Applicant: Yizhou Yao

Position: Data and Policy Analyst - Statistical Programmer

SAS Code Sample

```
/* writing all outputs into a pdf. */
ods pdf file='C:\Users\Victor\Desktop\stsci5010\hw3\Yao_Yizhou_HW3_HTML.pdf';
/* problem 1 */

/*    Created a libref called hw3.
      Added a new column called SumExpenses that accumulated Expenses */
libname hw3 'C:\Users\Victor\Desktop\stsci5010\hw3';
data hw3.RunningSum;
      set hw3.expenses;
      SumExpenses + Expenses;
run;

title1 'problem 1';
title2 'RunningSum Dataset';
title3 'Added a new column called SumExpenses ';
title4 'that accumulated Expenses';
/* Display dataset of RunningSum. */
proc print data=hw3.runningsum;
run;
footnote '-- Produced by Yizhou Yao --';
/* Total expense in DEC 1999 is 8059191. */

/* problem 2 */

/* Sorted data by flightID. */
proc sort data = hw3.expenses out = expenses_sorted;
      by FlightID;
run;

/* Accumulated expenses for each flightID. */
data Sum_by_flight (drop = date expenses);
      set expenses_sorted;
      by FlightID;
      if first.flightID then Sum_by_flight = 0;
      Sum_by_flight + expenses;
      if last.flightID;
run;

title1 'problem 2';
title2 'Sum_by_flight Dataset';
title3 'Summed expenses for each individual flightID';
/* Display dataset of Sum_by_flight. */
proc print data=Sum_by_flight;
run;

/* problem 3 (a) */

/* without creating a dataset */
/* Calculate date values for January 1, 1987
   and September 1, 2015 and calculated weeks in between.
   And put them in the log. */
data _null_;
      date1 = mdy(1, 1, 87);
      put date1 =;
      date2 = mdy(9, 1, 15);
      put date2 =;
      weeks = intck('week', '01jan1983'd, date2);
      put weeks =;
run;

/* With creating a new dataset */
/* Calculate date values for January 1, 1987
   and September 1, 2015 and calculated weeks in between.*/
data hw3.WeeksBetween;
      date1 = 'Jan 1st, 1987';
      date1_value = mdy(1, 1, 87);
      date2 = 'Sep 1st, 2015';
      date2_value = mdy(9, 1, 15);
      weeksInBetween = intck('week', date1_value, date2_value);
run;
/*
Jan 1st, 1987 = 9862
Sep 1st, 2015 = 20332
weeks = 1705 i.e. There are 1705 weeks in between. */

/* problem 3 (b) */

/* without creating a dataset */
/* Caculate the date 107 weeks after October 15th, 2017 and
   put it in log. Added alignment = 's' so that
   the date of exacltly 107 weeks after will be calculated. */
data _null_;
      targetDate = intnx('week', '15oct2011'd, 107, 's');
      put targetDate = ;
      put targetDate = date9.;
run;

/* with creating a dataset */
/* save the data and use format date9. */
data hw3.weeksAfter2015;
      startDate = '15OCT2011';
      endDate = intnx('week', '15oct2011'd, 107, 's');
      format endDate date9.;
run;
/* Date value = 19664
   OR
   Date is November 2, 2013 */

/* problem 3 (c) */

/* Create a dataset that extracts
   the first and last names in Company dataset. */
data hw3.names;
      set hw3.company;
      lname = scan(name, 1);
      fname = scan(name, 2);
run;
```

```
title1 'problem 3 (c)';
title2 'Names dataset';
title3 'Display the first and last names';
title4 'that were extracted from Company dataset';
/* Display the dataset. */
proc print data = hw3.names;
run;

/* problem 3 (d) */

/* Create a dataset called ssn that
      replace the 4th and 5th ssn digit to 0. */
data hw3.ssn;
      set hw3.company;
      if ssn ne '' then
      substr(ssn, 5, 2) = '00';
run;

title1 'problem 3 (d)';
title2 'SSN dataset';
title3 'Display the SSN with middle digits replaced by 0';
/* Display the dataset. */
proc print data = hw3.ssn;
run;

/* problem 3 (e) */

/* Display the value returned by a SAS function in the form like
01JAN1964: 5 semiyears after January 1, 1983.
