Learning and Discussing Seasonal Adjustment with R

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Disclaimer

This report is released to inform interested parties of research and to encourage discussion. The views expressed on statistical issues are those of the author and not necessarily those of the U.S. Census Bureau.

The problem. . .

When using X-13ARIMA-SEATS it can be cumbersome to

- explore different spec options
- have in-depth discussions electronically
- teach new users (let them explore without program failing)
- try/research new methods

A solution...

- Mix the computing ability of X-13ARIMA-SEATS with a scripting language, like R, that can easily store output.

Part 1 of talk: seasonal R package.

- Links X-13ARIMA-SEATS and R.
- same syntax as X-13ARIMA-SEATS .spc files
- easily store output to R variables

Part 2 of talk: x13story, R package.

- Have interactive stories which allow users to see output from X-13ARIMA-SEATS.
- Make creating websites, pdf reports and teaching applications easy
- allow users to send a single files back and forth for e-discussion

Part 1: The *seasonal* package.

Outline:

- How to get it?
- How to set it up?
- Running X-13ARIMA-SEATS within R
- Why is this an improvement?
- What have we done with it?

Introduction

- *seasonal* is an R-interface to X-13ARIMA-SEATS
- Created by Christoph Sax formerly of Switzerland's State Secretariat for Economic Affairs
- X-13ARIMA-SEATS binaries are installed along with the *seasonal* R package

How to get it?

- The *seasonal* package is on CRAN.

```
install.packages("seasonal")
```

- You no longer need to tell the seasonal package where to look for the X-13ARIMA-SEATS executable.
- Used to need to set environmental variable X13_PATH
- Now x13binary downloads and links x13 executable from U.S. Census website.

Default run of seas()

```r
m <- seas(AirPassengers)
class(m)
```

- The `seas()` function produces an object of class “seas”.
- A seas object is a list of lists/vectors.

X-13ARIMA-SEATS spec file

```
series{title = "Monthly Retail Sales of Household Appliance
       data = ( 530 529 526 532 568 785 543 510 554 523 540
                574 619 619 600 652 877 597 540 594 572 592
                 .
                 .
                 .
                2239 2253 2157 2190 2397 3659 2170 2086 229
       start = 1972.jul}
transform{function = log}
regression{variables = td}
arima{model = (0,1,1)(0,1,1)}
estimate{print = iterations}
forecast{maxlead = 60}
x11{seasonalma = s3x9} }
```

Spec file vs. seas()

- the `seas()` function

```
data <- ts(c(530, 529, ..., 2520),
           start = c(1972, 7),
           frequency = 12)
```

```
seas(x = data,
     transform.function = "log",
     regression.variables = "td",
     arima.model = "(0 1 1)(0 1 1)",
     estimate.print="iterations",
     forecast.maxlead=60,
     x11.seasonalma="s3x9")
```

A Helpful Reference

Many of the X-13ARIMA-SEATS Manual examples have been converted to `seas()` inputs.

`https://github.com/christophsax/seasonal/wiki/Examples-of-X-13ARIMA-SEATS-in-R`

Now we have a seas object

What does this do for us?

- Minimize amount of output from multiple runs
- Ease of access to auxiliary series
- Merge coding with X-13ARIMA-SEATS
- Easily produce customized holiday effects

An example where this has been used.

Moving Window Seasonal Adjustment

- Consider the research problem of looking at seasonal adjustment within moving windows of your data
- How would this be handled with X-13ARIMA-SEATS ?

Handling with `seasonal` package

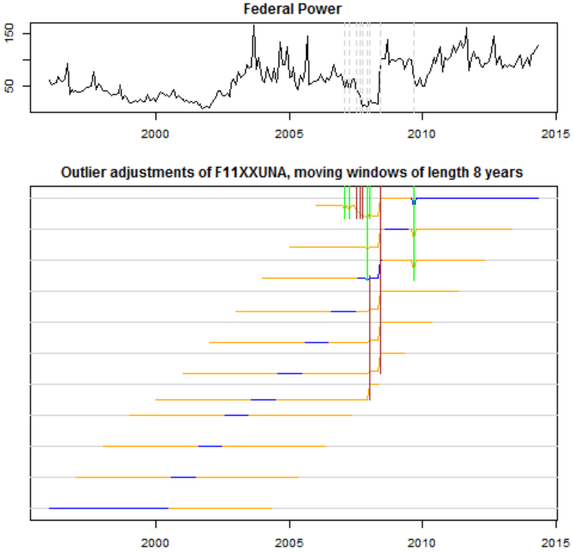
R Pseudocode for SEATS moving window adjustment

- Inputs:
  - Series
  - Window length
  - option for `seas()`

  (for example arima.model=“(0 1 1)(0 1 1)”)

Handling with seasonal package con't

- For each span within series length
  - Set beginning, ending date for span
  - Use `window()` to extract span from entire series
  - Run `seas()` on span with options specified via inputs
  - Save desired attributes of adjustment on span from seas object
- Return list of desired seasonal adjustment features



Federal Power

Outlier adjustments of F11XXUNA, moving windows of length 8 years

Figure 1:

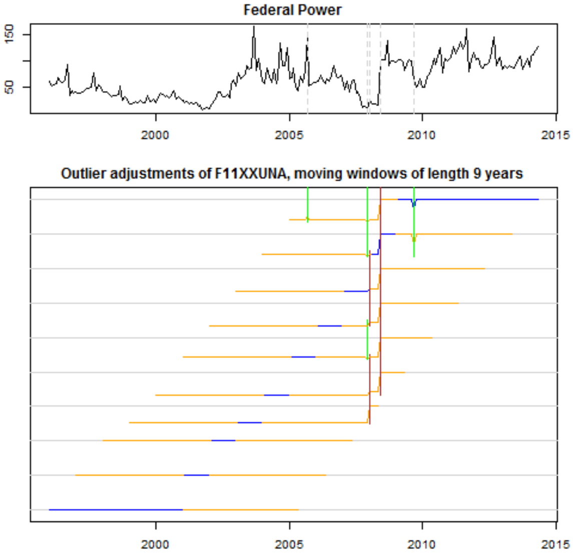

Federal Power
150
50
2000
2005
2010
2015
Outlier adjustments of F11XXUNA, moving windows of length 9 years
2000
2005
2010
2015

Figure 2:

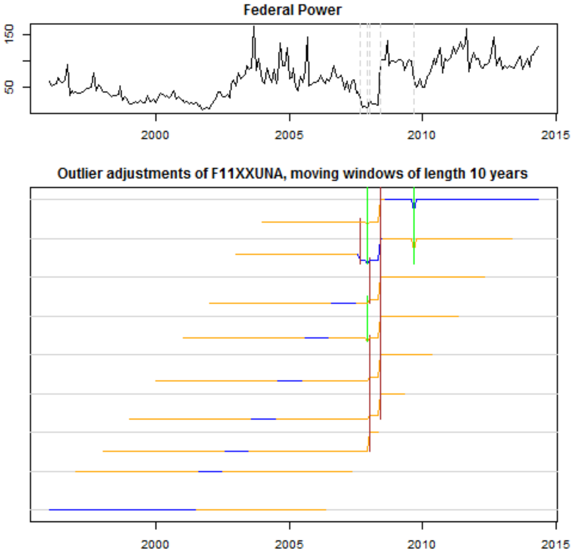

Federal Power
50
150
2000
2005
2010
2015
Outlier adjustments of F11XXUNA, moving windows of length 10 years
2000
2005
2010
2015

Figure 3:

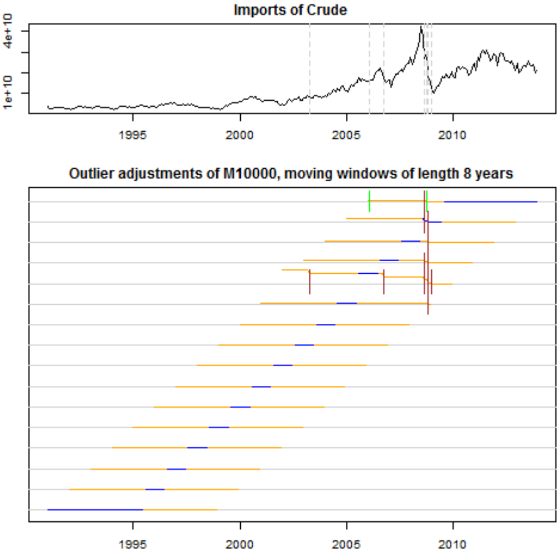

Imports of Crude
4e+10
1e+10
1995
2000
2005
2010
Outlier adjustments of M10000, moving windows of length 8 years
1995
2000
2005
2010

