Introduction to Web Development with R

moving to the cloud...

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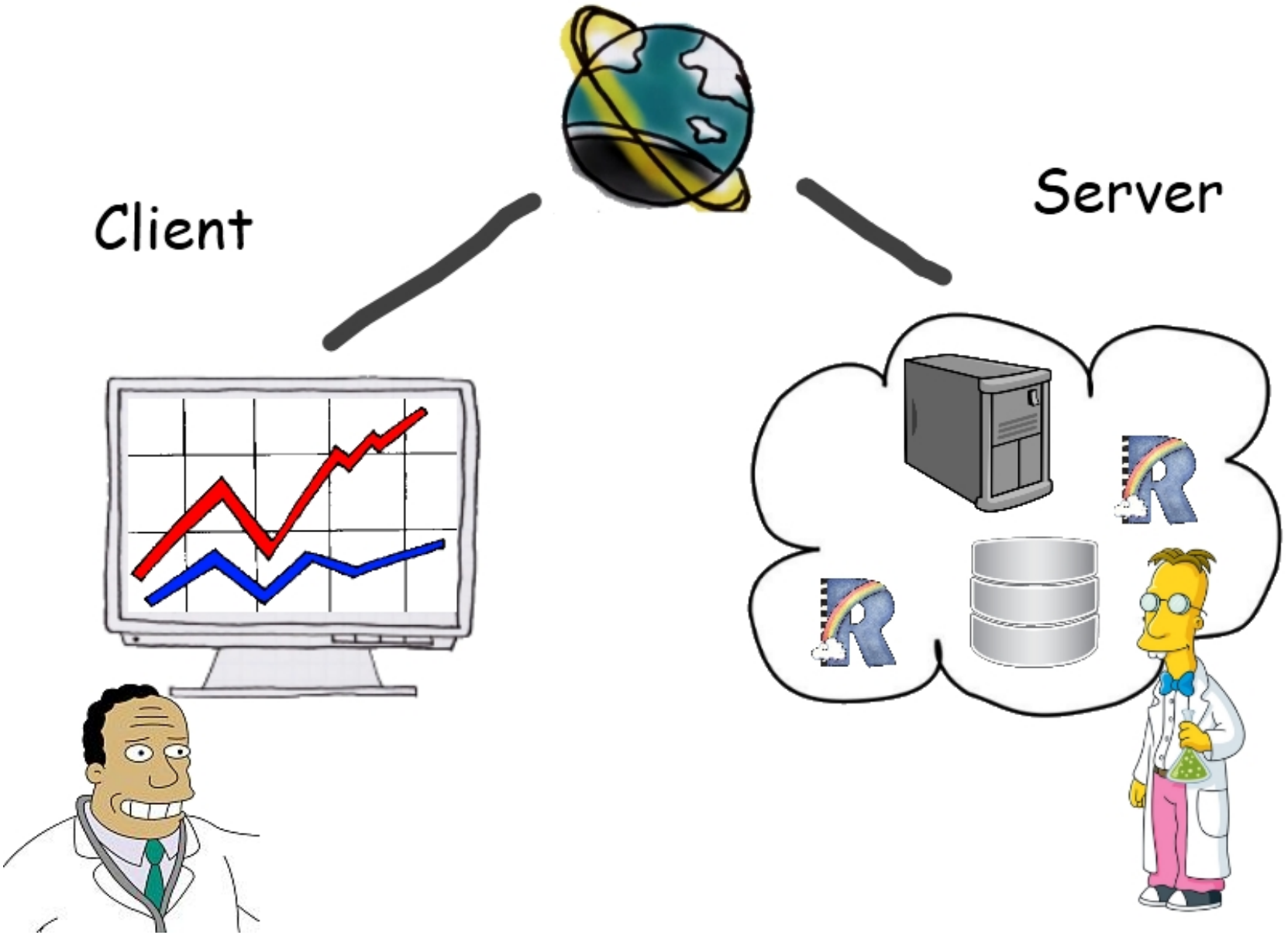
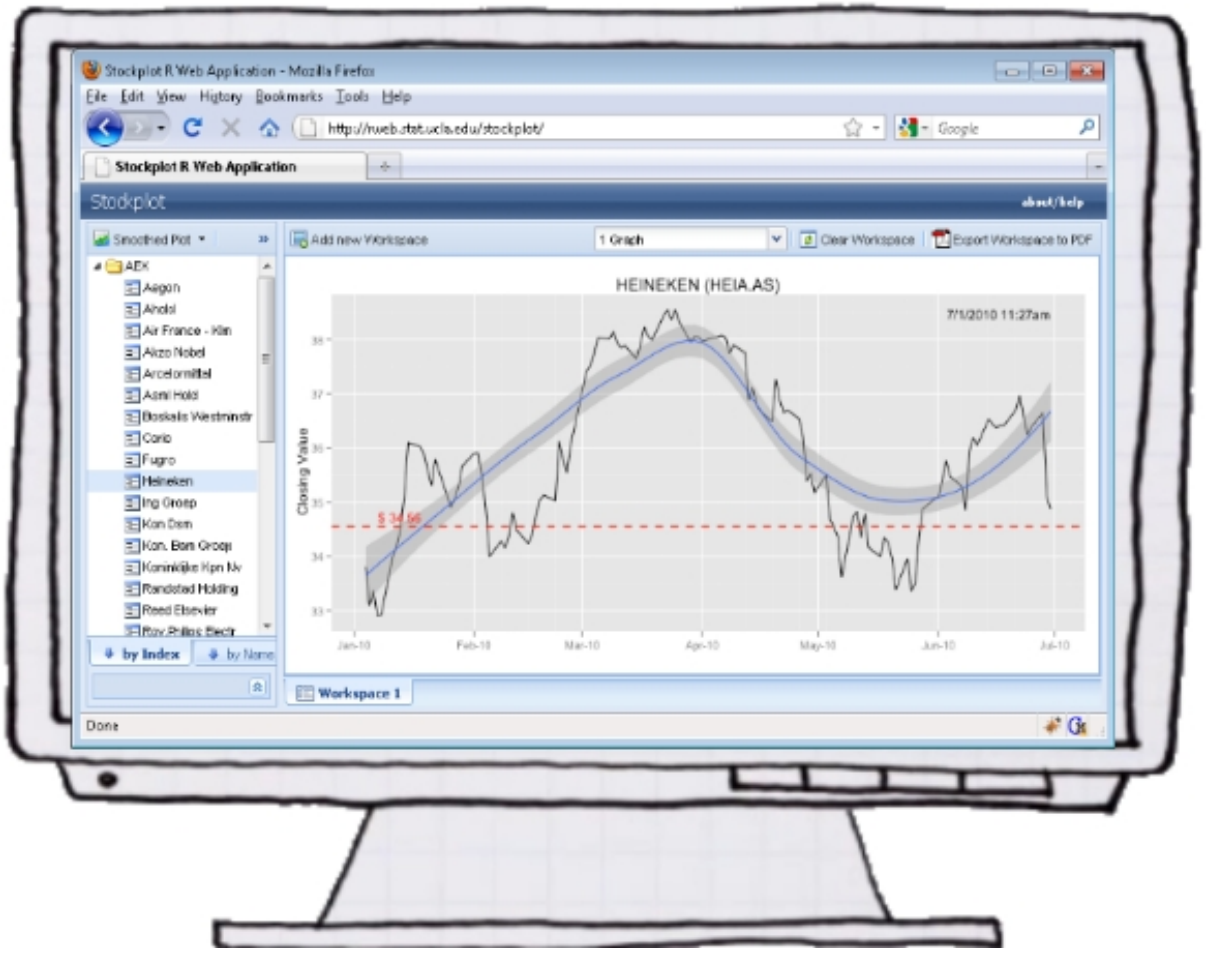
An example: stockplot

