will be performed
 - point (or estimation) specification: contains all parameter choices resulting from estimation

The user can transform a given “estimation specification” in a user defined specification

Additional algorithms

Tramo-Seats and X-13-Arima share a very similar and sophisticated pre-adjustment process for the Arima model selection phase.

For additional algorithms, the new philosophy is to offer

- a simplified pre-adjustment on the arima modelling side, reduced to airline model
- several enhanced decomposition options
 - stl+ (“+” stands for airline based pre-adjustment)
 - x12+: airline based pre-adjustment + new trend estimation filters (Local Polynomials)
 - seats+ (to come in the target v3 version): airline based pre-adjustment + AMB decomposition

SA with Basic Structural Models (BSM) (1/3)

In version 3.x, SA with Basic Structural Models is a fully integrated process with outlier detection, calendar correction and options on external regressors.

Fundamentally it is a one-step estimation, performing pre-adjustment and decomposition (with explicit components) in the same run

This makes regression variable selection more complicated:

- first step: a variable selection is performed with a Tramo like airline model regression
- second: the entire structural model is estimated

SA with Basic Structural Models (BSM) (2/3)

BSM output view in GUI

StsDoc-1 x

RF0812 (frozen) Spec: BSM

Input

Main results

- Charts
 - Sa, trend
 - Cal, sea., irr.
- Table
- S-I ratio

Pre-processing

- Regressors
- Arima
- Pre-adjustment series

Residuals

Model

- Selection**
- Sts components

Loglikelihood = -1146,591991
 Standard error of the regression (ML estimate) = NaN
 AIC = 2293,183983
 AICC = 2293,183983
 BIC (corrected for length) = 0,000000

Basic structural model

| Component | Variance | Q-Ratio |
|-----------|----------|---------|
| Level | 2.5217 | 0.1590 |
| Slope | 0.0000 | 0.0000 |
| Seasonal | 0.0070 | 0.0004 |
| Noise | 15.8583 | 1.0000 |

Regression model

| | Coefficients | T-Stat | P[T > t] |
|------|--------------|--------|------------|
| week | 1,1964 | 14,66 | 0,0000 |

Easter

| | Coefficients | T-Stat | P[T > t] |
|------------|--------------|--------|------------|
| Easter [6] | -4,1398 | -3,31 | 0,0010 |

Outliers

SA with Basic Structural Models (BSM) (3/3)

BSM specification box

| | | |
|---|----------------|-------------------|
| > | SERIES | |
| > | TRANSFORM | |
| ∨ | ESTIMATE | |
| > | Model span | All |
| | Tolerance | 0,0000001 |
| > | REGRESSION | |
| > | OUTLIERS | |
| ∨ | BSM | |
| | Level | Free |
| | Slope | Free |
| | Cycle | Unused |
| | Noise | Free |
| | Seasonal model | HarrisonStevens ∨ |
| | | Fixed |
| | | Dummy |
| | | Crude |
| | | HarrisonStevens |
| | | Trigonometric |

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New acceptable data frequencies

Low frequency data: p in 2, 3, 4, 6, 12 is admissible in all algorithms (main and additional)

In version 2, only Tramo-Seats supported all these frequencies, whereas X13-Arima was restricted to p in 2, 4, 12

High-Frequency (infra-monthly) data can display data **multiple** and **non integer** periodicities. It requires tailoring above mentioned classical algorithms (with or without rounding the periodicities e.g $p = 365, 25$)

JDemetra + algorithms have extensions for high-frequency data (for methodological details see the paper linked at the end of the presentation)

SA algorithms extended for high-frequency data

All algorithms are available via an R package and will be available in GUI (in target v 3.x version)

- Extended Airline estimation, reg-Arima like (rjd3highfreq and GUI)
- Extended Airline Decomposition, Seats like (rjd3highfreq and GUI)
- MX12+ (rjd3x11plus, GUI upcoming)
- MSTL+ (rjd3st1 and in GUI)
- MSTS (rjd3sts, GUI upcoming)

Data frequencies and seasonal patterns

In the Graphical User Interface (display constraints)

Input data: daily, weekly

Seasonal patterns: weekly ($p = 7$) or yearly ($p = 365.25$ or $p = 52.18$)

In corresponding R packages:

- no constraint on data input as no TS structure (numeric vector)
- any seasonal patterns, positive numbers

Graphical user interface for High-Frequency data

High quality (zoom-able) plot and specification box (same layout as for low frequency data)