 results are in the log file. */
data _null_;
      semi = intnx('semiyear', '01jan1983'd, 5);
      format semi date9.;
      put semi ':5 semiyears after January 1, 1983.';
run;

/* problem 4 */

/* Use a DO loop to calculate the
      accumulated interests for a 30-year investment
      with annual interest rate equal to 8.8%.*/
data Invest (drop = monthInterest Interest c_prev);
      monthInterest = 0.088/12;
      c_prev = 0;
      do Year = 1 to 30;
            Year = Year;
            Capital = (8000 + c_prev) * (1 + monthInterest)**12;
            Interest = Capital - c_prev - 8000;
            Accumulated_interest + Interest;
            Accumulated_month = year * 12;
            c_prev = Capital;
            output;
      end;
run;

title1 'problem 4';
```

```
title2 'Invest dataset';
title3 'Use a DO loop to calculate the';
title4 'accumulated interests for a 30-year investment';
title5 'with annual interest rate equal to 8.8%.';
/* Display the dataset and supress the observations */
proc print data=Invest noobs;
run;

/* close the ods pdf. */
ods pdf close;

ods html close;
ods html;
/* 1.a create libraries*/
libname hw2 "C:\Users\Victor\Desktop\STSCI5010\hw2";
libname file xlsx 'C:\Users\Victor\Desktop\STSCI5010\hw2\FBPandHIV.xlsx';
data hw2.FBP_HIV;
      set file.Data;
      base_bmi = (preweight/(height*height))*10000;
      post_bmi = (postweight/(height*height))*10000;
      delta_bmi = post_bmi - base_bmi;
run;
libname file clear;
title 'Question1 a';
footnote'produced by Yizhou Yao';
proc print data=hw2.fbp_hiv;
run;
/* 1.b create user-defined formats */
libname library 'C:\Users\Victor\Desktop\STSCI5010\hw2';
proc format library=library;
      value karnf
            low-<25 = 'Sick 24 or less'
            25-<75 = 'Disabled 25-74'
            75-high = 'Healthy 75 or greater'
            other='unknown';
      value ynf
            1 = 'Yes'
            0 = 'No';
      value genderf
            1 = 'Male'
            0 = 'Female';
      value mybmif
            low-<18.5 = 'Underweight'
            18.5-<25 = 'Normal Wight'
            25-<30 = 'Overweight'
            30-high = 'Obese'
            other='Unknown';
run;

/* 1.c use formats*/
title 'Question1 c';
footnote'produced by Yizhou Yao';
proc print data=hw2.fbp_hiv (obs=28);
      format FBP ynf. gender genderf. arv ynf.
               prekarn karnf. postkarn karnf.
               preweight 7.2 postweight 7.2 height 7.2
               precd4 7.2 postcd4 7.2 delta_bmi 5.2
               base_bmi mybmif. post_bmi mybmif.;
run;

/* 2 produce frequency tables*/
/* a */
title 'Question2 a';
footnote'produced by Yizhou Yao';
proc freq data = hw2.fbp_hiv;
      tables fbp * base_bmi;
      format fbp ynf. base_bmi bmif.;
run;
/* b */
title 'Question2 b';
footnote'produced by Yizhou Yao';
proc freq data = hw2.fbp_hiv;
      tables fbp * post_bmi;
      format fbp ynf. post_bmi bmif.;
run;
/* c */
title 'Question2 c';
footnote'produced by Yizhou Yao';
proc freq data = hw2.fbp_hiv;
      tables arv * base_bmi;
      format arv ynf. base_bmi bmif.;
run;
/* d */
title 'Question2 d';
footnote'produced by Yizhou Yao';
proc freq data = hw2.fbp_hiv;
      tables gender * arv * base_bmi;
      format gender genderf. arv ynf. base_bmi bmif.;
run;

/* 3.a */
title 'Question3 a';
footnote'produced by Yizhou Yao';
proc summary data=hw2.fbp_hiv print maxdec=1;
      var precd4 postcd4;
      class fbp;
run;
/* 3.b produce median, qrange table*/
title 'Question3 b';
footnote'produced by Yizhou Yao';
proc means data=hw2.fbp_hiv
    qrange median maxdec=1;
      var prekarn postkarn precd4 postcd4;
run;

/* 3.c */
title 'Question3 c';
footnote1 'Since p-value is greater than 0.05 significance level,';
footnote2 'we cannot reject the null hypothesis and thus';
footnote3 'the difference of BMI is not significantly away from zero.';
proc means data=hw2.fbp_hiv t probt;
      var delta_bmi;
run;
/* Since p-value is greater than 0.05 significance level,
   we cannot reject the null hypothesis and thus
   the difference of BMI is not significantly away from zero. */

/* 4 */
/* read in excel file */
libname mydata xlsx 'C:\Users\Victor\Desktop\STSCI5010\hw2\Medical.xlsx';
data mydata.Nutrition;
      set hw2.Nutrition;
      if gender="M" then gender="F";
      else if gender="F" then gender="M";
run;


ods html close;
ods html;
/* practice One */