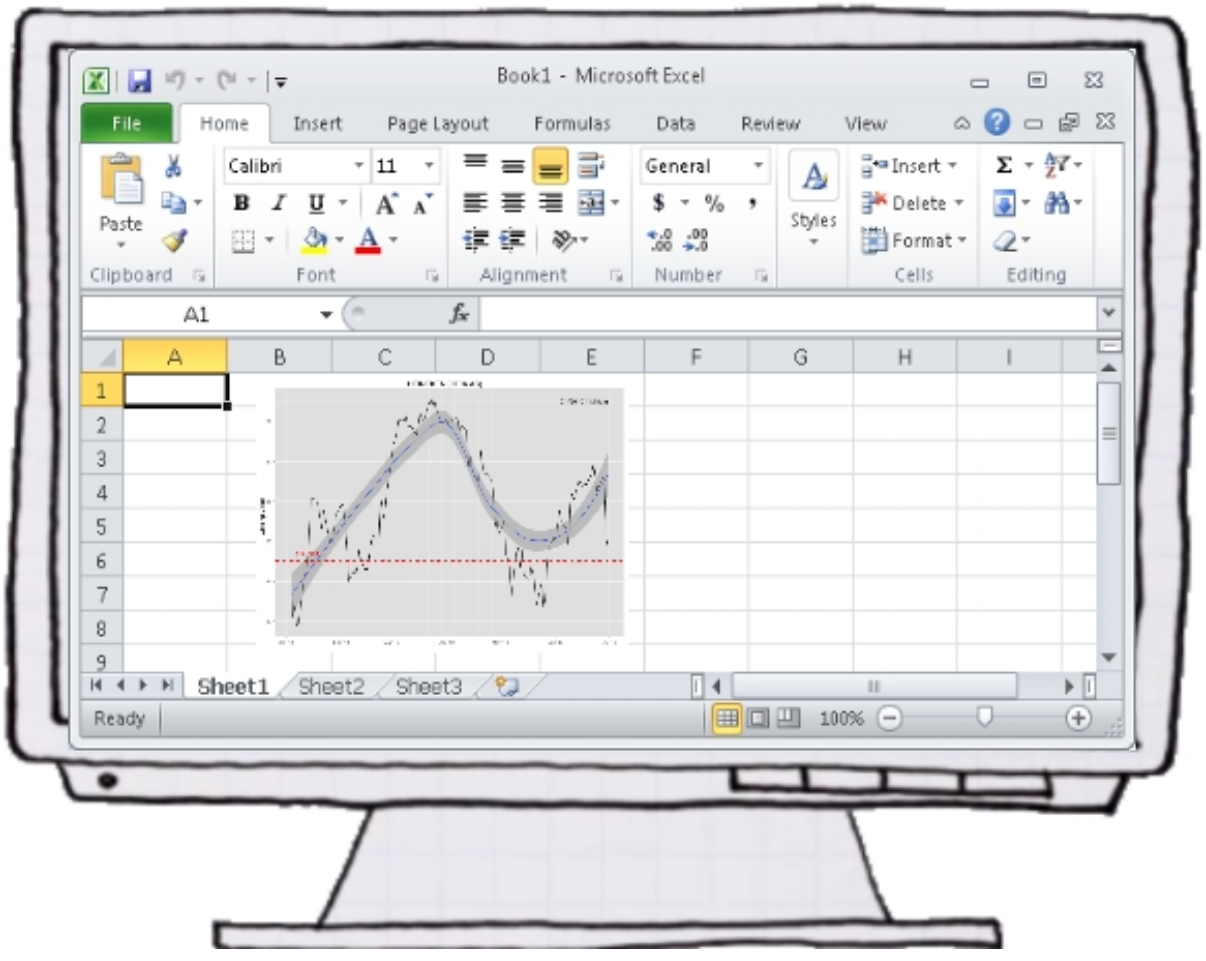
- Plots live data from Yahoo Finance.
- Uses a local MySQL database, some PHP.
- Intuitive Drag-n-drop interface.


Client
Server

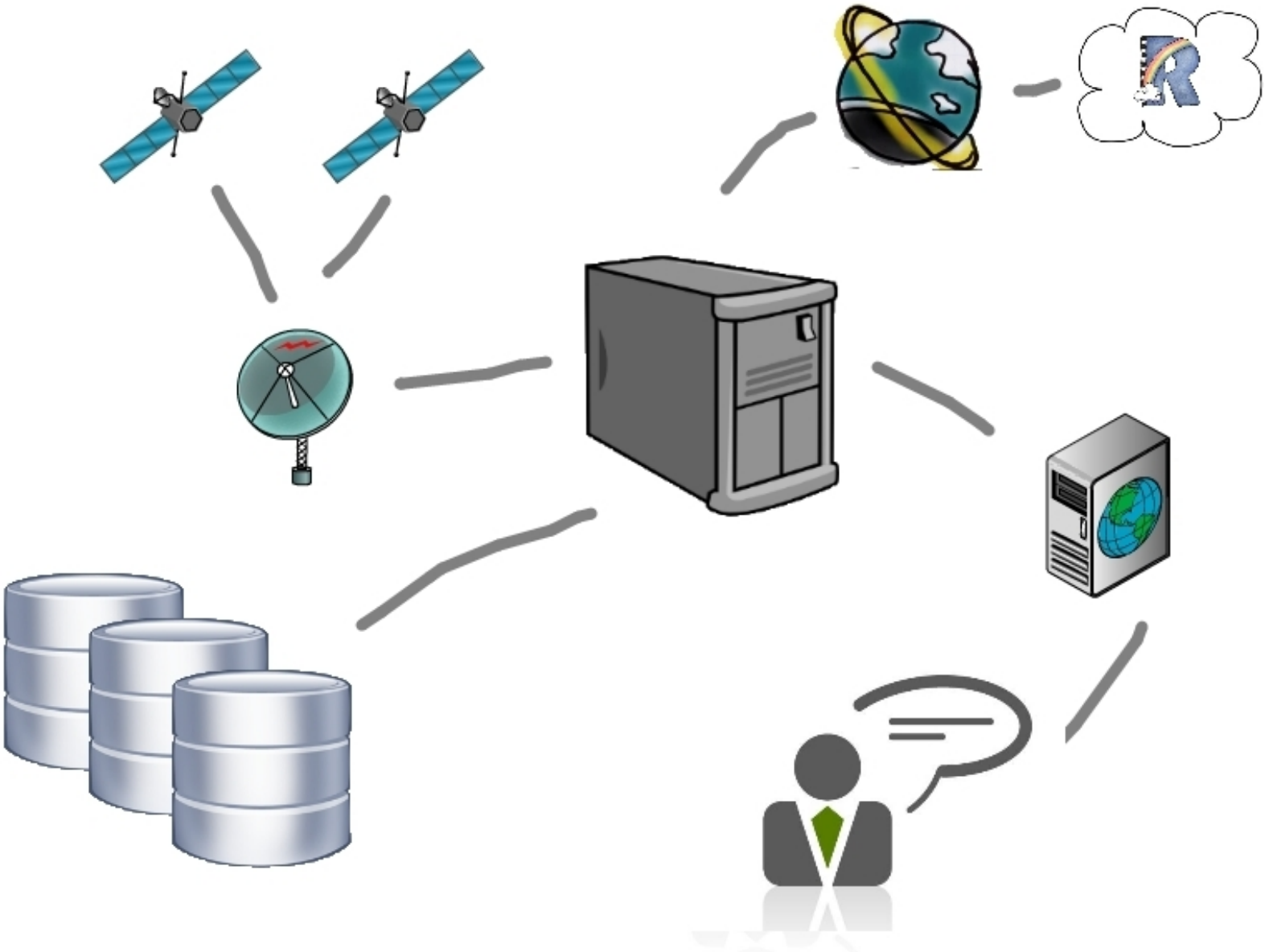
What is a client? A Browser



What is a client? Desktop software



What is a client? Your production process



Why Web Applications?

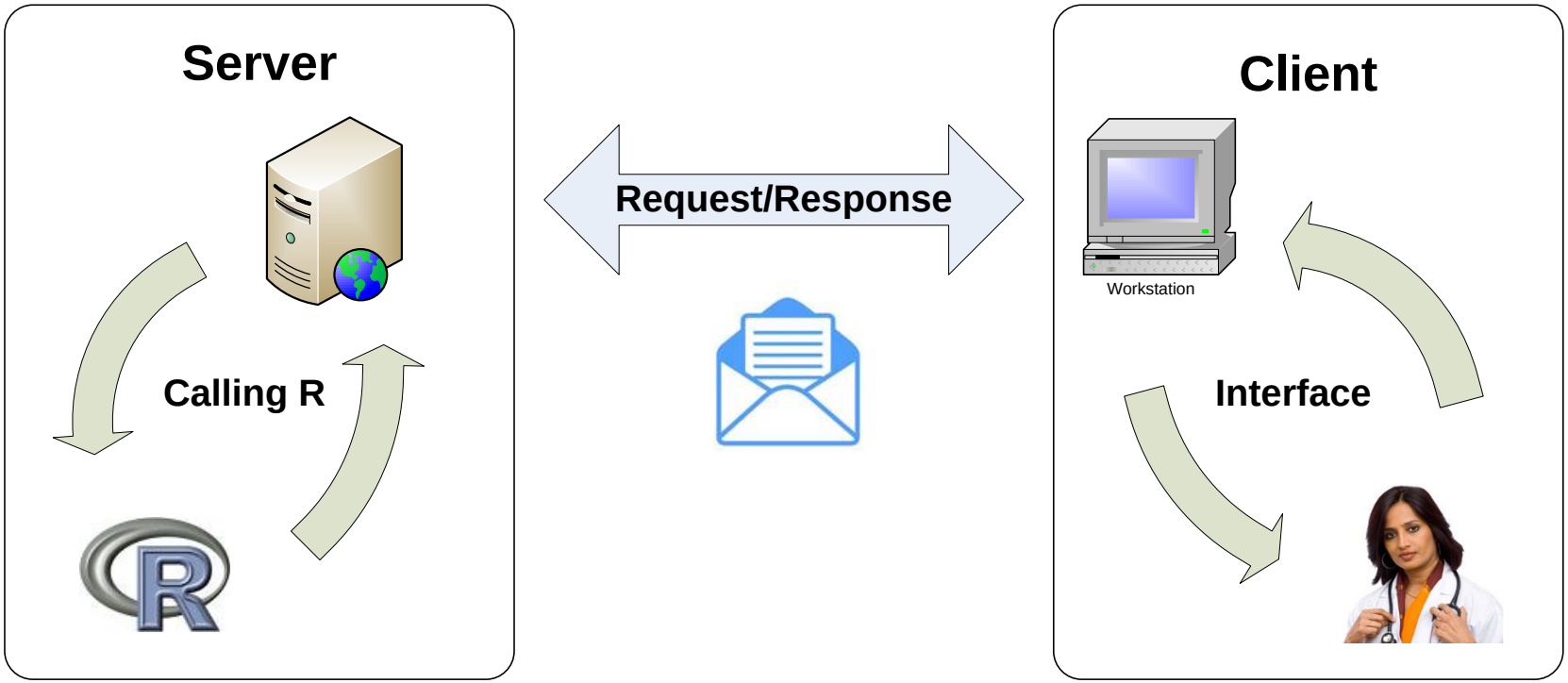
Convenient for the user:

