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A Journey from data to dashboard: Visualizing the university instructional classroom utilization and diversity trends with SAS® Visual Analytics

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ABSTRACT

Transforming data into intelligence for effective decision-making support is critically based on Office of Institutional Research's role and capacity in managing the institution's data. Presenters will share their journey from providing spreadsheet data into developing SAS programs and dashboards using SAS Visual Analytics. Experience gained and lessons learned will also be shared at this session.

The presenters will:

1. demonstrate two dashboards the IR office developed, one for classroom utilization and one for the University's diversity initiatives;
2. share the steps for creating the dashboards;
3. describe the process the office took in getting the stakeholders involved in determining the KPIs, evaluating and providing feedback regarding the dashboard; and
4. share their experience gained and lessons learned in building the dashboard;

INTRODUCTION

In this paper we will discuss the process our office went through in building dashboards using SAS Visual Analytics. The audience for this is SAS business users and business analysts. Team leaders and executives may find it useful as well.

CURRENT STATUS

Prior to developing dashboards to present data to the campus, the data was primarily provided in an excel spreadsheet (Figure 1) and/or through our web interface (Figure 2). Presenting the data in this way is manageable for power users, but often proved overwhelming for casual users. Additionally, these reports are canned, so users do not have much flexibility to find the data they need without reading over multiple pages.

Screen captures of current status are displayed in Figure 1 and Figure 2 below

Day-Hour Utilization Grid (Total number of times that the space is used in each slot)

	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM
Mon	77	223	228	231	187	216	185	122	49	37	21	5	4
Tue	95	276	29	269	261	24	257	219	28	61	40	7	3
Wed	71	234	246	235	189	206	181	121	54	37	22	9	3
Thu	94	272	21	265	256	24	238	200	20	51	22	3	0
Fri	56	203	209	206	170	172	124	62	14	5	1	1	0

	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM
Mon	22%	64%	66%	67%	54%	62%	53%	35%	14%	11%	6%	1%	1%
Tue	27%	80%	8%	78%	75%	7%	74%	63%	8%	18%	12%	2%	1%
Wed	20%	67%	71%	68%	54%	59%	52%	35%	16%	11%	6%	3%	1%
Thu	27%	78%	6%	76%	74%	7%	69%	58%	6%	15%	6%	1%	0%
Fri	16%	59%	60%	59%	49%	50%	36%	18%	4%	1%	0%	0%	0%

Total Room 347

Figure 1. Example of Classroom Utilization data provided in an excel spreadsheet

Degrees Conferred
Fiscal Year 2014

		Gender		Ethnicity						Citizenship	
Click buttons below column headings, to Filter Totals ->	Head Count	Female	Male	Asian	Black/ Afr Amer	Hispanic	Amer Indian	Multi - Racial	White	Citizen	Non Citizen
Bachelors											
Agr & Env Sci	384	198	186	15	25	17	2	7	318	375	9
Arts & Sciences	2,441	1,472	969	249	175	151	3	58	1,803	2,344	97
Business	1,355	535	820	141	63	59	2	26	1,063	1,285	70
Ecology	27	19	8	3	0	1	0	0	23	25	2
Education	621	451	170	26	30	22	1	10	532	606	15
Engineering	69	20	49	7	7	3	0	1	51	64	5
Env & Design	42	15	27	8	1	0	0	0	33	38	4
Fam & Consmr Sci	417	342	75	40	46	19	0	7	304	395	22
For & Nat Res	67	23	44	1	1	4	0	0	60	67	0
GRIF Agr&Env Sci	3	2	1	0	0	0	0	0	3	3	0
GRIF Arts & Sci	1	1	0	0	0	0	0	0	1	1	0
GRIF Business	7	4	3	1	1	0	0	0	5	7	0
GRIF Education	11	10	1	0	3	0	0	0	8	11	0
GRIF Fam&Con Sci	4	2	2	0	1	0	0	0	3	4	0
Jrl & Mass Comm	562	423	139	24	35	22	0	12	469	558	4
Pub & Intl Aff	383	202	181	28	28	24	0	9	294	373	10
Public Health	123	101	22	12	16	0	0	3	92	120	3
Social Work	44	42	2	1	4	2	0	3	34	43	1
TIFT Agr&Env Sci	14	5	9	0	0	0	0	0	14	14	0
Subtotal	**6,575**	**3,867**	**2,708**	**556**	**436**	**324**	**8**	**136**	**5,110**	**6,333**	**242**
Masters											