/* Created the libref called lab2 and filref called saledata. */
/* 1. */
libname lab2 'C:\Users\Victor\Desktop\stsci5010';
filename saledata 'C:\Users\Victor\Desktop\stsci5010\Sales.txt';

/* Test the program without reading in the observations. */
/* 2. */
data lab2.sales;
      infile saledata obs=0;
      input LastName 1-7 Month 9-11 Residential 13-21
      Commercial 23-31;
      Total=residential + commercial;
run;

/* There are errors because there are many Notes
   saying Invalid data for Lastname and Month. */
/* 0 records and 5 variables. */
/* In Input line, the dollar sign is missing for the
   LasteName and Month because they are character data
   and must be denoted by a dollar sign. */

/* Read all observations but does not create any data file. */
/* 3. */
data _null_;
      infile saledata;
      input LastName 1-7 Month 9-11 Residential 13-21
      Commercial 23-31;
      Total=residential + commercial;
run;
/* There are errors because there are many Notes
   saying Invalid data for Lastname and Month.
   Invalid data for Month and LastName.
   _ERROR_ = 1. */

/* Fixed the issue by adding $ to denote character data. */
/* 4. */
data _null_;
      infile saledata;
      input LastName $ 1-7 Month $ 9-11 Residential 13-21
      Commercial 23-31;
      Total=residential + commercial;
```

```
run;


/* 5. */
/* Created a dataset called Sales and saved it in lab2. */
data lab2.Sales;
      infile saledata;
      input LastName $ 1-7 Month $ 9-11 Residential 13-21
      Commercial 23-31;
      Total=residential + commercial;
run;


title1 'Practice One Problem 5';
title2 'Sales Dataset';
/* Print out the contents in lab2.Sales. */
proc print data=lab2.Sales;
run;
footnote 'Produced by Yizhou Yao';
/* 12 records and 5 variables. */

/* 6.A */
title1 'Practice One Problem 6.A';
title2 'Frequency Table Of Month';
/* print out the frequency table for month. */
proc freq data=lab2.Sales;
      tables month;
run;
footnote 'Produced by Yizhou Yao';

/* 6.B */
/* Create a dataset called Salesmonths in Lab2.
   Create a column called Type and set to incorrect
   if months is JAN, FEB, MAR. Also put an error message
   to the log if month is incorrect. */
data lab2.Salesmonths;
      set lab2.Sales;
      select(month);
            when('JAN', 'FEB', 'MAR')do;
                type = 'incorrect';
                  put _N_= month= type=;
                  put 'Data step'_N_ 'has an incorrect month: ' month=;
            end;
            when('AAA') type = 'correct';
      end;
run;

title1 'practice one problem 6.B';
title2 'Salesmonths Dataset';
proc print data=lab2.Salesmonths;
run;
footnote 'Produced by Yizhou Yao';

/* practice Two */
/* 1. */
/* Sort the empdata by location and save it in empdata_sorted. */
proc sort data=lab2.empdata out=lab2.empdata_sorted;
```

```
      by location;
run;

title1 'practice two problem 1';
title2 'empdata_sorted Dataset';
proc print data=lab2.empdata_sorted;
run;

/* 2. */
/* Calculate the total salary for each location. */
data lab2.Total_salary (keep=location total_salary);
      set lab2.empdata_sorted;
      by location;
      if first.location then total_salary = 0;
      total_salary + salary;
      if last.location;
run;

/* 3. */
/* Display Total_salary dataset */
title1 'practice two problem 3';
title2 'Total_salary Dataset';
proc print data=lab2.Total_salary noobs;
      sum total_salary;
      format total_salary dollar11.;
run;


/* Practie Three */
/* Created table1 using datalines */
data lab2.table1;
input Year 1-4 Var_X $ 6-7;
datalines;
1991 X1
1993 X3
1992 X2
1995 X5
1994 X4
;

/* Created table2 using datalines */
data lab2.table2;
input Year 1-4 Var_Y $ 6-7;
datalines;
1993 Y3
1991 Y1
1991 Y2
1994 Y4
1995 Y5
;

/* Sorted table1 by year */
proc sort data=lab2.table1;
      by year;
run;

/* Sorted table2 by year */
```

```
proc sort data=lab2.table2;
      by year;
run;

/* Merge table1 and table2 by year. */
data lab2.all;
      merge lab2.table1 lab2.table2;
      by year;
run;

/* Display All dataset */
title1 'Practice Three';
title2 'All';
proc print data=lab2.all;
run;

/* Practice Four */
/* A. */
/* sort demog by id */
proc sort data=lab2.demog;
      by id;
run;

/* sort visit by id */
proc sort data=lab2.visit;
      by id;
run;

/* merge demog and rename into all_matched and save it in lab2,
   without including unmatched records.
