Visualizing Eye-Tracking Data with SAS®
Creating Heat Maps on Images
Visualizing Eye-Tracking Data with SAS®: Creating Heat Maps on Images
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ABSTRACT
Eye-tracking data are collected by observing a person and logging the coordinates of their gaze on an image. In this example, an image depicting skydivers was presented to a test subject and his gaze was recorded. The intensity of his gaze is represented through varying shades of color. Essentially, the result is a heat map drawn on top of an image.

METHODS
- Data is collected across time. At regularly-spaced intervals, the pixel corresponding to a subject’s gaze is recorded.
  
<table>
<thead>
<tr>
<th>Time</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
</tbody>
</table>

- A third dimension, z, is projected using `proc freq`:
  ```sas
  proc freq data=infile nopermcnt;
  tables x*y / out=freq (rename=(COUNT=z));
  run;
  ```

- The bivariate distribution is smoothed using `proc kde`:
  ```sas
  proc kde data=freq;
  bivar x (grid=0 gridu=599 ngrid=600)
          y (grid=0 gridu=399 ngrid=400)
       / bwm = 1.2 out=density plots=(contour) levels;
  weight z;
  run;
  ```

- A GTL template is created using `proc template`.

- The template is used to render a heatmap over the image using `proc sgrender`.

RESULTS

```sas
%let height = 400;
%let width = 600;
```
Bivariate distribution is smoothed using kernel density estimate procedure

```sas
proc kde data=freq;
  bivar
    x (gridl=0 gridu=599 ngrid=600)
    y (gridl=0 gridu=399 ngrid=400)
  / bwm=1.2 out=density;
  weight z;
run;
```
Adjust the "bandwidth modifier" parameter to desired effect

```
proc kde data=freq;
   bivar
      x (gridl=0 gridu=599 ngrid=600)
      y (gridl=0 gridu=399 ngrid=400)
   / bwm=3.0
      density;
   weight 2.9;
run;
```

Adjust the "bandwidth modifier" parameter to desired effect
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```
proc template; define statgraph eyemap; begingraph;

layout overlay/

  xaxisopts=( offsetmin=0 offsetmax=0 linearopts=(viewmin=0 viewmax=%sysevalf(&width.-1, int)))

  yaxisopts=( offsetmin=0 offsetmax=0 linearopts=(viewmin=0 viewmax=%sysevalf(&height.-1, int)) reverse=true)

  opaque=false walldisplay=none;

drawimage "C:\Pictures\Jumpers.jpg" /

    width=100 widthunit=percent height=100 heightunit=percent x=50 y=50 drawspace=wallpercent layer=back transparency=0;

heatmapparm x=x y=y colorresponse=z/

    name = "map" colormodel =(blue cyan yellow red) includemissingcolor=FALSE datatransparency=.8

    xgap=0 ygap=0 xbinaxis=false ybinaxis=false;

  continuouslegend "map" /

    title="Intensity of Subject's Gaze" location=outside valign=bottom ;

endlayout;

digraph; end; run;
```
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colormodel = (blue cyan yellow red)
colormodel = (white black)
colormodel = (red orange yellow green blue indigo violet)
colormodel = (red pink white)
colormodel = (CX6497EB CXFFFFFF CXDD6060)
A well-developed template is reusable and can be parameterized to accept images with varying dimensions and apply a variety of color models. The applications are numerous. Here are a handful of examples: