SAGE2 Documentation

November 17, 2014

1. SAGE2

SAGE2™: Scalable Amplified Group Environment

SAGE™ software enables teams of users to manage their data in a room covered with displays, as if the room were one seamless canvas. SAGE lets users post and manipulate information, visualizations and animations. The goal of SAGE is to make it possible for people to look at large amounts of information and come to conclusions with greater speed, accuracy, comprehensiveness and confidence.

SAGE was originally conceived in 2004. With National Science Foundation (NSF) funding in 2009, the SAGE team was able to continue to develop and harden SAGE, thereby helping over 100 major institutions worldwide better utilize content on their display walls with SAGE.

With NSF funding in 2013, the SAGE team had an opportunity to develop SAGE2, the next-generation SAGE. SAGE is being rewritten from the ground up, using new and emerging technologies.

SAGE2 is browser-based, and everything is done from the Chrome web browser. Special software is no longer needed. By simply dragging and dropping content from one's laptop to a visual representation of the wall in the browser, one can transfer the content to the wall.

The user interface has been completely redesigned to make it easier and faster for users to work on really large display walls. The SAGE2 interface emphasizes transportable interfaces rather than stationary interfaces so a user can control SAGE2 from anywhere in a room (or even away from the room). Entire laptop screens can also be pushed onto windows in SAGE2, again directly leveraging browser technology. SAGE2 also enables users to connect to collaborating SAGE2 walls and send documents among them by simply dragging and dropping the content in specially marked "collaboration folders".

Custom applications are easily built in SAGE2. While SAGE is written in C++, SAGE2 is written entirely in Javascript. SAGE2 includes a small software toolkit that enables users to develop applications or modify existing applications to work seamlessly across multiple displays in a synchronized fashion. This unleashes the possibility of creating a new generation of applications that can take advantage of the special qualities of ultra-high-resolution display walls.

1.0.1. Install SAGE2

- Install (Windows)
- Install (Mac OS X)
- Install (openSUSE)
- Install (Ubuntu)

1.0.6. Install for Mac OS X (10.7 - 10.10)

1.0.6.0.1. Download

- Download Node.js and install (follow installer instructions)
- Download homebrew and install (Terminal command creates full install)
  - run `brew doctor` once install finishes

1.0.6.0.2. Install Dependencies

- Open Terminal
  - `brew install ffmpeg --with-libvpx --with-libvorbis`
  - `brew install imagemagick --with-ghostscript --with-webp`
  - `brew install exiftool`

1.0.6.0.3. Clone SAGE2

- Open Terminal
  - `cd <directory_to_install_SAGE2>`
  - `git clone https://bitbucket.org/sage2/sage2.git`

1.0.6.0.4. Generate HTTPS Keys

- Open the file 'GO-mac' inside the '/keys/' folder
  - Add additional host names for your server in the variable `servers` (optional)
  - Save file
- Open Terminal
  - `cd <SAGE2_directory>/keys`
  - `./GO-mac`
    - enter your password when asked (the keys are added into the system)

1.0.6.0.5. Install Node.js Modules

- Open Terminal
  - `cd <SAGE2_directory>`
  - `npm install`

1.0.7. Install for Ubuntu (14.04)

1.0.7.0.1. Download

- Download Node.js
- Download FFMpeg (2.2.1 "Muybridge" gzip tarball)

1.0.7.0.2. Install Dependencies

- Open Terminal
  - `sudo apt-get install g++`
  - `sudo apt-get install libx264-dev`
  - `sudo apt-get install yasm`
  - `sudo apt-get install imagemagick`
  - `sudo apt-get install libnss3-tools`
  - `sudo apt-get install git`
  - `sudo apt-get install libimage-exiftool-perl`

1.0.7.0.3. Install Node.js

- Open Terminal
  - `cd <Downloads_directory>`
  - `tar xzvf <downloaded_nodejs_tar.gz>`
  - `cd <extracted_nodejs_directory>`
  - `./configure`
  - `make`
  - `sudo make install`

1.0.7.0.4. Install FFMpeg

- Open Terminal
  - `cd <Downloads_directory>`
  - `tar xzvf <downloaded_ffmpeg_tar.gz>`
  - `cd <extracted_ffmpeg_directory>`

- `./configure --enable-gpl --enable-libx264`
- `make`
- `sudo make install`

1.0.7.0.5. Clone SAGE2

- Open Terminal
  - `cd <directory_to_install_SAGE2>`
  - `git clone https://bitbucket.org/sage2/sage2.git`

