

# A Dynamic Visualization Tool for the Analysis of SPIKE Scheduling Constraints

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## Introduction

The goal of my project was to create a dynamic visualization tool that would enable SPIKE developers and users to easily understand the information encoded within a PCF. The tool had to be lightweight, loading input information quickly and efficiently. It had to be interactive, allowing the user to zoom in on a particular time period or view time and value information dynamically. Lastly, it had to be independent, producing a stand-alone web page that you could easily pass to a collaborator who could then view it without necessarily having access to SPIKE. With this tool, SPIKE developers and users would be able to analyze scheduling constraints more efficiently, and ultimately streamline the process of space-based data acquisition.

The tool will display PCF information as a one-dimensional image, with time information displayed across the single horizontal axis and value information encoded in various colors along the image. Time information is calculated automatically in the tool based on the input PCFs, however the color mappings are input by the user (this may change shortly).

## User-Input Information

### input-pcfs

The keyword input-pcfs contains the PCF information that will populate the visualization tool. Each input PCF must first contain a string that identifies the unique PCF and then the PCF information itself (Figure X). The time information within the PCF must be in tjd format. The suggested maximum number of input PCFs is 4500. Below is an example of input PCF information as a LISP structure and its resulting output visualization. Colors correspond to the example Legend, found in the Features subsection.

```
((("Example 1" (-6666666666666666 0.0 12915.1 0.1 12916.1 0.4 12917.1 0.3 12918.1 0.2 12919.1 0.0)))
```

Example 1



**Note:** It has been suggested to change the input-pcfs keyword to a function, so it may not stay within the user-input information.

### start

The keyword start indicates either the minimum non-negative time step among all the input PCF information, or the user-input start value.

### end

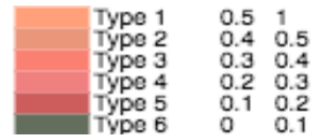
The keyword end indicates either the maximum time step among all the input PCF information, or the user-input end value.

### color-ranges

The keyword color-ranges contains the lower and upper bounds of the user-input value ranges, their associated colors and associated labels. These value ranges will be displayed within the Legend in the top left corner of the window (see Features below).

## Features

**Legend:** The Legend tells users which types of information are encoded in the input PCF values, and in turn which values have been assigned their respective colors. The Legend contains first the user-input color for a particular value range, the label that corresponds to that color, and finally the lower and upper bounds of the value range that the color is meant to encode.



Type 1	0.5	1
Type 2	0.4	0.5
Type 3	0.3	0.4
Type 4	0.2	0.3
Type 5	0.1	0.2
Type 6	0	0.1

For each value range, the lower bound is exclusive, and the upper bound is inclusive. The image above contains an example of a Legend.

**Time Display:** The Time Display features PCF time and value information, as it corresponds to the user's cursor position within the window. The Unzoomed Timeline Time Bar Position refers to the beginning and end dates of a user-selected time period. Before a time period has been selected, this region will remain empty. After zooming or unzooming, this region will contain the start and end dates of the current selected time period, as additionally reflected in the Zoomed Timeline. The Zoomed Timeline Time Bar Position indicates the Selected Time. The Selected Time is directly connected to the Zoomed Timeline, as both respond to the information within the user-selected time period. The Transition Time Range for Selected PCF indicates the previous and subsequent time steps with regard to both the Selected Time and the Selected PCF. The PCF Value at Selected Time refers to the value contained within the Transition Time Range. Both the Transition Range and PCF Value are unique to each PCF, so even as the user scrolls vertically along the same Selected Time, those values will change to match the information within the Selected PCF.

**Time Scroll:** The Time Scroll Feature allows users to view time and value information dynamically, as it corresponds to the cursor's position within the window. The elements of the Time Scroll Feature include the black horizontal bar indicating the Selected PCF, the red vertical bar indicating the Selected Time, and all of the printed values that appear in the Time Display when this feature is activated.

**Zooming:** The Zooming Feature was created so that users could easily examine the details of a PCF without manually inputting start and end times. When the user selects a specific time period (instructions below), both the Zoomed Timeline and the PCF Data will be redrawn to contain only the information within the user-selected time period. The Time Display will reflect the time and value information in the newly-scaled image.

**Unzooming:** The Unzooming Feature was created so that users could quickly and easily return to the default, unzoomed time period after having previously selected a zoomed time period. This feature returns the Zoomed Timeline and PCF Data to their original format, to include all of the time and value information within all the input PCFs. The Time Display will reflect the time and value information in the newly-scaled image.

## User Instructions for Interactive Features

**Time Scroll:** Place the cursor over the input PCF data that is located underneath the Zoomed Timeline. Two lines will appear on the window and then continually follow the location of the cursor while it remains over the PCF data. The black horizontal line refers the Selected PCF. When a PCF becomes Selected, its identification number on the left-hand side of the screen will be drawn in bold. The vertical red line is the Time Bar and indicates the Selected Time. The numerical value of the Selected Time is reflected in the Time Display above, where it says Zoomed Timeline Time Bar Position.

**Zooming:** Place the mouse over the Unzoomed Timeline and press down with the mouse without releasing. At this point you should see a vertical blue line appear at the location of the mouse. Drag the mouse to the right along the Unzoomed Timeline to a different, later time and release the mouse. Once the mouse is

released, several actions will occur: 1) another blue line will appear on the Unzoomed Timeline at the position where the mouse was released, 2) the entire user-selected time period will be highlighted in blue on the Unzoomed Timeline, 3) both the Zoomed Timeline and the PCF data itself will be redrawn to include only the information contained in the user-selected time period, 4) the information in the Time Display will generally reflect that contained within the Zoomed PCFs, however the time information in the Unzoomed Timeline Time Bar Position will indicate the beginning and end dates of the user-selected time period. These beginning and end dates will remain constant until the user either selects a new time period or unzooms.

**Unzooming:** Press any key. Notice the Zoomed Timeline, PCF data, and Time Display return to their original format.

## Functions

### LISP Functions

**plot-pcfs:** Primary function

**font:** Sets font parameters

**subrange:** Returns all values in a list between given range of values

**collect-time:** Returns all time values from a PCF

**collect-suitability:** Returns all suitability values from a PCF

**create-seq-list:** Creates list of integers

**overlay-id:** Creates overlay ID: "Example-overlay"

**create-canvas:** Creates a canvas with a relative position

**create-top-canvas:** Creates a canvas with a fixed position at the top of the screen

**create-bottom-canvas:** Creates a canvas with a fixed position at the bottom of the screen

**create-time-array:** Creates an array of days between the first positive input time step and the last input time step. Time formats include tjd, sogs-date, and abs-time. This function necessarily interacts with a JavaScript function of the same name.

**create-transition-array:** Creates an array with all the positive input time steps in tjd, sogs-date, and abs-time. This function necessarily includes a JavaScript function of the same name.

**create-pcf-array:** Creates an exact copy of an input PCF LISP structure as a JavaScript array. This function necessarily interacts with a JavaScript function of the same name.

**create-color-array:** Creates an exact copy of an input color range LISP array as a JavaScript array. This function necessarily interacts with a JavaScript function of the same name.

**build-page:** Draws all items onto the window display

### JavaScript Functions

**addOverlay:** Adds the overlay id of a particular PCF to an existing array of overlay ids

**addCanvas:** Adds the canvas id of a particular PCF to an existing array of canvas ids

**addIndicatorListener:** Adds an event listener to a particular canvas. The event listener will note the cursor's position within the window and return information about its position to be later reflected in the location of the vertical red Time Bar and the time information in the Time Display

**addTimeDrag:** Adds the relevant event listeners for the Zooming and Unzooming Features, including dragging events (mousedown and mouseup) for Zooming and keypress events for Unzooming

**createTimeArray:** Creates an array of days between the first positive input time step and the last input time step. Time formats include tjd, sogs-date, and abs-time. This function necessarily interacts with a LISP function of the same name.

**createTransitionArray:** Creates an array with all the positive input time steps in tjd, sogs-date, and abs-time. This function necessarily interacts with a LISP function of the same name.

**createPCFArray:** Creates an exact copy of an input PCF LISP structure as a JavaScript array. This function necessarily interacts with a LISP function of the same name.

**createColorArray:** Creates an exact copy of an input color range LISP array as a JavaScript array. This function necessarily interacts with a LISP function of the same name.

**lfulmerJDUT:** Recreates the built-in LISP function jdut

**lfulmerDMYtoDOY:** Recreates the built-in LISP function day-month-year-to-day-of-year

**lfulmerTJDtoShortSogs:** Recreates the built-in LISP function tjdt-to-short-sogs-date

**drawColorBarLabels:** Draws all static information within the Legend & Time Display

**drawGlobalTimeline:** Draws the Unzoomed Timeline

**drawLocalTimeline:** Draws the Zoomed Timeline

**drawPCFData:** Draws the input PCF data

**redrawPCFData:** Draws the input PCF data after a user-selected time period has been set or an Unzoom event has been initialized

**clearCanvas:** Clears a particular canvas

**drawLine:** Draws a line

**drawFillRect:** Draws a filled rectangle

**drawBar:** Draws a bar

**drawHLine:** Draws a horizontal line

**drawVLine:** Draws a vertical line

**drawHTick:** Draws a horizontal tick

**drawVTick:** Draws a vertical tick

**drawText:** Draws text

**initPlotWidth:** Sets a width attribute for a canvas

### **Contact Information**

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