- Making new tools available to a wide audience.
- Make applications that only require a browser.
- Cross-platform.

Server-based by design:

- Efficient use of resources.
- Easier to maintain.
- Integration with existing services/databases/etc.

Web application Setup



Stateful or Stateless

Stateful R session:

- Efficient for multiple operations on the same workspace.
- Essential for big data.
- What to do with parallel requests?
- When to timeout sessions?

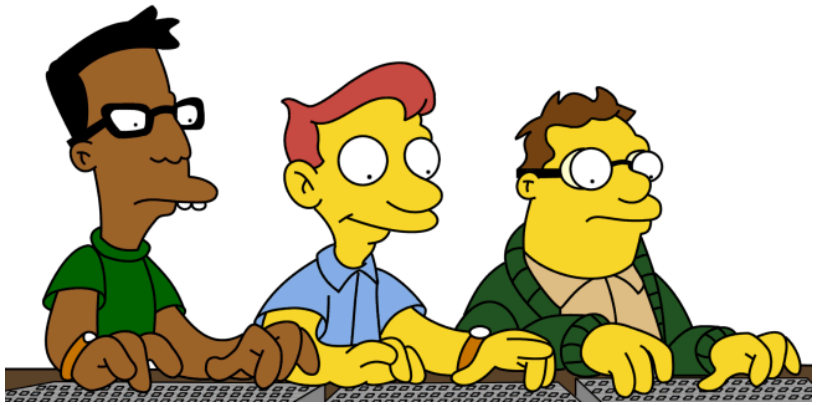
Stateless R sessions:

- Every request gets a new empty R session.
- Session is killed after operation finishes.
- Parallel requests no problem.
- Simulate statefulness by saving/loading workspaces.

Resources and Scalability

How to prevent overloading your servers?

- Limit memory per R session?
- Limit CPU time per R session?
- Limits per user or per request?
- Prevent DoS (1000 requests/sec).
- Load balancing, CPU distribution.



Security

How to prevent users from abusing your servers?

- R interacts freely
  with the system shell, which can be abused.
- What is the trust relationship with the user?
- Allow free code execution
  or only run predefined parameterized scripts?
- If only scripts, still watch out for code injection.
- Public (anonymous)
  privileges vs authorized privileges.
- Sandboxing users?

Error Catching

What to do with R errors?

- It is often useful to feed errors back to the client.
- Catch the errors in your R scripts.
- Always return a 'success' property in your response.

```
<response>
    <success> true </success>
    <results> // here the results </results>
</response>
```

OR:

```
<response>
    <success> false </success>
    <error> line 1 did not have 8 elements </error>
</response>
```

Graphics rendering

At the server

- use R's graphics device
- plot to PNG, PDF, SVG, etc
- Easy, fast, pretty plots
- Limited by R's graphics, no interaction, etc
- [example: sales]

At the client

- use R only for 'numbercrunching'
- return just data, no figure.
- render a plot on the client.
- more work, more eye candy.
- [example: BA]

General Advice

- Use R for calculations and plots. Do not generate HTML in R.
- Separate statistical/R layer from data layer, presentation layer, etc.
- Use a CMS or Web Development framework for UI stuff.
- Use R semantically. Think about Input/Output of your R scripts in terms of the statistical model.
- Standardize your R services. They should be client-independent.
- Make XML or JSON interfaces to your R services.

Connecting R

Low level tools:

- RScript - execute R scripts from the shell (stateless)
- RApache - execute R scripts from Apache httpd (stateless)
- Rserve - stateful R session with socket access.
- py2R - call R locally from python.
- JRI - call R locally from Java.

Problems:

- You need to be both web developer and R programmer to use any of these.
- A lot of work is required to get some simple functionality.
- Little control over resources, security, scalability.

Phoenix Server: a high level solution

Phoenix (codename) server:

- Framework for R web development by Revolution Analytics.
- Commercial and Academic (free) licences.
- Can be hosted locally or 'in the cloud'.
- Scalability {1..n] R Servers with load balancing.
- Runs on Linux and Windows.