1.0.7.0.6. Generate HTTPS Keys

- Open the file 'GO-linux' inside the '/keys/' folder
  - Add additional host names for your server in the variable `servers` (optional)
  - Save file
- Open Terminal
  - `cd <SAGE2_directory>/keys`
  - `./GO-linux`

1.0.7.0.7. Install Node.js Modules

- Open Terminal
  - `cd <SAGE2_directory>`
  - `npm install`

1.0.8. Install for Windows (7 or 8.1)

1.0.8.0.1. Download

- Download 7-Zip and install (follow installer instructions)
- Download Node.js and install (follow installer instructions)
- Download ImageMagick and install (follow installer instructions)
- Download Ghostscript and install (follow installer instructions)
- Download Git for Windows and install (follow installer instructions)
- Download TortoiseGit and install (follow installer instructions)
- Download FFMpeg
- Download ExifTool

1.0.8.0.2. Install FFMpeg

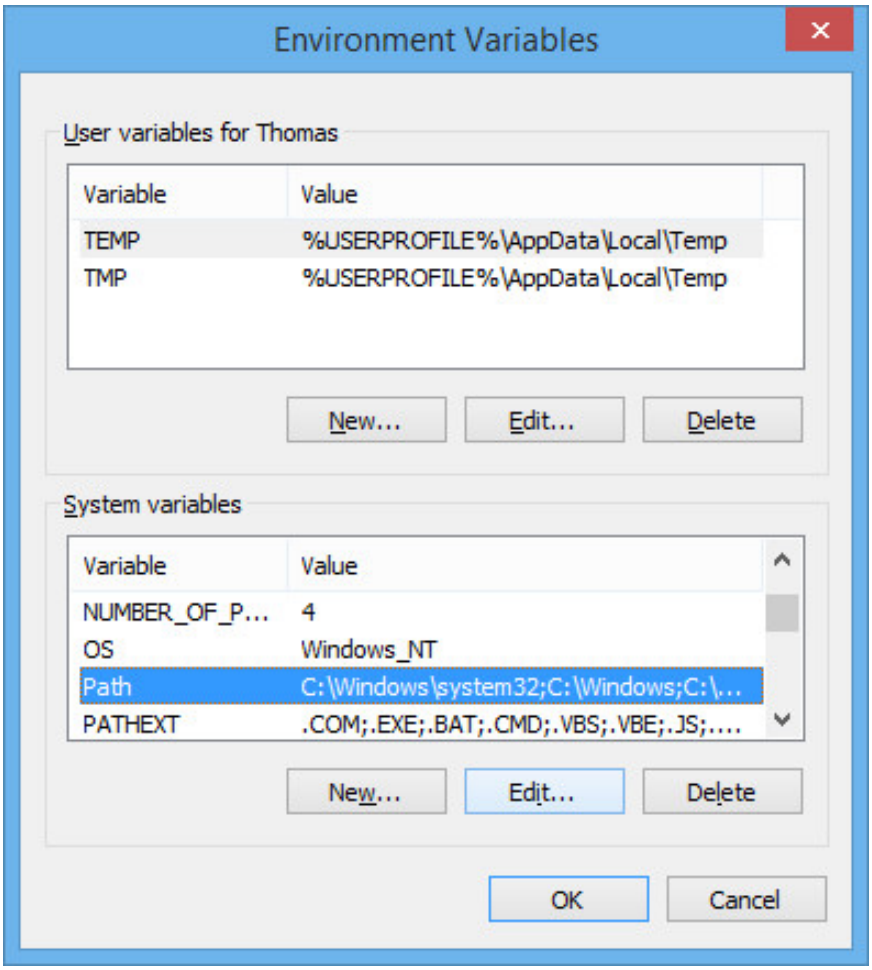
- Create folder 'C:'
- Right-click on downloaded FFMpeg 7z file
  - 7-Zip > Extract Here
- Copy all files from extracted directory to 'C:'

1.0.8.0.3. Install ExifTool

- Right-click on downloaded Exiftool file
  - 7-Zip > Extract Here
- Rename binary to 'exiftool.exe' and move to 'C:'

1.0.8.0.4. Set Environment

- For Windows 7
  - Right-click 'Computer'
  - Click 'Properties'
  - Click 'Advanced system settings'
- For Windows 8.1
  - Click Windows Logo and type 'e'
  - Click 'Edit the system environment variables'
- Click 'Environment Variables'
- Add 'C:;C:Files (x86)' to your system PATH variable
- You may have to log out and log back in for the environment variables to apply



Edit Windows PATH

1.0.8.0.5. Clone SAGE2

In directory where you want to install SAGE2, right-click and select 'Git Clone'

- Set URL to 'https://bitbucket.org/sage2/sage2.git'
- Set directory to where you want to install SAGE2

1.0.8.0.6. Generate HTTPS Keys

- Edit '-windows.bat'
  - Add lines with list of hostnames for your server
  - Save file
- Double click 'GO-windows.bat'

- On Windows 8.1 you will need right click and select 'Run as Administrator'

1.0.8.0.7. Install Node.js Modules

- Launch command prompt (`cmd.exe`)
  - `cd <SAGE2_directory>`
  - `npm install`
  - 'Error: ENOENT, stat 'C:{User Name}'
    - You will need to manually create that folder

1.0.9. Install for Linux openSUSE (13.1)

For older versions of openSUSE (and future versions), the name of the packages might change slightly, but the instructions remain mostly valid.

1.0.9.0.1. Install Dependencies

- In a Terminal window as 'root' user (or using a sudo command)
- The default version of nodejs provided by default is usually pretty old. It seems better to add the NodeJS repository to the system and install it from there:
  - `zypper ar http://download.opensuse.org/repositories/devel:/languages:/nodejs/openSUSE_13.1/ Node.js`
  - `zypper in nodejs nodejs-devel npm`
- after install, test:
  - `node -v` will tell you which version is installed
- `zypper install git` : distributed revision control system
- `zypper install openssl`: Secure Sockets and Transport Layer Security
- `zipper install mozilla-nss-tools` : NSS Security Tool
- `zypper install ImageMagick` : Viewer and Converter for Images
- `zypper install exiftool` : Metadata extraction for files
- `zypper install poppler-tools` : PDF Rendering Library Tools
- `zypper install xdotool` : Tools to fake mouse/keyboard input and move the mouse outside the viewport
- some packages that we use might require the compiler and development packages to be installed
  - `zypper install -t pattern devel_C_C++`
- if you want to use privileged network ports (port 80 for HTTP and 443 for HTTPS), you need to add capabilities to the `node` binary:
  - `zypper install libcap-progs`

    - `sudo setcap 'cap_net_bind_service=+ep' /usr/bin/node`
        - this allows a regular user to use node with privileged ports
- Packages provided by other repositories
    - add repositories:
        - `zypper ar http://packman.inode.at/suse/13.1 Packman_13.1`
        - `zypper ar http://dl.google.com/linux/chrome/rpm/stable/x86_64 Google_chrome`
        - `zypper refresh`
    - `zypper install ffmpeg` : Viewer and Converter for Images
    - `zypper install google-chrome-stable`: Google Chrome browser

1.0.9.0.2. Clone SAGE2

- Open Terminal
    - `cd <directory_to_install_SAGE2>`
    - `env GIT_SSL_NO_VERIFY=true git clone https://bitbucket.org/sage2/sage2.git`
        - enter bitbucket login information when asked

1.0.9.0.3. Generate HTTPS Keys

- Open the file 'GO-linux' inside the '/keys/' folder
- Add additional host names for your server in the variable `servers` (optional)
    - for instance add the short name and the fully qualified domain name of your server
- Save file
- In a Terminal
- `cd <SAGE2_directory>/keys`
- `./GO-linux`

1.0.9.0.4. Install Node.js Modules

- Open Terminal
- `cd <SAGE2_directory>`
- `npm install`

1.0.1.1. Configure

- Create a configuration file for your display environment

- Save file in /config
- Select your configuration file
  - Option 1: name your configuration file '-cfg.json'
    (eg. host = thor.evl.uic.edu, config file is 'thor-cfg.json')
  - Option 2: create a file 'config.txt' in
    Specify the path to your configuration file in 'config.txt'

1.0.1.2. Run

- Open Terminal / Cmd
  - `cd <SAGE2_directory>`
  - `node server.js` (options: `-i` interactive prompt, `-f <file>` specify a configuration file)
- Open Web Browser
  - Google Chrome
    - First time use - install SAGE2 Chrome Extension
  - Firefox
    - First time use - go to `about:config` and set `media.getusermedia.screensharing.enabled` to true and add domain(s) for SAGE2 server(s) to `media.getusermedia.screensharing.allowed_domains`
  - SAGE2 pages
    - Table of Contents: `http://<host>:<index_port>`
    - Display Client: `https://<host>:<port>/?clientID=<ID>`
    - Audio Client: `https://<host>:<port>/audioManager.html`
    - SAGE UI: `https://<host>:<port>/sageUI.html`
    - SAGE Pointer: `https://<host>:<port>/sagePointer.html`
      (Allow pop-ups)
- Create a one button SAGE2 launcher for the server and displays

1.0.1.3. Supported File Types

- Images
  - JPEG
  - PNG
  - TIFF
  - BMP
  - PSD
- Videos
  - MP4
  - M4V
  - WEBM
- PDFs

2. SAGE2 config

A JSON file to configure the display environment

2.0.1. Fields:

```
{
    host:                   // hostname or ip address of the web server
    port:                   // HTTPS port that all clients are served
                               on (default: 443)
    index_port:             // HTTP port, provides a reroute to HTTPS
                               (default: 80)
    rproxy_port:            // OPTIONAL: port of the HTTPS reverse
                                proxy (only required for reverse proxy setups)
    rproxy_index_port:      // OPTIONAL: port of the HTTP reverse proxy
                               (only required for reverse proxy setups)
    background: {
        color:              // CSS color for the background
                               (hex, rgba(), etc.)
        image: {            // OPTIONAL:
            url:            // relative path from the publicHTTPS
                                directory to an image used for
                                the background
            style:          // either "fit", "stretch", or "tile"
        }
        watermark: {        // OPTIONAL:
            svg:            // relative path from the publicHTTPS
                               directory to a monochrome SVG image
                               used for the watermark
            color:          // CSS color for the watermark (rgba() recommended)
        }
        clip:               // OPTIONAL: boolean, whether or not to clip the
                               display at the exact resolution (default: false)
    }
    ui: {
        clock:              // 12 or 24 (specifies whether to use a
                               12 or 24 hour clock)
        show_url:           // boolean, whether or not to show the host
                               url on the display clients
        show_version:       // boolean, whether or not to show the
                               SAGE2 version number on the display clients
        menubar: {              // OPTIONAL:
            backgroundColor:    // OPTIONAL: CSS color for the background
                                   of the menubar (default: "rgba(0,0,0,0.5)")
            textColor:          // OPTIONAL: CSS color for the text of the
                                   menubar (default: "rgba(255,255,255,1.0)")
            remoteConnectedColor:    // OPTIONAL: CSS color for remote sites
                                        that are connected
                                        (default: "rgba(55, 153, 130, 1.0)")
            remoteDisconnectedColor: // OPTIONAL: CSS color for remote sites
                                        that are not connected
                                        (default: "rgba(173, 42, 42, 1.0)")
        }
        auto_hide_ui:       // OPTIONAL: boolean, whether or not to
                               autohide wall UI decoration (default: false)
        auto_hide_delay:    // OPTIONAL: integer, number of seconds after
                               which to hide the wall UI (default: 30)
        titleBarHeight:     // OPTIONAL: integer, specify window titlebar
                               height in pixels (default: 2.5% of minimum
```

```
                                dimension of total wall)
    titleTextSize:          // OPTIONAL: integer, specify text size of ui
                                titles in pixels (default: 1.5% of minimum
                                dimension of total wall)
    pointerSize:            // OPTIONAL: integer, specify pointer size in
                                pixels (default: 8% of minimum dimension
                                of total wall)
    noDropShadow:           // OPTIONAL: boolean, whether or not to disable
                                drop shadows on wall UI decoration
                                (default: false)
    minWindowWidth:         // OPTIONAL: integer, minimum width for
                                application windows in pixels (default:
                                8% of minimum dimension of total wall)
    minWindowHeight:        // OPTIONAL: integer, maximum width for
                                application windows in pixels (default:
                                120% of maximum dimension of total wall)
    maxWindowWidth:         // OPTIONAL: integer, minimum height for
                                application windows in pixels (default:
                                8% of minimum dimension of total wall)
    maxWindowHeight:        // OPTIONAL: integer, maximum height for
                                application windows in pixels (default:
                                120% of maximum dimension of total wall)
}
resolution: {
    width:                  // width in pixels of a display client
                                (browser window width)
    height:                 // height in pixels of a display client
                                (browser window height)
}
layout: {
    rows:                   // number of rows of display clients
                               (browser windows) that make up the display
                                wall
    columns:                // number of columns of display clients
                                (browser windows) that make up the display
                                 wall
}
displays: [                 // array of displays
    {
        row:                // the row where this display tiles in the
                               display wall (row origin starts with zero
                               at left)
        column:             // the column where this display tiles in the
                               display wall (column origin starts with
                               zero at the top)
    },
    ...                     // list length should equal rows*columns
]
alternate_hosts: [          // array of alternate hostnames for machine
                               (i.e. private network IP, localhost, etc.)
    ...
]
remote_sites: [             // array of remote SAGE2 sites to be able
                               to share content with
    {
        name:               // name to be displayed on display wall
        host:               // specify the remote machine to connect with
                                (in conjunction with port)
        port:               // specify the remote machine to connect with
                                (in conjunction with host)
    },
    ...                     // list as many remote sites as desired
]
```

```
    dependencies: {
        ImageMagick:          // full path to ImageMagick (use "/" as path
                                  delimiter, required for Windows only)
        FFMpeg:               // full path to FFMpeg (use "/" as path
                                  delimiter, required for Windows only)
    }
    apis: {                   // OPTIONAL:
        twitter: {            // OPTIONAL: required only for Twitter enabled Ap
ps
            consumerKey:      // Twitter API 'Consumer Key'
            consumerSecret:   // Twitter API 'Consumer Secret'
            accessToken:      // Twitter API 'Access Token'
            accessSecret:     // Twitter API 'Access Token Secret'
        }
    }
}
```