   rename date to BirthDate.
   put messages for each step.*/
data lab2.all_matched(keep = ID Sex BirthDate Visit Weight VisitDate);
      merge lab2.demog(in=indemog
                        rename=(date=BirthDate))
              lab2.visit(in=invisit
                        rename=(date=VisitDate));
      by id;
      if indemog=1 and invisit=1 then do;
            put _N_= indemog= invisit=;
            put ' Data step' _N_ 'has output to the target data set.';
      end;
      else do;
            put _N_= indemog= invisit=;
            put ' Data step' _N_ 'has not output to the target data set.';
      end;
      if indemog=1 and invisit=1;
run;

title1 'Practice Four Step A';
title2 'all_matched Dataset';
/* print out the data for all_mathced dataset */
proc print data=lab2.all_matched;
run;

/* B. */
/* craete heavy_female_patient only including women
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   with weight greater than or equal to 250 pounds and
   save it in lab2. */
data lab2.heavy_female_patient;
      set lab2.all_matched;
      where sex='f' and weight>=250;
run;

/* Display heavy_female_patient dataset. */
title1 'Practice Four Step B';
title2 'heavy_female_patient Dataset';
proc print data=lab2.heavy_female_patient;
run;


/* Exercise 1 */
/* In this exercise, I assigned a new SAS library called Lab1,
   printed out the metadata of the Nutrition table,
   and printed out all the data on Nutrition table.*/
ODS HTML CLOSE;
ODS HTML;
options nonumber nodate;
libname Lab1 "C:\Users\Victor\Desktop\Lab1";
title 'metadata of nutrition table';
proc contents data=Lab1.nutrition;
run;
title;
/* Char variables: GENDER, VIT_A, VIT_B6, VIT_B12
   VIT_C, VIT_D, VIT_E, VIT_K. */
title 'nutrition table';
options pagesize=max linesize=max;
proc print data=Lab1.nutrition;
run;
title;
/* Abnormal feature: columns FOLATE and VIT_B2 have no values */
title 'rows 10 to 20 of nutrition table';
proc print data=Lab1.nutrition(firstobs=10 obs=20);
run;
title;

/* Exercise 2 */
/* In this exercise, I created a new table called males3000kcal
   from Nutrition table by selecting the rows that meet the condition
   using where clause.
   I sorted the table by calories and printed out the top 15 records
   with title and footnote. */
options pagesize=30 linesize=100;
data Lab1.males3000kcal;
      set Lab1.nutrition;
      where kcal>=3000 AND gender="M";
run;
proc sort data=Lab1.males3000kcal out=work.sortedM3000;
      by descending kcal;
run;
title1 'Males with calories intake no less than 3000';
title2 'sorted in descending order';
footnote 'Data from Nutrition table ';
proc print data=work.sortedM3000(obs=15);
```

```
       var GENDER KCAL KCAL_FAT KCAL_CHO KCAL_PRO;
run;
title;
footnote;

/* Exercise 3 */
/* In this exercise, I sorted the table in descending order by iron and
   then by fiber. I printed out the subset of table by selecting the rows
   that meet the condition using where clause with title and footnote.*/
proc sort data=lab1.nutrition out=work.sorted_IRON_FIBER;
      by descending iron descending fiber;
run;
title 'Nutrition Table Sorted By Descending Iron and Fiber';
footnote 'Data from sorted_Iron_Fiber';
proc print data=work.sorted_iron_fiber;
      where gender='F' AND iron<4 AND fiber<4;
      var  GENDER KCAL VIT_A VIT_D FIBER IRON PROTEIN;
run;
title;
footnote;
/* 2 women met the criteria and are included in my report. */

/* Exercise 4*/
/* In this exercise, I selected rows that meet condition by using
   where clause and formatted the SODIUM column. I printed out the
   resulting table with title and footnote. */
options pagesize=50 linesize=80;
title 'Males with iron greater than 20 and fat greater than 120';
footnote 'Data from sorted_iron_fiber';
proc print data=work.sorted_iron_fiber;
      where gender='M' AND iron>20 AND fat>120;
      var  IRON FIBER GENDER PROTEIN SODIUM;
      format sodium comma8.2;
run;
title;
footnote;


/* 1 */
ODS HTML CLOSE;
ODS HTML;
/* assign a path to a libref called hw1. */
libname hw1 'C:\Users\Victor\Desktop\stsci5010\hw1';
/* Import the .txt data using datalines into a SAS table,
   and save it as activity in hw1 library. */
data hw1.activity;
      input ID $ Name $ Sex $ Age Date Height Weight ActLevel $ Fee;
      datalines;
      2458 Murray M 27 1 72 168 HIGH 85.24
      2462 Almers F 34 3 66 152 HIGH 124.85
      2501 Bonavent F 31 17 61 123 LOW 155.77
      2523 Johnson F 43 31 63 137 MOD 149.75
      2539 LaMance M 71 4 71 158 LOW 124.86
      2544 Jones M 29 6 76 193 HIGH 124.89
      2552 Reberson F 32 9 67 151 MOD 149.75
      2555 King M 35 13 70 173 MOD 199.75
      2563 Pitts M 65 22 73 154 LOW 124.88
      2568 Eberhard F 49 27 64 172 LOW 124.81
      2571 Nunnelly F 44 19 66 140 HIGH 149.75
      2572 Oberon F 28 17 62 118 LOW 85.26
      2574 Peterson M 30 6 69 147 MOD 149.75
      2575 Quigley F 40 8 69 163 HIGH 124.83
      2578 Cameron M 47 5 72 173 MOD 124.84
      2579 Underwoo M 60 22 71 191 LOW 180.18
      2584 Takahash F 43 29 65 123 MOD 124.82
      2586 Derber M 25 23 75 188 HIGH 85.26
      2588 Ivan M 66 20 63 139 LOW 85.27
      2589 Wilcox F 41 16 67 141 HIGH 149.75
      2595 Warren M 54 7 71 183 MOD 165.75
;
/* print out the summary table of the data table. */
title 'problem 1';
footnote 'Produced by Yizhou Yao';
options ps=50;
proc contents data=hw1.activity;
run;
title;
footnote;
/* As shown, there are 21 observations and 9 variables and the data
   are all loaded compared to the original text file. */

/* 2 */
/* Create a new temporary data set by selecting
   rows whose activity level is HIGH. */
data work.al_high;
      set hw1.activity;
      where actlevel='HIGH';
run;
/* Create a new temporary data set by selecting
   rows whose activity level is MOD. */
data work.al_mod;
      set hw1.activity;
      where actlevel='MOD';
run;
/* Create a new temporary data set by selecting
   rows whose activity level is LOW. */
data work.al_low;
      set hw1.activity;
      where actlevel='LOW';
run;

/* print out the data in al_high table . */
title 'problem 2';
title2 'people with HIGH activity level';
footnote 'Produced by Yizhou Yao';
options ps=18;
proc print data=al_high;
run;
title;
title2;
footnote;
/* print out the data in al_mod table . */
title 'problem 2';
title2 'people with MOD activity level';
```

```
footnote 'Produced by Yizhou Yao';
proc print data=al_mod;
run;
title;
title2;
footnote;
/* print out the data in al_low table . */
title 'problem 2';
title2 'people with LOW activity level';
footnote 'Produced by Yizhou Yao';
proc print data=al_low;
run;
title;
title2;
footnote;
/* Since WORK library is temporary and the SAS session has been
   terminated, we cannot find those three files again. */

/* 3 */
/* a */
/* print out the data with actlevel is high or mod AND
   with fee between 100 and 130.*/
title 'problem 3 (a)';
title2 'people with HIGH or MOD activity level';
title3 'and activity level between 100 and 130';
footnote 'Produced by Yizhou Yao';
proc print data=hw1.activity;
      where (actlevel='HIGH' or actlevel='MOD') and
             (fee <= 130 and fee>=100);
run;
title;
title2;
title3;

/* b */
/* print out the data with name containing an 'o' and 'n'. */
title 'problem 3 (b)';
title2 'people whose name contains o and n';
footnote 'Produced by Yizhou Yao';
proc print data=hw1.activity;
      var  ID name sex age;
      where name ? 'o' and name ? 'n';
run;
title;
title2;
footnote;

/* c */
/* print out the data who are female and fee is greater than 100. */
title 'problem 3 (c)';
title2 'female whose fee is greater than 100';
footnote 'Produced by Yizhou Yao';
proc print data=hw1.activity label;
      id ID;
      where sex='F' and fee>100;
      format fee dollar7.2;
      label actlevel='Activity Level';
```

```
run;
title;
title2;
footnote;

/* 4 */
/* create and save a new data set called oldmale into
   hw1, by selecting male with age over 65 and setting
   the format and label. */
data hw1.OldMale;
      set hw1.activity;
      where sex='M' and age>=65;
      label fee='Fee charged at the time of admission ($)';
      format fee dollar7.2;
run;

/* print out the data with pre-saved label. */
title 'problem 4';
title2 'male who are at least 65';
footnote 'Produced by Yizhou Yao';
proc print data=hw1.oldmale label;
run;
title;
title2;
footnote;

/* overwrite the previously saved label and print
   out the new table. */
title 'problem 4';
title2 'male who are at least 65 with updated column name';
footnote 'Produced by Yizhou Yao';
proc print data=hw1.oldmale label;
      label fee = 'Admission Fee';
      format fee dollar6.1;
run;
title;
title2;
footnote;
```

SQL Code Sample:

```
/* Fall 2020 STSCI 5060 Final Project */

/* Name: Yizhou Yao */

/* NetID: yy856 */


/* set the pagesize and linesize */

set linesize 5000

set pagesize 1000


/* clear up all tables/views after each session. */
```

```
drop table fedrev_t;

drop table strev_t;

drop table locrev_t;

drop table school_t;

drop view sd#_v;

drop view mfr_v;

drop view msr_v;

drop view mlr_v;

drop view total_rev_v;

drop view fed_contribution_v;

drop view st_contribution_v;

drop view loc_contribution_v;

drop view fsl_contribution_v;

drop table state_t cascade constraints;


ttitle '******** Step 3 ********' skip 2

/* update the state_t table by changing the single-digit values, 1-9, of
state code to two-digit values, 01-09.  */

update state_t

    set stcode='0'||substr(stcode,1,1)

        where cast(stcode as int)<10;


/* display the 9 rows whose Stcode values are less than 10 */

select * from state_t where cast(stcode as int)<10;


ttitle '******** Step 4 ********' skip 2


/*********************** please note ************************************

Because of my computer setting, the numeric data in sql was automatically set

to BINARY_DOUBLE instead of NUMBER. I consulted professor Yang about this

and he said it was OK and CC'ed the grader about this situation.If you have

any additional question please do not hesitate to let me
```

```
and I'm more than willing to provide more info.
Thank you very much for your understanding.
************************************************************************/

/* see the metadata about school_finance_2010_t table. */
describe school_finance_2010_t;

/* display the top 10 rows of school_finance_2010_t. */
select * from school_finance_2010_t
where rownum <= 10;

ttitle '******** Step 5 ********' skip 2
/* change idcesus's datatype to varchar2(15) */
alter table school_finance_2010_t
    modify idcensus varchar2(15);

/* change name's datatype to varchar2(60) */
alter table school_finance_2010_t
    modify name varchar2(60);

ttitle '******** Step 6 ********' skip 2
/* rename name to SD_NAME */
alter table school_finance_2010_t
rename column name to SD_NAME;

/* rename state to stcode */
alter table school_finance_2010_t
rename column state to STCODE;

ttitle '******** Step 7 ********' skip 2
/* create fedrev_t table by summing up some columns */
create table fedrev_t as
```

```
select idcensus, stcode,
(c14+c15+c16+c17+c18+c19+b11+c20+c25+c36+b10+b12+b13) as fed_rev

from school_finance_2010_t;


/* create strev_t table by summing up some columns */

create table Strev_t as

select idcensus, stcode,
(c01+c04+c05+c06+c07+c08+c09+c10+c11+c12+c13+c24+c35+c38+c39) as st_rev

from school_finance_2010_t;


/* create locrev_t table by summing up some columns */

create table Locrev_t as

select idcensus, stcode,
(t02+t06+t09+t15+t40+t99+d11+d23+a07+a08+a09+a11+a13+a15+a20+a40+u11+u22+u30+
u50+u97) as loc_rev

from school_finance_2010_t;


/* create school_t from school_finance_2010_t */

create table school_t as

select idcensus, stcode, sd_name

from school_finance_2010_t;


ttitle '******** Step 8.A ********' skip 2

/* Set the stcode column as the primary key of the State_t table */

alter table state_t

add constraint stcode_pk primary key (stcode);


ttitle '******** Step 8.B ********' skip 2

/* Set the idcensus column in the Fedrev_t as the primary key. */

alter table fedrev_t

add constraint idcensus_PK primary key(idcensus);


/* Set the idcensus column in the strev_t as the primary key. */

alter table Strev_t
```

```
add constraint idcensus_PK2 primary key(idcensus);


/* Set the idcensus column in the school_t as the primary key. */

alter table school_t

add constraint idcensus_PK3 primary key(idcensus);


/* Set the idcensus column in the locrev_t as the primary key. */

alter table Locrev_t

add constraint idcensus_PK4 primary key(idcensus);


ttitle '******** Step 8.C ********' skip 2

/* Set the idcensus column of the Fedrev_t as the foreign key that

references the idcensus column of the School_t table. */

alter table fedrev_t

add constraint idcensus_fk foreign key (idcensus) references
school_t(idcensus);

/* Set the idcensus column of the strev_t as the foreign key that

references the idcensus column of the School_t table. */

alter table Strev_t

add constraint idcensus_fk2 foreign key (idcensus) references
school_t(idcensus);

/* Set the idcensus column of the locrev_t as the foreign key that

references the idcensus column of the School_t table. */

alter table Locrev_t

add constraint idcensus_fk3 foreign key (idcensus) references
school_t(idcensus);


ttitle '******** Step 8.D ********' skip 2

/* Set the stcode column of the School_t table as the foreign key that
references the stcode

column of the State_t table. */

alter table school_t

add constraint stcode_fk foreign key (stcode) references state_t(stcode);
```

```
ttitle '******** Step 10 ********' skip 2
/* display idcensus, stcode and fed_revenue of school districts with more
than
1000000k funds. */
select idcensus, stcode, to_char(fed_rev,'999999999.9') as fed_revenue from
fedrev_t
where fed_rev > 1000000;

/* display idcensus, stcode and st_revenue of school districts with more than
1000000k funds. */
select idcensus, stcode, to_char(st_rev,'999999999.9') as st_revenue from
strev_t
where st_rev > 1000000;

/* display idcensus, stcode and loc_revenue of school districts with more
than
1000000k funds. */
select idcensus, stcode, to_char(loc_rev,'999999999.9') as loc_revenue from
locrev_t
where loc_rev > 1000000;

ttitle '******** Step 11.A ********' skip 2
/* find the state(s) that with the lowest number of school districts by using
sd#_v. List the
state code, state name and the total number of school districts. */
create view sd#_v as select count(stcode) as SD#,stcode from  school_t
group by stcode;

select v.stcode, stname, sd#
from sd#_v v inner join state_t t on v.stcode=t.stcode
where sd# = (select min(sd#) from sd#_v);

ttitle '******** Step 12.A ********' skip 2
/* create three views in Oracle called mfr_v,
msr_v, and mlr_v to calculate the maximum federal, state, and local revenues
in each
state. */
create or replace view mfr_v as select stcode,max(fed_rev) as MAX_FED_REV
from fedrev_t
group by stcode
order by stcode;
create or replace view msr_v as select stcode,max(st_rev) as MAX_ST_REV from
strev_t
group by stcode
order by stcode;
create or replace view mlr_v as select stcode,max(loc_rev)as MAX_loc_REV from
locrev_t
group by stcode
order by stcode;


ttitle '******** Step 12C ********' skip 2
/* use the mfslr_t table created by above SAS DATA Step to get the results.