Figure 2. Web Example of Diversity data

NEED FOR DATA VISUALIZATION

A picture is a worth a thousand words and the advent of various data visualization tools has made it easier and affordable for business users to create dashboards in a very short amount of time.

A dashboard is a function that helps us turn data into information and send a message to the users. After careful selection, our office chose SAS Visual Analytics as our data visualization tool.

DEVELOPING OUR FIRST DASHBOARD - CLASSROOM UTILIZATION

We chose Classroom Utilization as our first dashboard project by applying the following approach:

- **Scope**: We wanted to keep the scope within reach and make sure it was achievable;
- **Strategy**: our strategy was to target the low hanging fruit, i.e.
    - easily available data, and
    - areas with broad impact.

We used the following guidelines for dashboard development. The dashboard should:

- convey a message,
- be a visual presentation of performance measures,
- provide quick identification of trends and correlations,
- be a measure of efficiencies/inefficiencies,
- provide optional detailed numbers besides the graphs, and
- include Key Performance Indicators (KPIs) bought-in by the users.

STEPS TO CREATE CLASSROOM UTILIZATION DASHBOARD:

1. **Start from the End:** We looked at various classroom utilization dashboards and developed one that fit our needs.

2. **Need for Key Performance Indicators (KPIs) buy-in:** We reviewed University of Minnesota's Classroom Utilization dashboard and adopted their KPIs. We met with our stakeholders and received their approval on the various KPIs.

3. **Data preparation is the key:** We found that we get the best results when we prepare the data at the onset. We created a SAS program to deliver a SAS dataset that has comprehensive and calculated data with fields that we require in our dashboard.

4. **Loading data in SAS Visual Analytics:** We loaded the SAS dataset prepared in step 3 in SAS Visual Analytics using the local import feature.

5. **Creating a Dashboard:** We used SAS Visual Analytics' Report Designer module and created various charts and tables based on step 1 above. We went through multiple iterations of steps 3, 4, and 5 to reach a stage where we were confident to provide a demo to our stakeholders and receive their feedback.

CLASSROOM UTILIZATION DASHBOARD EXAMPLE:

Screen captures of the Classroom Utilization Dashboard are displayed in Figure 3 to Figure 13 below

Time Utilization: Total Used Minutes / Total Available Minutes **i.e.** Total minutes the classroom is used divided by the total minutes the classroom was available to be scheduled expressed as a percentage.
Example: Time Period = 8am-5pm (9 hours * 60 = 540 minutes); 5 days in a week; Total minutes number of minutes classroom scheduled = 1,350 minutes; then **Time Utilization = (1,350) / (540 * 5) = 50%**
Key Performance Indicator Goals (24 State Standards*): Time Utilization target is 65%
0% <= Time Utilization < 20% <= Time Utilization < 50% <= Time Utilization < 65% <= Time Utilization* <= 100%

Seat Utilization: Occupied Seats / Available Seats **i.e** The average percentage of seats occupied in the classroom when the class is in use.
Example: Occupied Seats = Enrollment in class (50) , Available Seats = 100, then Seat Utilization = 50/100 = 50%
Key Performance Indicator Goals (24 State Standards*): Seat Utilization target is 66%
0% <= Seat Utilization < 20% <= Seat Utilization < 50% <= Seat Utilization < 66% <= Seat Utilization* <= 100%