2.0.2. Minimal Sample:

```
{
    host: "hostname.com",
    port: 443,
    index_port: 80,
    background: {
        color: "#333333"
    },
    ui: {
        clock: 12,
        show_version: true,
        show_url: true
    },
    resolution: {
        width: 1920,
        height: 1080
    },
    layout: {
        rows: 1,
        columns: 1
    },
    displays: [
        {
            row: 0,
            column: 0
        }
    ],
    alternate_hosts: [
        "127.0.0.1"
    ],
    remote_sites: [
    ]
}
```

2.0.3. Expanded Sample

```
{
    host: "hostname.com",
    port: 443,
    index_port: 80,
    background: {
        color: "#333333",
        image: {
            url: "images/background/dbgrid.png",
            style: "tile"
        },
        watermark: {
            svg: "images/EVL-LAVA.svg",
            color: "rgba(255, 255, 255, 0.5)"
        },
        clip: true
    },
    ui: {
        clock: 12,
        show_version: true,
        show_url: true,
        menubar: {
            backgroundColor: "rgba(24, 30, 79, 0.5)",
            textColor: "rgba(235, 230, 175, 1.0)",
            remoteConnectedColor: "rgba(96, 171, 224, 1.0)",
            remoteDisconnectedColor: "rgba(100, 100, 100, 1.0)"
        },
        auto_hide_ui: true,
        auto_hide_delay: 15,
        titleBarHeight: 30,
        titleTextSize: 18,
        pointerSize: 90,
        noDropShadow: true,
        minWindowWidth: 35,
        minWindowHeight: 35,
        maxWindowWidth: 1920,
        maxWindowHeight: 1920
    },
    resolution: {
        width: 1920,
        height: 1080
    },
    layout: {
        rows: 1,
        columns: 1
    },
    displays: [
        {
            row: 0,
            column: 0
        }
    ],
    alternate_hosts: [
        "host.private.com",
        "localhost",
```

```
        "127.0.0.1"
    ],
    remote_sites: [
        {
            name: "Remote1"
            host: "other.com"
            port: 443
        },
        {
            name: "Remote2"
            host: "another.com"
            port: 9090
        },
    ],
    dependencies: {
        ImageMagick: "C:/Program Files/ImageMagick-6.8.9-Q16/",
        FFMpeg: "C:/local/bin/"
    },
    apis: {
        twitter: {
            consumerKey:    "xxxxxxxxxxxxxxxxxxxxxxxxxx",
            consumerSecret: "xxxxxxxxxxxxxxxxxxxxxxxxxx",
            accessToken:    "xxxxxxxxxxxxxxxxxxxxxxxxxx",
            accessSecret:   "xxxxxxxxxxxxxxxxxxxxxxxxxx"
        }
    }
}
```

2.0.3.0.1. Note:

Default ports `80` and `443` are convenient when visiting SAGE2 clients because the port does not have to be explicitly entered (eg. in this sample config a user could simply visit `https://hostname.com/sagePointer.html` instead of `https://hostname.com:443/sagePointer.html`).

However, these ports require privileged access. If you do not have the necessary permissions, please choose port numbers larger than `1024` and explicitly specify the chosen port numbers when typing a URL.

2.0.4. Starting SAGE2 with one button

2.0.4.0.1. Windows

- Single Machine
  - Create file 'GO-.bat' and save in '/GO-scripts'

2.0.4.0.2. Mac OSX

- Single Machine

- Create file 'GO-' and save in '/GO-scripts'

2.0.4.0.3. openSUSE

- Single Machine
  - Create file 'GO-' and save in '/GO-scripts'
- Cluster
  - Create file 'GO-' and save in '/GO-scripts'

2.0.4.0.4. Ubuntu

- Single Machine
  - Create file 'GO-' and save in '/GO-scripts'

2.0.5. SAGE2 Application Methods:

Method	Parameters
init (id, width, height, resrc, date)	`id` is canvas element id, `width` is the initial application width, `height` is the initial application height, `resrc` is path to resource directory, `date` is the date
load (state, date)	`state` is the initial application state (eg. initial data to display), `date` is the date
draw (date)	`date` is the date (used to calculate t and dt for animations). Within your application, call 'refresh' if you need a redraw. If it's interactive application, you can enable 'animation' in the file "instruction.json". the default frame rate is 60fps. Maximum frame rate can be controlled by the variable maxFPS (`this.maxFPS = 20.0` for instance)
resize (date)	`date` is the date. Application can trigger a resize if needed by calling `this.sendResize (newWidth, newHeight)`
moved (px,py, wx,wy, date)	application was moved to (px,py) position in wall space (top-left corner), (wx,wy) contains the size of the wall
event (type, position, user, data, date)	`type` is the type of event, `position` contains the x and y positions of the event, `user` contains data about the user who triggered the event, `data` is an object containing extra data about the event, `date` is the date. See event description below.
quit()	called when an application is closed

2.1. Boiler-plate for a canvas application

```
var myApp = SAGE2_App.extend( {
    construct: function() {
        // call the constructor of the base class
        arguments.callee.superClass.construct.call(this);

        // initialize your variables
        this.myvalue = 5.0;

        this.resizeEvents = "continuous";
             //see below for other options
    },

    init: function(id, width, height, resrc, date) {
        // call super-class 'init'
        arguments.callee.superClass.init.call(this, id,
               <html-tag container for your app (eg. img, canvas)>,
               width, height, resrc, date);

        // application specific 'init'
        this.log("Init");
    },

    //load function allows application to begin with a particular
             state.  Needed for remote site collaboration.
    load: function(state, date) {
        //your load code here- state should define the
             initial/current state of the application
    },

    draw: function(date) {
        // application specific 'draw'
        this.log("Draw");

        //may need to update state here
    },

    resize: function(date) {
        // to do:  may be a super class resize
        // or your resize code here
        this.refresh(date); //redraw after resize
    },

    event: function(type, position, user, data, date) {
        // see event handling description below

        // may need to update state here

        // may need to redraw
        this.refresh(date);
    },

    moved: function(px, py, wx, wy, date) {
        // px, py : position in wall coordinate, top-left corner
                    of the window
```

```
        // wx, wy : width and height of the wall
                // date: when it happened
                // may need to redraw
        this.refresh(date);
       },

    quit: function() {
        // It's the end
        this.log("Done");
    }
});
```

2.2. Function Descriptions

2.2.1. Construct

2.2.2. Init

2.2.3. Draw

2.2.4. Resize

2.2.5. Load

2.2.6. Event

2.2.7. Quit

```
event: function(type, position, user, data, date) {

}
```

type can be any one of the following:

- *pointerPress* (button down) - data.button will indicate whether it is 'left' or 'right' button that caused the event

- *pointerRelease* (button up) - data.button will indicate whether it is 'left' or 'right' button that caused the event
- *pointerMove*
- *pointerDoubleClick* (left button double click)
- *keyboard* (printable key events from the keyboard) - data.code is the character code, data.character is the printable character's string
- *specialKey* (key events for all keys on the keyboard including Backspace, Delete, Shift, etc...) - data.code is the character code, data.state is 'up' or 'down'

position has x and y to give the position of the event.

user has id, label, and color to describe the user who generated the event

date object may be used for synchronizing.

2.3. External Libraries

2.4. How to write an app

2.4.1. instructions.json

2.4.2. Load into application library

2.5. Widgets

Four different types of widgets are available for custom applications. Namely:

- Buttons
- Sliders
- Text Input (Single line) and
- Labels

Any application may request SAGE2 to enable widget support for that application. This is done setting the enableControls property to true (this can be done as a part of the construct function).

```
construct: function() {
        ...
        this.enableControls = true;
}

init: function(id, width, height, resrc, date) {
        ...
        this.controls.<addWidget>(paramObject);
}
```

2.5.1. Button

To add a button to the widget bar, the application may call addButton function on the controls. AddButton function takes one object with two properties, namely type and action. Type specifies the type of the button (appearance and animation of the button) and action is the callback that is executed when the button is clicked.