Figure 4:

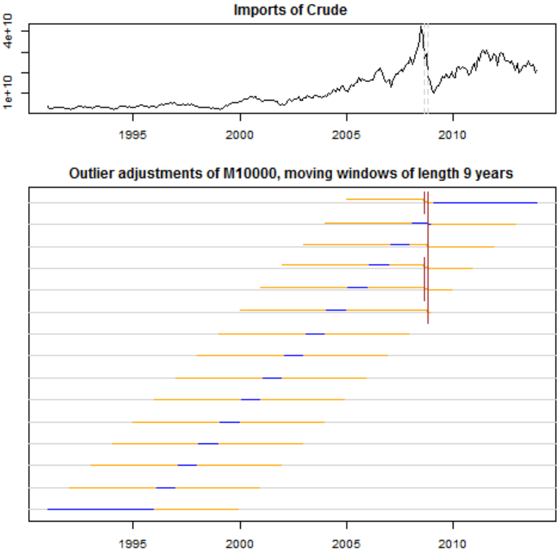

Imports of Crude
4e+10
1e+10
1995
2000
2005
2010
Outlier adjustments of M10000, moving windows of length 9 years
1995
2000
2005
2010

Figure 5:

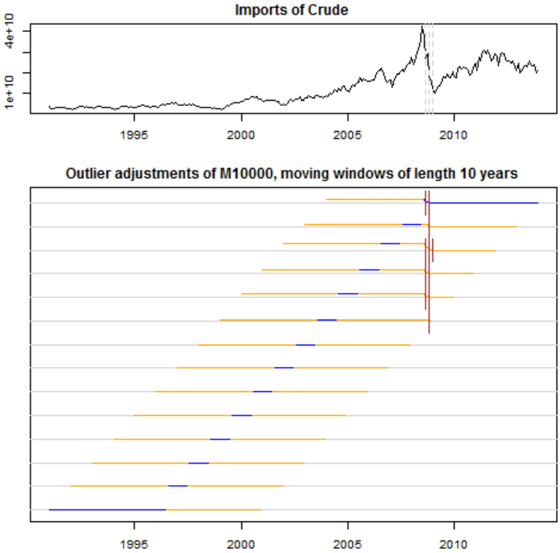

Imports of Crude
4e+10
1e+10
1995
2000
2005
2010
Outlier adjustments of M10000, moving windows of length 10 years
1995
2000
2005
2010

Figure 6:

Part 2: The *x13story* package.

Outline:

- What is it?
- How to get it?
- workflow with x13story
- Why is this an improvement?

Motivation

- learning about SA can be a difficult venture
- helping customers can yield bulky electronic footprint
- documenting/disseminating can be an arduous task

Steps in Traditional Seasonal Adjustment Workflow

- problem posed
- test possible solutions
- discuss with others
- document
- disseminate your results

Where can we improve?

Main Idea

- create an R package that allows users to use a simple markup language to discuss seasonal adjustment problems.
- closely mimic an actual workflow (test, discuss, document, disseminate)
- Easy to create interactive websites showcasing an X-13ARIMA-SEATS run
  - also allows interactive changes to X-13ARIMA-SEATS run

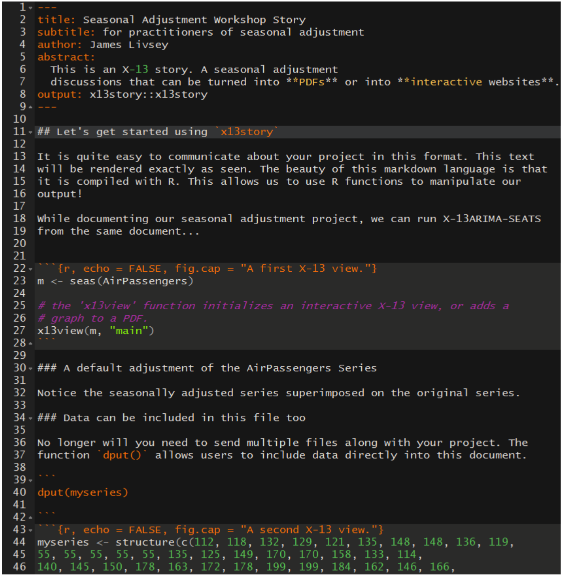
www.seasonal.website/x13story

How to get it?

- Currently not on CRAN.
- Can easily be installed from github.
  - www.github.com/christophsax/x13story

```r
library(devtools)
install_github("christophsax/x13story")
```

An R markdown document



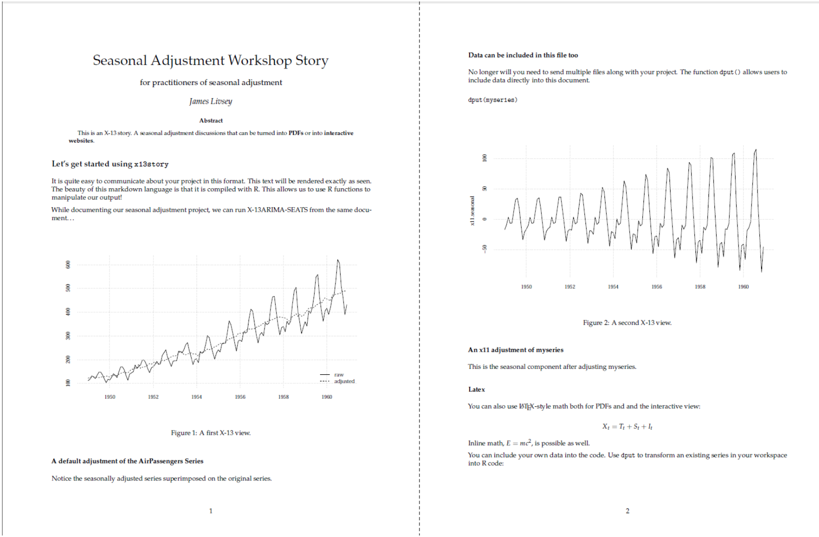
~~~
---
title: Seasonal Adjustment Workshop Story
subtitle: for practitioners of seasonal adjustment
author: James Livsey
abstract:
  This is an X-13 story. A seasonal adjustment
  discussions that can be turned into **PDFs** or into **interactive websites**.
output: x13story::x13story
---

## Let's get started using `x13story`

It is quite easy to communicate about your project in this format. This text
will be rendered exactly as seen. The beauty of this markdown language is that
it is compiled with R. This allows us to use R functions to manipulate our
output!

While documenting our seasonal adjustment project, we can run X-13ARIMA-SEATS
from the same document...


```{r, echo = FALSE, fig.cap = "A first X-13 view."}
m <- seas(AirPassengers)

# the 'x13view' function initializes an interactive X-13 view, or adds a
# graph to a PDF.
x13view(m, "main")
```

### A default adjustment of the AirPassengers Series

Notice the seasonally adjusted series superimposed on the original series.

### Data can be included in this file too

No longer will you need to send multiple files along with your project. The
function `dput()` allows users to include data directly into this document.

~~~

dput(myseries)

~~~
```{r, echo = FALSE, fig.cap = "A second X-13 view."}
myseries <- structure(c(112, 118, 132, 129, 121, 135, 148, 148, 136, 119,
55, 55, 55, 55, 55, 135, 125, 149, 170, 170, 158, 133, 114,
140, 145, 150, 178, 163, 172, 178, 199, 199, 184, 162, 146, 166,
~~~

Figure 7:

Rendered as a PDF



Seasonal Adjustment Workshop Story

for practitioners of seasonal adjustment

James Livsey

Abstract

This is an X-13 story. A seasonal adjustment discussions that can be turned into **PDFs** or into **interactive websites**.

Let's get started using `x13story`

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While documenting our seasonal adjustment project, we can run X-13ARIMA-SEATS from the same document…

Figure 1: A first X-13 view.

A default adjustment of the AirPassengers Series

Notice the seasonally adjusted series superimposed on the original series.

1

Data can be included in this file too

No longer will you need to send multiple files along with your project. The function `dput()` allows users to include data directly into this document.

```
dput(myseries)
```

Figure 2: A second X-13 view.

An x11 adjustment of myseries

This is the seasonal component after adjusting myseries.

Latex

You can also use LaTeX-style math both for PDFs and and the interactive view:

$$X_t = T_t + S_t + I_t$$

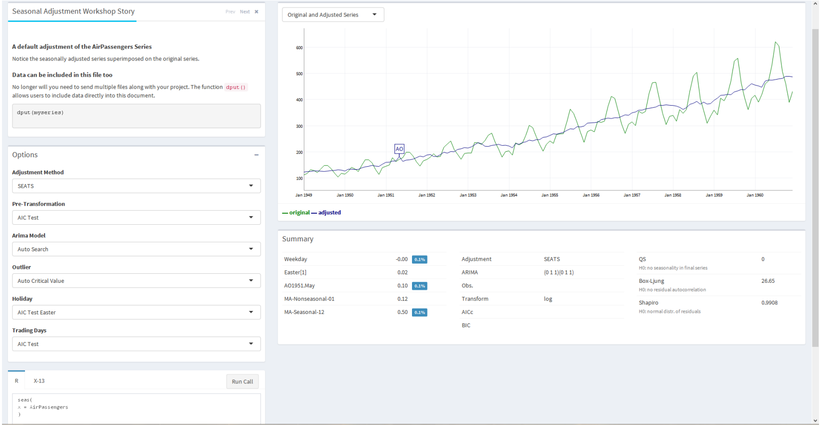
Inline math, $E = mc^2$, is possible as well.

You can include your own data into the code. Use `dput` to transform an existing series in your workspace into R code:

2

Figure 8:

Rendered as html interactive Website



Seasonal Adjustment Workshop Story

A default adjustment of the AirPassengers Series

Notice the seasonally adjusted series superimposed on the original series.

Data can be included in this file too

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```
dput(myseries)
```

Options

Adjustment Method
SEATS

Pre-Transformation
AIC Test

Arima Model
Auto Search

Outlier
Auto Critical Value

Holiday
AIC Test Easter

Trading Days
AIC Test

```
seas(
x = AirPassengers
)
```

Summary

Weekday	-0.00	0.1%
Easter[1]	0.02	
AO1951.May	0.10	0.1%
MA-Nonseasonal-01	0.12	
MA-Seasonal-12	0.50	0.1%

Adjustment	SEATS
ARIMA	(0 1 1)(0 1 1)
Obs.	
Transform	log
AICc	
BIC	

QS H0: no seasonality in final series	0
Box-Ljung H0: no residual autocorrelation	26.65
Shapiro H0: normal distr. of residuals	0.9908

Figure 9:

Disseminating your work

1. PDF file is easy way to send report
2. Host html on your website
3. Send us your R markdown file. It will appear on www.seasonal.website/x13story
4. Use viewer function and gist (or host Rmarkdown file elsewhere)
   - www.gist.github.com
   - allows both secret and public code sharing

```
viewer("gist.github.com/anonymous/86e9c7f37061a.Rmd")
```

Conclusions

- If you are an R user who dabbles in X-13ARIMA-SEATS
  - The `seasonal` R package and `x13story` is for you
- If you are an X-13ARIMA-SEATS user who dabbles in R
  - The `seasonal` R package and `x13story` is for you
- Strengths of using R to make X-13ARIMA-SEATS runs
  - Simulation
  - Customized graphics/output
  - Integration of R functions

Thank you

- `james.a.livsey@census.gov`

I encourage anyone interested to use the `x13story` package from our github repository and let us know what you think.