Classroom Hours Per week: Total Used Minutes / 60 **i.e.** Total hours the classroom is scheduled in a week
Example: time period = 8am-5pm (9 hours * 60), 5 days in a week, number of hours classroom scheduled = 22.5 hours
Key Performance Indicator Goals (24 State Standards*): Course Hours Per week target is 35.5 hours
0 <= Classroom Hours Per Week < 10 <= Classroom Hours Per Week < 25 <= Classroom Hours Per Week < 35.5 <= Classroom Hours Per Week* <= 45

Occupancy Rate: Classroom Hours Per week x Seat Utilization **i.e** The actual number of hours a given seat is used in a week - (Classroom Hours Per week) x (Seat Utilization)
Example: Classroom Hours Per week = 30 hours, Seat Utilization = 50%, then occupancy rate = 30 * 0.5 = 15
Key Performance Indicator Goals (24 State Standards*): Occupancy Rate target is 23.5
0 <= Occupancy Rate < 5 <= Occupancy Rate < 15 <= Occupancy Rate < 23.5 <= Occupancy Rate* <= 45

*Source: Maximum Space Utilization Report by 2010 The Advisory Board Company, Washington, DC

Figure 3. Various KPIs in Classroom Utilization Dashboard

Figure 4. Classroom Utilization Summary (all calculations are based on 8am-5pm Monday-Friday time period)

Figure 5. Overall Time Utilization Trend; SAS VA Object – Line Chart

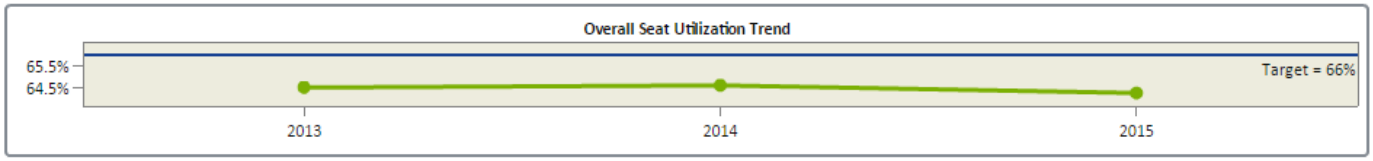

Figure 6. Overall Seat Utilization Trend; SAS VA Object – Line Chart

Classroom	Rooms Available
GENERAL CLASSROOM	248
LARGE LECTURE ROOM	117	
	365

Figure 7. Rooms Used; SAS Visual Analytics object: List Table

Classroom	Rooms Used	Smallest	Average	Largest	Avg Enrollment	Time Utilization	Seat Utilization	Classroom Hours Per Week	Occupancy Rate
GENERAL CLASSROOM	234	12	34	80	23	46%	67%	21	14
LARGE LECTURE ROOM	109	51	122	409	80	48%	58%	22	12
	343	12	63	409	42	47%	64%	21	13

Figure 8. Rooms Used; SAS Visual Analytics Object: List Table with Display rules

Room Assignment	Rooms Used	Smallest	Average	Largest	Avg Enrollment	Time Utilization	Seat Utilization	Classroom Hours Per Week	Occupancy Rate
Centrally Assigned	82	12	84	409	65	48%	72%	22	16
Department Assigned	261	12	56	365	35	46%	62%	21	13
	343	12	63	409	42	47%	64%	21	13

Figure 9. Centrally Scheduled and Department Classroom; SAS Visual Analytics object: List Table with Display rules

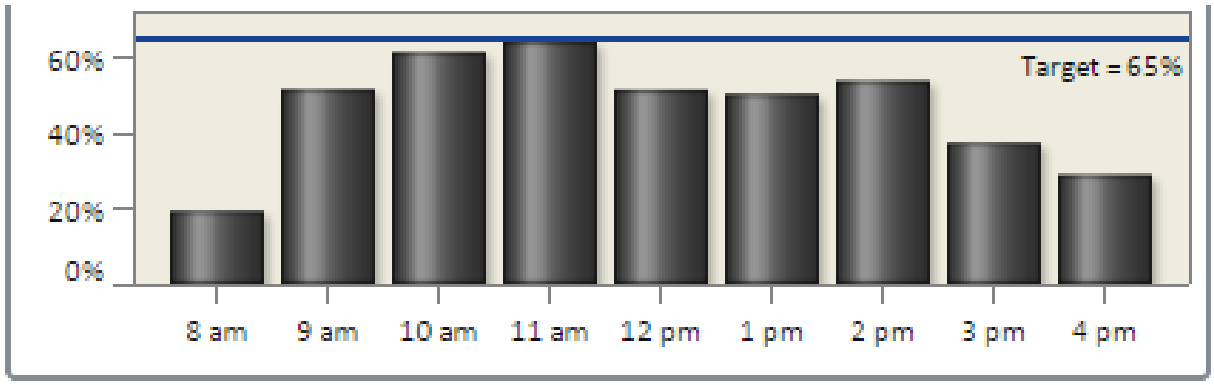

Figure 10. Time Utilization by Clock hour; SAS Visual Analytics object: Bar Chart with Target line showing the KPI Goal

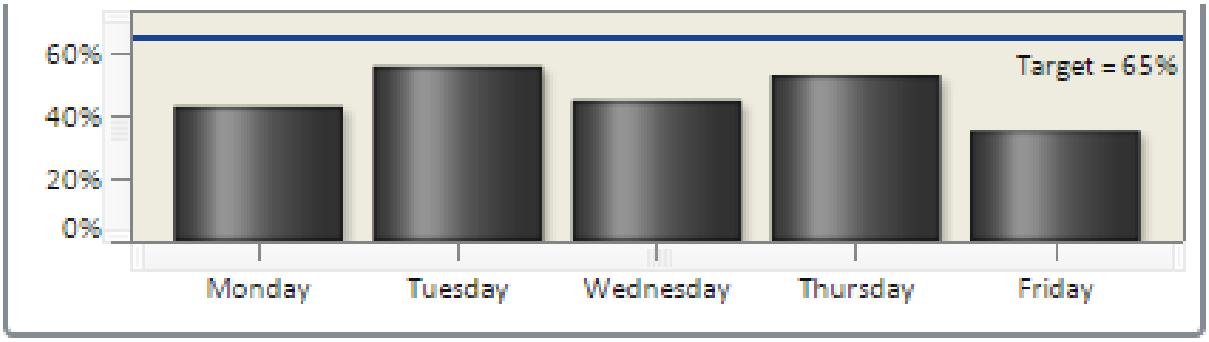

Figure 11. Time Utilization by Day; SAS Visual Analytics object: Bar Chart with Target line showing the KPI Goal

	Start Time ▲	8 am	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm
Classroom ▲	Day ▲	Time Utilization	Time Utilization	Time Utilization	Time Utilization	Time Utilization	Time Utilization	Time Utilization	Time Utilization	Time Utilization
GENERAL CLASSROOM	Monday	19%	55%	62%	54%	49%	50%	45%	35%	24%
	Tuesday	22%	45%	58%	80%	56%	54%	72%	52%	47%
	Wednesday	19%	58%	67%	60%	51%	50%	49%	38%	26%
	Thursday	23%	43%	54%	77%	53%	53%	69%	44%	38%
	Friday	17%	49%	57%	47%	42%	44%	36%	22%	11%
LARGE LECTURE ROOM	Monday	15%	61%	68%	57%	49%	44%	40%	31%	20%
	Tuesday	28%	54%	67%	88%	65%	63%	79%	53%	50%
	Wednesday	16%	61%	67%	55%	49%	43%	41%	31%	21%
	Thursday	25%	53%	68%	86%	65%	64%	78%	48%	43%
	Friday	8%	50%	61%	44%	44%	41%	29%	19%	11%

Figure 12. Day-Hour Time Utilization Grid; SAS Visual Analytics object: Crosstab with Display rules

Building Name	Room Number	Avg Room Capacity	Avg Enrollment	Avg Room Square Foot	Time Utilization	Seat Utilization	Classroom Hours Per Week	Occupancy Rate
ADERHOLD HALL	00G5	78	60	1,120	43%	77%	19	15
ADERHOLD HALL	0102	33	16	612	69%	48%	31	15
ADERHOLD HALL	0112	30	14	612	48%	48%	22	10
ADERHOLD HALL	0114	36	18	890	43%	51%	19	10
ADERHOLD HALL	0116	40	19	998	44%	49%	20	10
ADERHOLD HALL	0119	48	23	997	52%	49%	24	12
ADERHOLD HALL	0206	40	18	920	64%	46%	29	13
ADERHOLD HALL	0215	35	25	907	26%	70%	12	8
ADERHOLD HALL	0306	25	20	593	44%	81%	20	16
ADERHOLD HALL	0317	46	25	889	44%	55%	20	11

Figure 13. Room Utilization Summary; SAS Visual Analytics object: List table with Display rules

DIVERSITY DASHBOARD

STEPS TO CREATE THE DIVERSITY DASHBOARD:

1. **Begin at the End:** Before beginning work on the Diversity Dashboard we wanted to understand what types of visualizations were needed by the users. We looked at prior requests for data, reports previously generated, and current web reports which include a diversity component. We did not want to duplicate work already published in the Fact Book or our online FACTS reporting site, however, we did look at ways to make already available reports more easily read by the casual user. We then decided on three major areas for the dashboard: Student Enrollment, Degrees Conferred, and Faculty and Staff.

2. **Data preparation is the key:** With the end in mind, we then turned back to the beginning. Before starting a data visualization project you need a good data source. We found that while we could pull components from multiple tables and quickly tabulate within SAS ® Enterprise Guide ® to create quick visualizations in Excel, we could not join tables within Visual Analytics and therefore, needed to have all the data together in one dataset before loading into SAS Visual Analytics. Using SAS Enterprise Guide, we created separate datasets for each separate area of our dashboard and then loaded those into SAS Visual Analytics.

3. **Creating a Dashboard:** After the end was visualized, and the data was prepared, we began the process of actually creating the dashboard within SAS Visual Analytics. We found as we went that there were many times we needed an additional piece of data which was not included in our dataset. When this would happen we would return to the SAS program, add the missing piece, and reload the dataset to SAS Visual Analytics. This was a long process of back and forth, but in the end we were able to achieve our goal and have a diversity dashboard which displays the components we visualized at the beginning.

DIVERSITY DASHBOARD EXAMPLE:

Screen captures of the Diversity Dashboard are displayed in Figure 14 to Figure 16 below

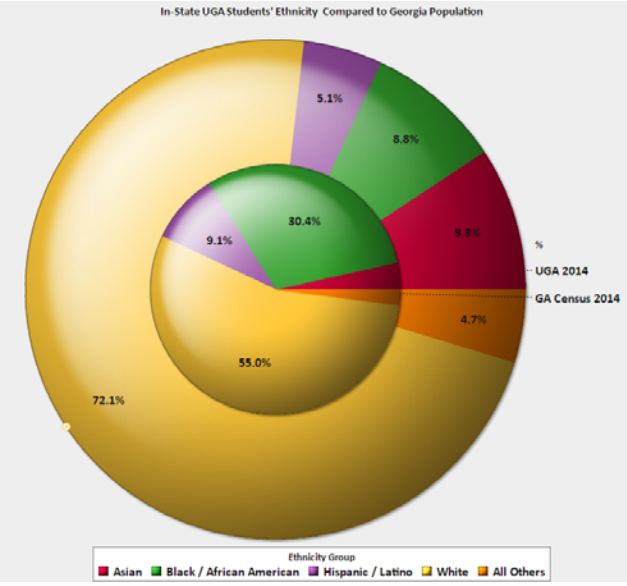

Figure 14. In-State Student Population Compared with Overall State Population

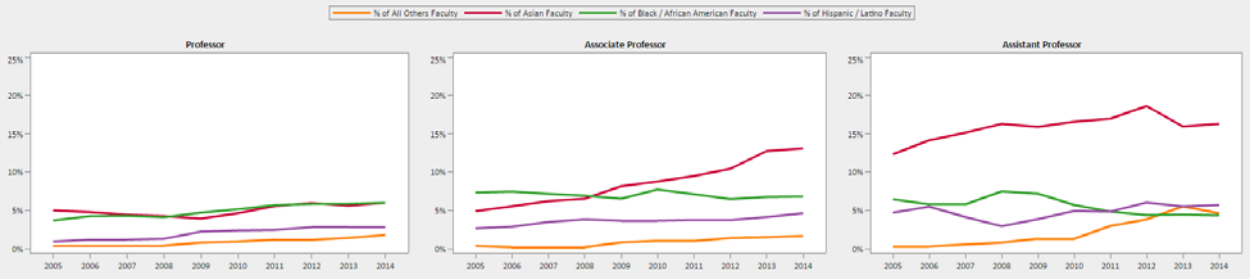

Figure 15. 10-Year Trend of the Percent of Tenured and Tenure-Track Minority Faculty

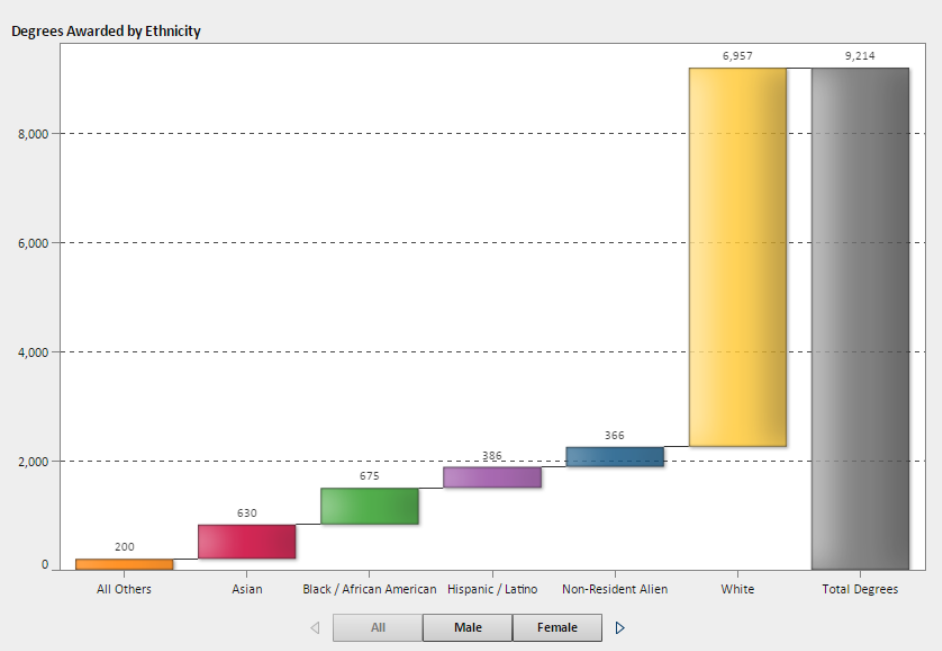

Figure 16. Degrees Awarded by Ethnicity and Year

ONGOING AND FUTURE WORK

DATA LOAD AUTOMATION:

In addition to developing new dashboards, one of our goals is to automate loading data into SAS LASR to the extent possible. To that effect, we are working on the following plan:

1. While developing the dashboard, there is a need to prepare the data, load the data in SAS LASR and update the dashboard multiple times.

    a. Write a SAS program to create and register the dataset directly in SAS LASR

        i. Process data steps to generate SAS dataset by pulling data from various sources
        ii. Unload data from SAS LASR
        iii. Data step to load dataset into SAS LASR
        iv. Register SAS dataset in metadata

    b. Refresh and update the dashboard with the updated data and new fields, if any.

    c. Repeat steps a and b, above until the dashboard is ready to be moved to production

2. Once the dashboard has been developed and moved to production, follow the steps below:

    a. Create a SAS program to generate an updated dataset and store it in the autoload directory defined by the sysadmin

    b. Create a cronjob to run the SAS program created in step 2.a above on a periodic basis

ABOUT SAS VISUAL ANALYTICS

The dashboards demonstrated in this paper were developed using SAS Visual Analytics version 6.4. In April 2015, we upgraded to version 7.1, released March, 2015.

In our experience, developing a dashboard in SAS Visual Analytics has the following benefits and limitations:

BENEFITS

- SAS Visual Analytics has drag and drop functionality and is very easy to use.
- Once data is prepared and loaded in the SAS LASR Server, it is very easy to navigate and create reports.
- It is very easy for analysts to develop the reports themselves and hence limited IT expertise is required for developing the reports.
- It is web enabled and therefore, easy to share insights with anyone, anywhere.
- SAS has an excellent customer support team and we have taken advantage of their support many times with an average turnaround time of 1 to 3 business days.

FRINGE BENEFITS

- SAS Visual Analytics is quick and easy to use and we are planning to use if for creating ad-hoc reports requested by our users. This helps us answer complex questions faster and is able to enhance the productivity of our analysts.
- With a click of a button, the detailed data can easily be exported in excel format.

LIMITATIONS

- We had some of the following difficulties with set-up:
    - Single Sign on: We have had some challenges in getting SAS Visual Analytics to work with our Lightweight Directory Access Protocol (LDAP) authentication and Central Authentication System (CAS).
    - The current version uses Adobe Flash which is not available on i-Devices and the newer Android devices. As a solution to this limitation, SAS has a mobile app for both platforms which can be downloaded from the app store and configured for use.
    - Mobile app and computer screen do not match. The view needs to be tweaked in design mode so that it will render on the desktop, laptop, and the mobile app in a desirable manner.
- Some simple features are unavailable:
    - Sorting days of the week as Monday, Tuesday, Wednesday, etc. rather than alphabetically was not available in version 6.4. To resolve this, we created a user defined format in SAS to allow for weekday and hour sorting, which was a time consuming process. This issue has been resolved in version 7.1, where there is a feature to define custom sorting.
    - We are unable to change or hide labels and this sometimes causes clutter on the dashboard.
    - When maximizing a chart, the text size does not change proportionately, resulting in a chart that covers the screen with a disproportionately small title at the top (see Figure 14).
    - The data used in an object must be available in a single table in SAS LASR. We took the approach of preparing a comprehensive dataset prior to loading it to SAS LASR and hence a lot of data preparation is needed prior to the table being available for use in SAS Visual Analytics. Another approach is to use SAS Visual Data Builder to join datasets.

CONCLUSION

These are some of the lessons that we learned from our journey of data to dashboard. We hope that this will help you in building a dashboard using SAS Visual Analytics.

LESSONS LEARNED

1. **Data preparation is the key:** Initially we loaded raw data and used SAS Visual analytics calculations in most places. With this approach, we found that we don't always get the desired results. Hence, we took the approach of preparing a SAS dataset that has comprehensive and calculated data with fields that we require in our dashboard. We have reaped many benefits with this method.
2. **Involve the clients and stakeholders at an early stage:** We work very closely with our clients and/or stakeholders to identify their needs and then keep them engaged and involved in the development process. This has helped us get buy-in from our clients and stakeholders and there are no last minute surprises.
3. **Setting a goal and target is essential:** Defining a clear goal and target for our dashboard has been extremely beneficial in keeping the scope limited and within reach.
4. **Sending a Clear Message:** Our aim is to send a clear message with our dashboard so that there is clear understanding of data and charts and there is no room for ambiguity.

REFERENCES

1. University of Minnesota's Classroom Utilization dashboard: http://www.classroom.umn.edu/scheduling/dashboard.html

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