The type property can take any one value out of: play-pause, play-stop, rewind, fast-forward, prev, and next.

```
this.controls.addButton({type:"rewind", action:function(appObj, date){
        // appObj is the instance of the application that this widget
           is bound to

}});
```

2.5.2. Slider

To add a slider to the widget bar, the application may call addSlider function on the controls. addSlider function takes an object with the following properties:

- *appObj*: The instance of the application that is bound to this slider. Usually 'this' reference is set as the value of appObj.
- *property*: A string representing the property of the application that is tied to the slider. (A change in the value of appObj.property will be reflected in the slider and vice versa)
- *begin*: starting (minimum) value of the property associated with the slider.
- *end*: last (maximum) value of the property associated with the slider.
- *increments*: The step value change that occurs in the property when the slider is moved one unit. (alternatively, parts can be specified in place of increments, where parts represents the number of increments from begin to end)
- *action*: The callback that is executed after the slider has been moved. This callback is not executed when the property value changes from within the app

and in turn affects the slider, it is only executed when the property is changed by the slider.

```
this.controls.addSlider({
                            begin:  ,
                            end:  ,
                            increments:  ,
                            appObj:  ,
                            property: ,
                            action:function(appObj, date){
                                ...
                            }
                        });
```

2.5.3. Text Input

To add a slider to the widget bar, the application may call addSlider function on the controls. addSlider function takes an object with two properties, namely width and action. Width specifies the width of the text input widget (in pixels) and action is the callback that is executed when the Enter key is hit, which marks the end of the input.

```
this.controls.addTextInput({ width: , action: function(appObj, text){
      // appObj is the instance of the application that this widget is
bound to
      // text data from the widget is sent to this callback.
}});
```

2.5.4. Label

To add a label to the widget bar, the application may call addLabel function on the controls. addLabel function takes an object with three properties, namely textLength, appObj and property. textLength specifies the maximum length of the string that will be displayed in the label. appObj is the instance of the application that this widget is bound to. property is the property of the appObj whose value will be converted to a string to be displayed in the label.

The changes to the value of the 'property' are immediately reflected in the text displayed in the label.

```
this.controls.addLabel({textLength:10,appObj:this, property:"pageVal"})
;
```

In the above example, the value of *this.pageVal* will be displayed on the label.

2.6. Future: Inter-application communication

2.7. Example Application: Clock

```
var clock = SAGE2_App.extend( {
    construct: function() {
        arguments.callee.superClass.construct.call(this);
        this.ctx = null;
        this.minDim = null;
        this.timer = null;
        this.redraw = null;

        this.resizeEvents = "continuous";
    },

    init: function(id, width, height, resrc, date) {
        // call super-class 'init'
        arguments.callee.superClass.init.call(this, id, "canvas",
                width, height, resrc, date);

        // application specific 'init'
        this.ctx = this.element.getContext("2d");
        this.minDim = Math.min(this.element.width,
                               this.element.height);
        this.timer = 0.0;
        this.redraw = true;
        this.log("Clock created");
    },

    load: function(state, date) {

    },

    draw: function(date) {
        // application specific 'draw'
        // only redraw if more than 1 sec has passed
        this.timer = this.timer + this.dt;
        if(this.timer >= 1.0) {
            this.timer = 0.0;
            this.redraw = true;
        }

        if(this.redraw) {
            // clear canvas
            this.ctx.clearRect(0,0, this.element.width,
                                    this.element.height);

            this.ctx.fillStyle = "rgba(255, 255, 255, 1.0)"
            this.ctx.fillRect(0,0, this.element.width,
                                   this.element.height)

            var radius = 0.95 * this.minDim / 2;
            var centerX = this.element.width / 2;
```

```
            var centerY = this.element.height / 2;

            // outside of clock
            this.ctx.lineWidth = (3.0/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(85, 100, 120, 1.0)";
            this.ctx.beginPath();
            this.ctx.arc(centerX, centerY, radius, 0, Math.PI*2);
            this.ctx.closePath();
            this.ctx.stroke();

            // tick marks
            var theta = 0;
            var distance = radius * 0.90; // 90% from the center
            var x = 0;
            var y = 0;

            // second dots
            this.ctx.lineWidth = (0.5/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(20, 50, 120, 1.0)";

            for(var i=0; i<60; i++){
                // calculate theta
                theta = theta + (6 * Math.PI/180);
                // calculate x,y
                x = centerX + distance * Math.cos(theta);
                y = centerY + distance * Math.sin(theta);

                this.ctx.beginPath();
                this.ctx.arc(x, y, (1.0/100.0) * this.minDim,
                             0, Math.PI*2);
                this.ctx.closePath();
                this.ctx.stroke();
            }

            // hour dots
            this.ctx.lineWidth = (2.5/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(20, 50, 120, 1.0)";

            for(var i=0; i<12; i++){
                // calculate theta
                theta = theta + (30 * Math.PI/180);
                // calculate x,y
                x = centerX + distance * Math.cos(theta);
                y = centerY + distance * Math.sin(theta);

                this.ctx.beginPath();
                this.ctx.arc(x, y, (1.0/100.0) * this.minDim,
                             0, Math.PI*2, true);
                this.ctx.closePath();
                this.ctx.stroke();
            }

            // second hand
            var handSize = radius * 0.80; // 80% of the radius
            var sec = date.getSeconds();

            theta = (6 * Math.PI / 180);
```

```
            x = centerX + handSize * Math.cos(sec*theta - Math.PI/2);
            y = centerY + handSize * Math.sin(sec*theta - Math.PI/2);

            this.ctx.lineWidth = (1.0/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(70, 35, 50, 1.0)";
            this.ctx.lineCap = "round";

            this.ctx.beginPath();
            this.ctx.moveTo(x, y);
            this.ctx.lineTo(centerX, centerY);
            this.ctx.moveTo(x, y);
            this.ctx.closePath();
            this.ctx.stroke();

            // minute hand
            handSize = radius * 0.60; // 60% of the radius
            var min = date.getMinutes() + sec/60;

            theta = (6 * Math.PI / 180);
            x = centerX + handSize * Math.cos(min*theta - Math.PI/2);
            y = centerY + handSize * Math.sin(min*theta - Math.PI/2);

            this.ctx.lineWidth = (1.5/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(70, 35, 50, 1.0)";
            this.ctx.lineCap = "round";

            this.ctx.beginPath();
            this.ctx.moveTo(x, y);
            this.ctx.lineTo(centerX, centerY);
            this.ctx.moveTo(x, y);
            this.ctx.closePath();
            this.ctx.stroke();

            // hour hand
            handSize = radius * 0.40; // 40% of the radius
            var hour = date.getHours() + min/60;

            theta = (30 * Math.PI / 180);
            x = centerX + handSize * Math.cos(hour * theta-Math.PI/2);
            y = centerY + handSize * Math.sin(hour * theta-Math.PI/2);

            this.ctx.lineWidth = (2.0/100.0) * this.minDim;
            this.ctx.strokeStyle = "rgba(70, 35, 50, 1.0)";
            this.ctx.lineCap = "round";

            this.ctx.beginPath();
            this.ctx.moveTo(x, y);
            this.ctx.lineTo(centerX, centerY);
            this.ctx.moveTo(x, y);
            this.ctx.closePath();
            this.ctx.stroke();

            this.redraw = false;
        }
    },
```

```
    resize: function(date) {
        this.minDim = Math.min(this.element.width,this.element.height);
        this.redraw = true;

        this.refresh(date);
    },

    event: function(type, position, user, data, date) {
        // this.refresh(date);
    },

    quit: function() {
        // done
    }
});
```

2.8 Startup using *systemd*

If you have SAGE2 installed in a production environment, you may want to add it to your startup scripts so it starts with every reboot.

Note: This only starts the node sage2 server, not the display clients!

2.8.1. Prerequisites

Your OS distribution needs to be using *systemd* to startup items.

2.8.2. Installation

Edit GO-scripts/sage2Server.service and set the WorkingDirectory to your SAGE2 directory.

```
sudo cp sage2Server.service /usr/lib/systemd/system/ sudo systemctl daemon-reload
```

2.8.3. Enabling sage2Server to start on boot

```
sudo systemctl daemon-reload
```

2.8.4. Start sage2Server

```
sudo systemctl start sage2Server
```

2.8.5. Stop sage2Server

```
sudo systemctl stop sage2Server
```

2.8.6. Restart sage2Server

```
sudo systemctl restart sage2Server
```

2.8.7. Reload the script

Reminder: Every time you modify the sage2Server.service file, you also need to run:

```
sudo systemctl daemon-reload
```