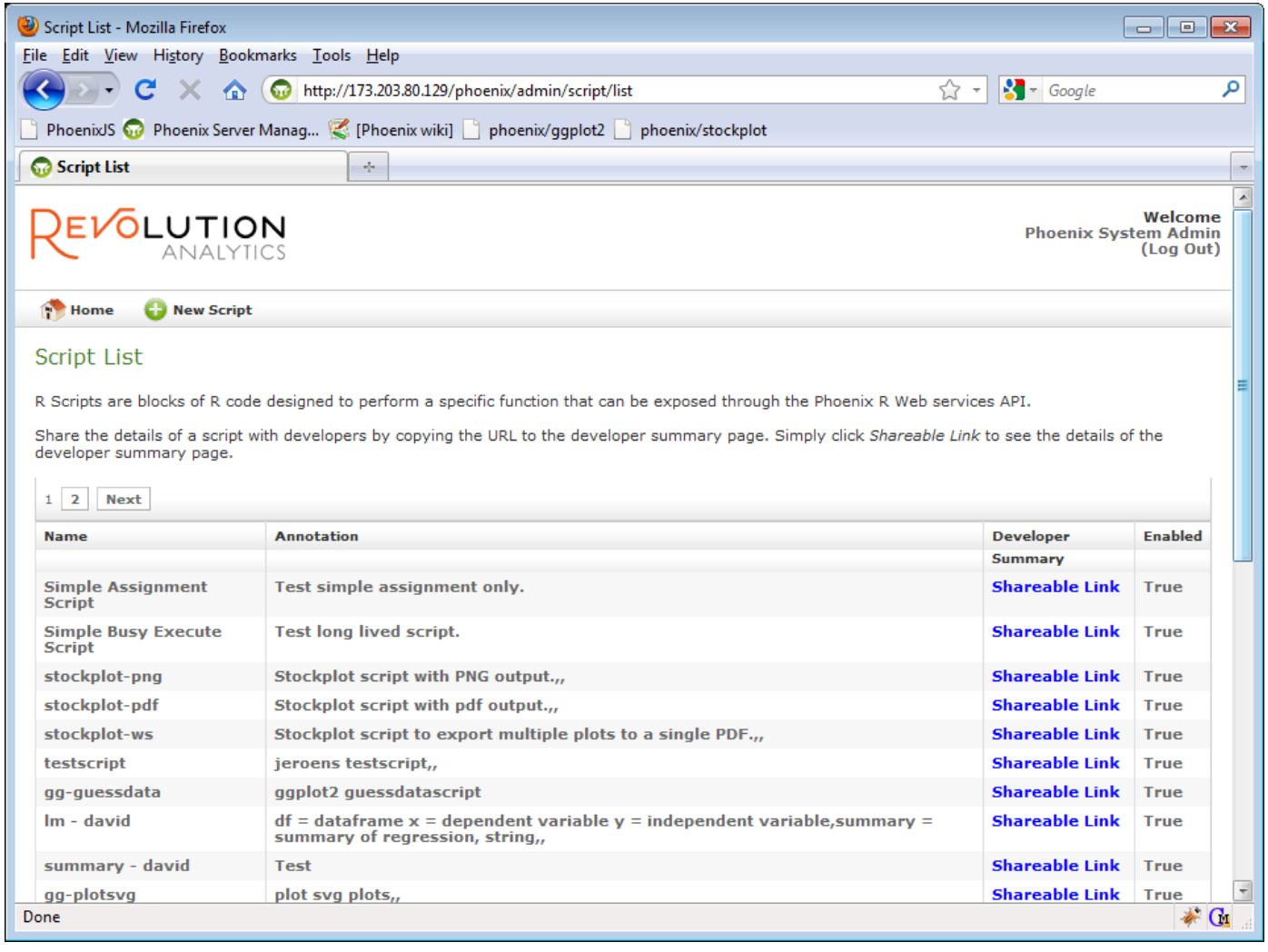
Our Goals:

- Keywords: Scalable, Standardized, Secure.
- Easily add R functionality to any application.
- Separates the R/statistical programming from the web development.

Phoenix Server: features

- RESTful API
- Management Console
- Standardized XML/JSON Interfaces.
- JSON/XML object encoding.
- Stateful and Stateless code execution.
- Deploy R scripts without any programming.
- Open source clients available for Java, .NET, PHP, Javascript, Excel, etc.

Management Console



RESTful API

Every command is called from a http url
E.g. http://calc.company.org/r/session/login

- /r/session/login
- /r/session/create
- /r/session/file/upload
- /r/session/execute/script
- /r/session/object/list
- /r/session/object/save
- /r/project/save
- /r/session/close
- etc

XML/JSON interfaces

Example call:

```
POST /r/session/save
format=json&
session=LIVE-92d9c643-5620-40a1-8626-47ded19970cc&
descr=My Workspace 1
```

Example response:

```
"phoenix": {
   "response": {
      "success": true,
      "call": "/r/session/saveworkspace",
      "pobjects": {
         "My Workspace 1": {
            "value": "CBNRY-7f8fa254-cc5a-4f77-a9d9-3b873be1bad3"
         }
      },
      "session": "LIVE-92d9c643-5620-40a1-8626-47ded19970cc"
   }
}
```

XML/JSON Data-object Encoding

```
"myDataFrame" : {
   "type": "dataframe",
   "value": {
      "age": {
         "type": "vector",
            "value": [
               13,
               15,
               16
            ]
         },
      "gender": {
         "type": "factor",
         "value": [
             "female",
             "male",
             "female"
         ]
      }
   }
}
```

Stateful and Stateless code execution

Execute an R script that exists on the server.

Interfaces:

- /r/script/execute
- /r/session/execute/script

Features:

- Execute an R script that exists on the server.
- Either stateless or stateful.
- Paramaterize by pushing R objects before execution.
- Retreive encoded objects or files after execution.

Privilege Roles

Some built-in standard roles (customizable):

- Administrator: Deploy R-Scripts, Manage users, etc
- Unrestricted user: Use entire API.
- Restricted user: Use entire API, except for custom code execution.
- Public: permits the execution of stateless scripts anonymously.

Open Source Client Libraries

jPhoenix (Java) client Lib

```
String phoenixUrl = "http://www.thecloud.com/phoenix/";

PClient pClient = PClientFactory.createClient(phoenixUrl);
pClient.login(new PBasicAuthentication("testuser", "password"));

PSession pSession = pClient.createSession();
pSession.executeCode("x <- rnorm(1000);");
pSession.executeScript("predict-stocks", ...);

pSession.closeSession();

pClient.release();
```

Open Source Client Libraries

phpPhoenix client lib:

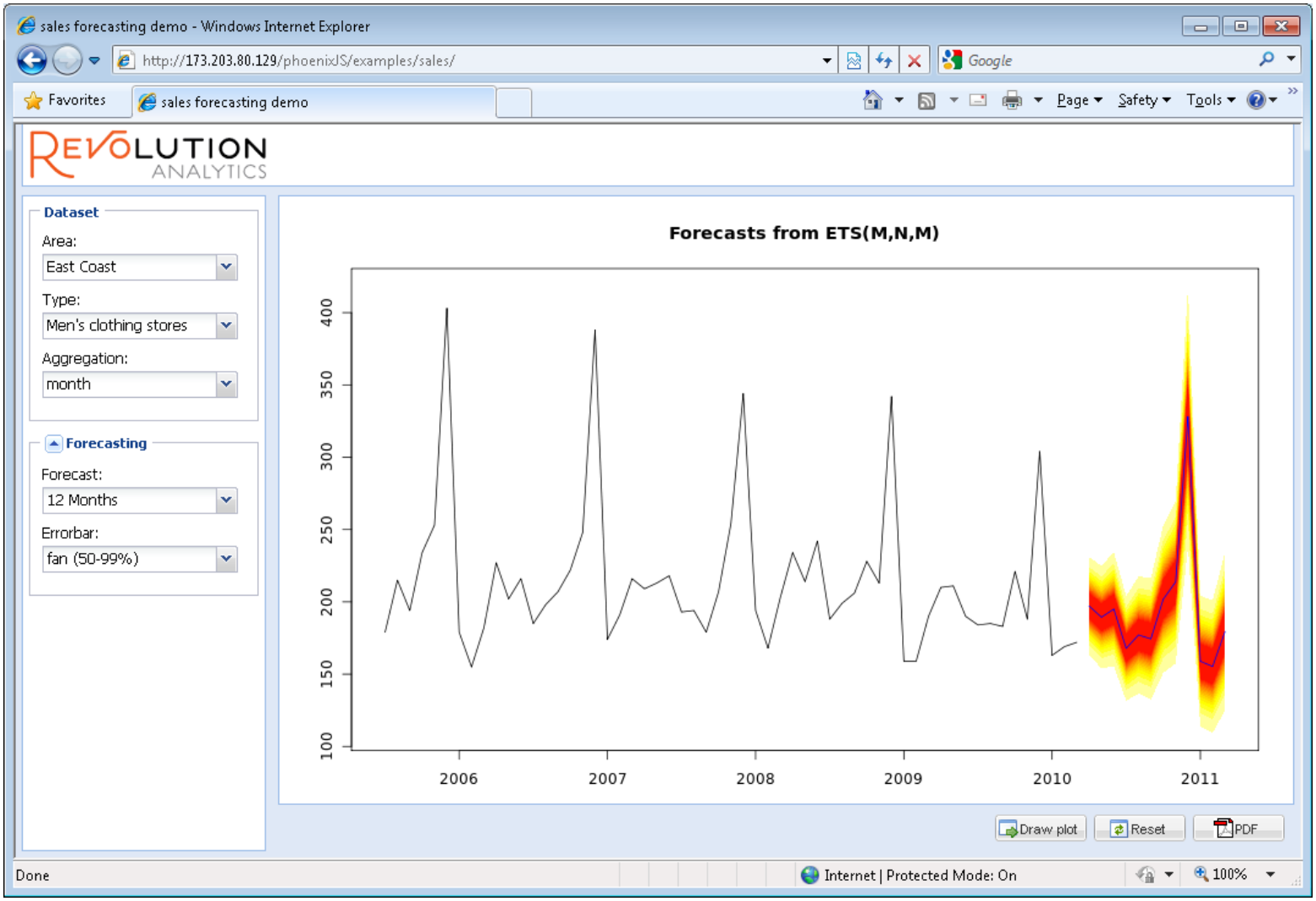
```
$webSession = WebSession::getInstance();

$client = new PhoenixClient::createHttpClient(PHOENIX_URL,
    $webSession);

$client->login(new PhoenixBasicAuthentication(USERNAME, PASSWORD));

$session = $client->createSession('calculate_average_session');

$phoenixExecution = $session->executeCode('myvar <- rnorm(100)',
    'myvar');

$robjects = $phoenixExecution->getRObjects();
```

Open Source Client Libraries

phoenixJS client library (sales example)

```
button.onClick = function(){
    pExecuteScript({
        scriptname: 'plotsales-png',
        inputs: plotparams,
        files: ['salesplot.png'],
        mask: Ext.getCmp('plotpanel').getLayoutTarget(),
        success: function(robjects,files){
            insertPlot(files['salesplot.png'].value);
        }
    });
}
```

Example: sales forecasting



Finally, dinner!

Thank you for your attention.