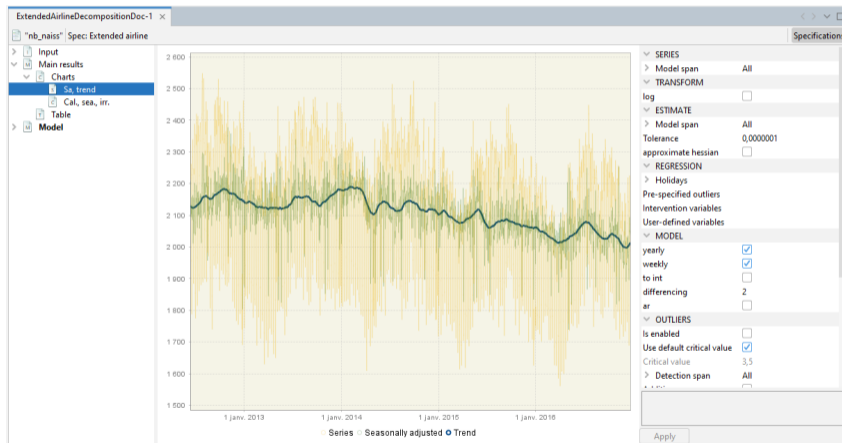


Figure 1: Raw, SA and trend

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Time series general purpose tools

Version 3.x offers more stand alone tools (mainly in `rjd3toolkit`)

- Tests (seasonality, auto-correlation, normality, randomness. . .)
- (Fast) Arima Modelling
- Flexible Calendar regressors generation
- Auxiliary variables for pre-adjustment
- Spectral analysis (in GUI)
- Detection of multiple seasonal patterns (Canova-Hansen test)
- State space frame work as a toolbox (`rjd3sts`)

Canova-Hansen test to identify multiple seasonal patterns

```
rjd3toolkit::seasonality_canovahansen(data = df_daily$births,  
  p0 = min(ch.sp), p1 = max(ch.sp), np = max(ch.sp) - min(ch.sp) + 1)
```

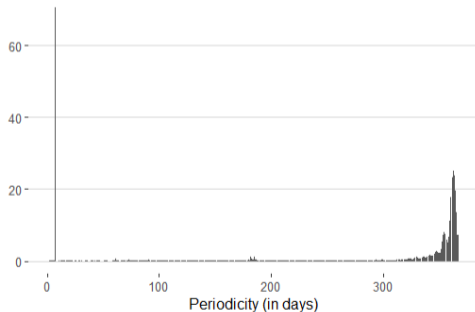


Figure 2: Canova Hansen seasonality test

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(Mass) SA production set-up in v 2.x

Setting up a workspace: specific JD+ data structure (raw data, parameters, diagnostics) allowing to generate results (sa series)

- estimation can be done by a production module (the cruncher) in a fully automatic way
- data can be refreshed applying a selected revision policy (constrained estimation)
- readable by the GUI (manual fine-tuning of selected series)

This widely used set-up had shortcomings:

- portability (cumbersome to change path to raw data)
- defining series by series specifications on a massive scale (for example a customized set of pre-specified outliers for the covid crisis period)

Improvements in v 3.x (1/2)

New R Tools for wrangling workspaces, with functions for

- changing raw data path
- customizing specifications
- merging workspaces by series names, as you would do with a data table

These functions are in `rjd3providers` and `rjdemetra3` packages, (already in a v 2.x stable precursor `rjdworkspace`)

Improvements in v 3.x (2/2)

Production fully in R, without a workspace structure

- TS objects and full flexibility for customizing specifications
- new R functions enabling to apply revision policies (`rjd3x13::refresh` and `rjd3tramoseats::refresh`), with even more flexibility on data spans

Inherent shortcoming: data no readable by GUI, depriving of more sophisticated and visual feedback (compared to R) for manual fine tuning.

Solution : new R functions to create GUI readable dynamic workspaces on the fly (in aforementioned packages).

In the target 3.x, additional algorithms (X12+, STL+, STS) will also be usable in production with a workspace and cruncher (on low frequency data)

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Conclusion

Over the recent years JDemetra+ scope in Seasonal Adjustment has expanded significantly.

Further methodological research is needed on automatic filter selection (X-11, STL).

Further developments are underway:

- Moving Trading Days module integrated in all SA algorithms (for low and high frequency data), with two implementations one based on rolling windows and one on state space modelling
- Using Cubic Splines for smoother seasonal factors estimation of long periodicities ($p = 365, 25$)

THANK YOU FOR YOUR ATTENTION

Useful Links

To get the Software:

- R Packages giving access to JDemetra+ v3.x: <https://github.com/rjdemetra>
- Graphical User Interface version 3.x: <https://github.com/jdemetra>

Methodological tweaks on algorithms for High-Frequency data:

- Towards Seasonal Adjustment of Infra-Monthly Time Series with JDemetra+, Webel and Smyk (2023), [Bundesbank Discussion Paper](#)

Documentation and news:

- Online documentation: <https://jdemetra-new-documentation.netlify.app/>
- Blog: <https://jdemetra-universe-blog.netlify.app/>
- YouTube channel (Tutorials, Webinars)
<https://www.youtube.com/@TSwithJDemetraandR>