- http://www.stat.ucla.edu/~jeroen
- http://www.revolutionanalytics.com

Object Encoding: XML

```
<myModel>
    <family>Gaussian</family>
    <deviance>3569.23</deviance>
    <coefficients>
       <coef>
           <name>Intercept</name>
           <value>5.69</value>
       </coef>
       <coef>
           <name>Age</name>
           <value>0.36</value>
       </coef>
       <coef>
           <name>Gender</name>
           <value>2.54</value>
       </coef>
    </coefficients>
</myModel>
```

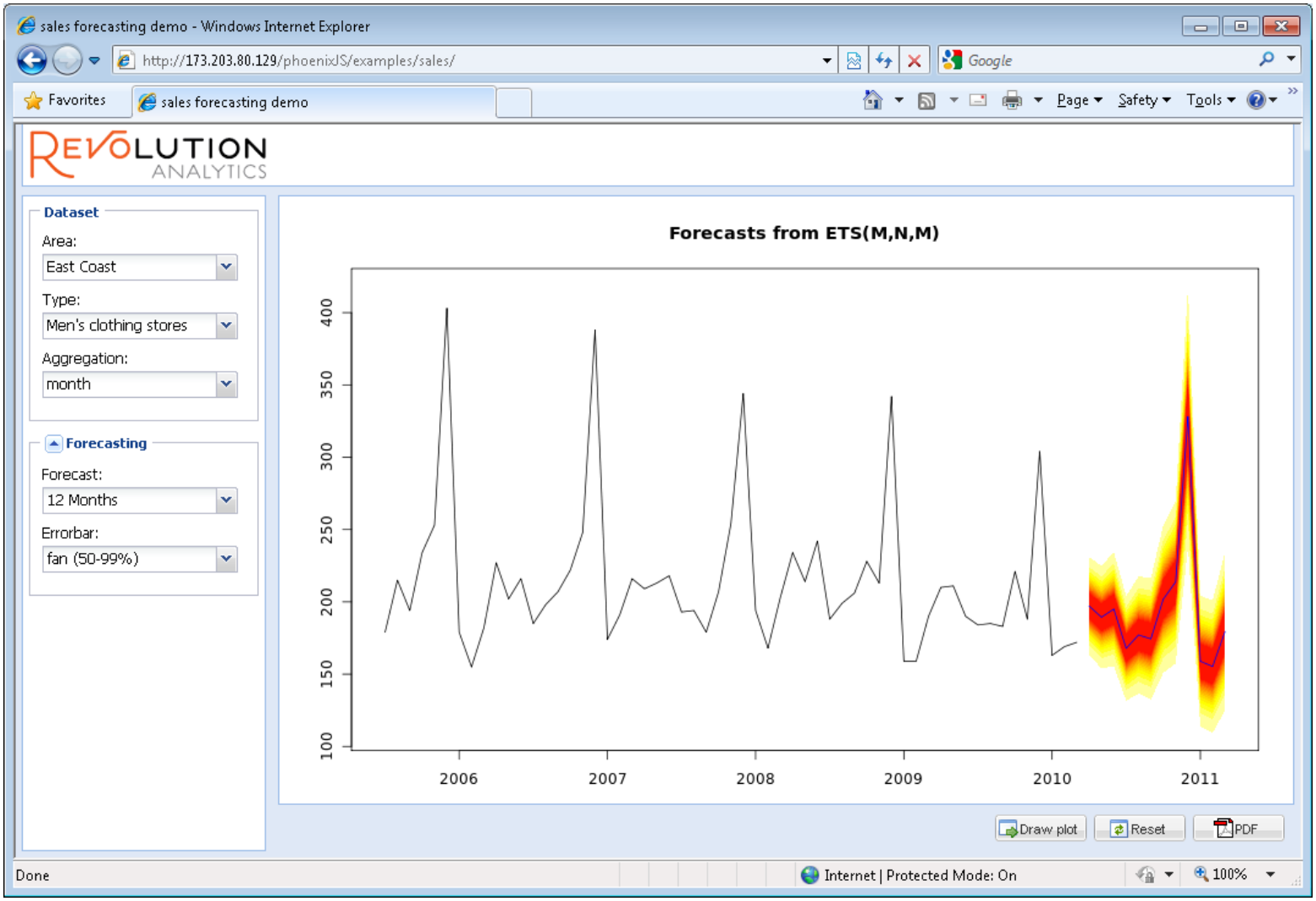
Object Encoding: JSON

```
{"myModel": {
    "family": "Gaussian",
    "deviance": 3569.23,
    "coefficients":
        [ {"Intercept": 5.69}, {"Age": 0.36}, {"Gender": 2.54} ]
    }
}
```

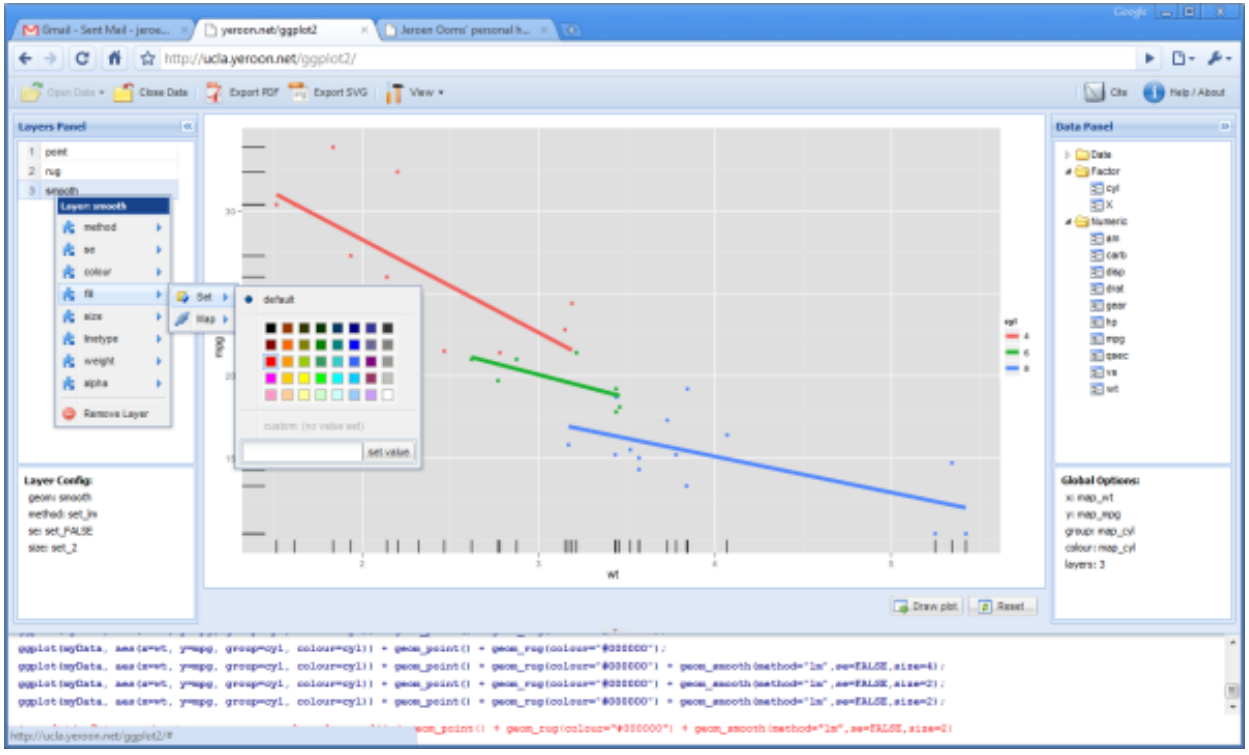
Or for example a dataframe:

```
{"myData": {
    "Age":[9,8,12,6,7,8,9,8,10,11,9,6,8],
    "Gender":["M","F","F","M","F","M","F","F","M","F","M","F","F"],
    "Treatment":[1,0,0,1,1,1,0,0,0,1,1,1,0]
    }
}
```

Examples: sales forecasting

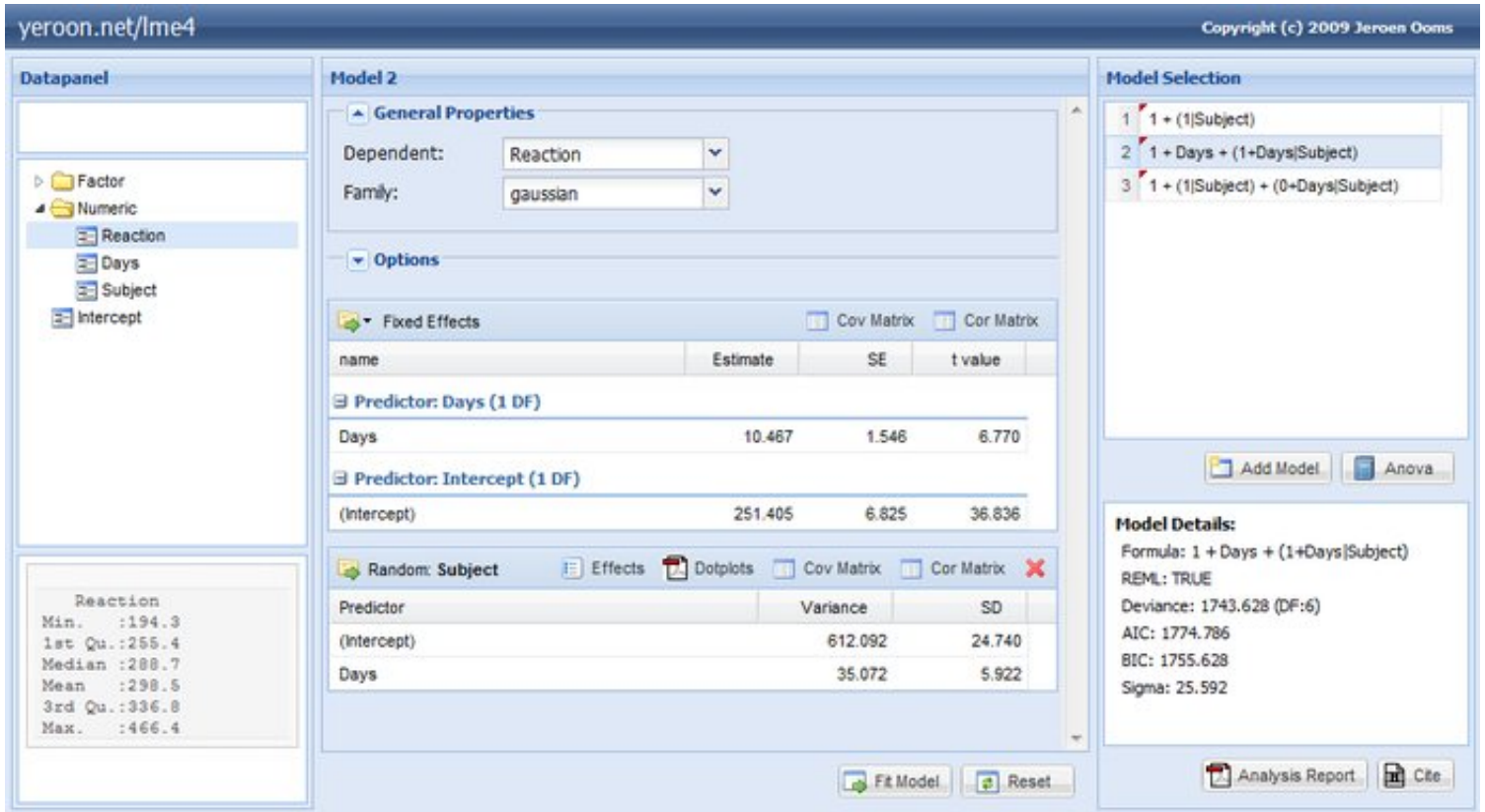


Examples: yeroon.net/ggplot2



- Exploratory graphical analysis and education of stats and R.
- Upload data or import spreadsheet from Google Docs.
- Add graphical layers and map/set any aesthetics.
- Export to PNG, PDF, SVG

Examples: yeroon.net/lme4



- Online random effects / multilevel modeling.
- Upload data, maintain several models.
- Export PDF report (Latex)

Examples: stockplot

- Plots live data from Yahoo Finance.
- Uses a local MySQL database, some PHP.
- Intuitive Drag-n-drop interface.