*/
select to_char(m.stcode,'99') as stcode,to_char(max_fed_rev, '999999999.9')
as max_fed_rev, to_char(max_st_rev,'999999999.9') as max_st_rev,
to_char(max_loc_rev,'999999999.9') as max_loc_rev, stname as state_name from
mfslr_t m,state_t s
where m.stcode=s.stcode;


ttitle '******** Step 13 ********' skip 2
/* list the state code and the highest federal revenue (use aliases,
state_code for state code, state_name for stname, and
max_fed_rev for the highest total federal revenue of the school district in
that state */
select to_char(m.stcode,'999999999')as state_code, stname as state_name,
to_char(max_fed_rev, '999999999.9') as max_fed_rev, sd_name
from school_t sc, mfslr_t m, fedrev_t f,state_t st
where f.idcensus=sc.idcensus and
      m.stcode=sc.stcode and
      sc.stcode=f.stcode and
      st.stcode=sc.stcode and

      m.max_fed_rev=f.fed_rev

order by max_fed_rev desc;


ttitle '******** Step 14 ********' skip 2

/* Create a view called Total_Rev_v from fedrev_t, strev_t, and locrev_t by
including idcensus,

state code, total federal revenue (named tfedrev), total state revenue (named
tstrev), and total

local revenue (named tlocrev) of each school district. */

create or replace view total_rev_v as

select f.idcensus, f.stcode, fed_rev as tfedrev, st_rev as tstrev, loc_rev as
tlocrev

from fedrev_t f, strev_t s, locrev_t l

where f.idcensus=s.idcensus and

      s.idcensus=l.idcensus;


ttitle '******** Step 15 ********' skip 2

/* display the top 100 columns in the order of stcode, stname, idcensus,
total_revenue

and sd_name, in descending order */

select * from

(select t.stcode, stname, t.idcensus,
to_char((tfedrev+tstrev+tlocrev),'999999999.9') as total_revenue, sd_name

from total_rev_v t, school_t s, state_t st

where t.stcode=s.stcode and

      st.stcode=s.stcode and

      t.idcensus=s.idcensus

order by total_revenue desc)

where rownum<=100;


ttitle '******** Step 16 ********' skip 2

/* display stcode, stname, and the total school expenditure of

the state. Sort output with the total school expenditure in descending order.
```

```
 */
select sc.stcode, stname, to_char(sum(totalexp),'999999999.9') as totalexp_st
from school_finance_2010_t sc, state_t st
where sc.stcode = st.stcode
group by sc.stcode, stname
order by sum(totalexp) desc;


ttitle '******** Step 17 ********' skip 2
/* display the total amount of the money that the United State spent on the
public school
systems in 2010 */
set heading off
select 'The total amount that the United States spent on the public school
systems in 2010 was',to_char(sum(totalexp),'$999999999.9'), 'K.'
from school_finance_2010_t;
set heading on


ttitle '******** Step 18.A ********' skip 2
/* Find out school districts that received federal revenues greater than
the total expense, listing all the columns that exist in the
fed_contribution_v and sorting in
descending order by fed_pcnt. */
create or replace view fed_contribution_v as
select f.idcensus, f.stcode, stname, sd_name,
to_char((fed_rev/totalexp),'9.9999')as fed_pcnt
from fedrev_t f,school_finance_2010_t s, state_t st
where s.idcensus=f.idcensus and
      f.stcode=s.stcode and
      s.stcode=st.stcode and
      totalexp is not null and
      totalexp <> 0;


select * from fed_contribution_v where fed_pcnt > 1 order by fed_pcnt desc;
```

```
ttitle '******** Step 18.B ********' skip 2
/* Find out school districts that received state revenues greater than
the total expense, listing all the columns that exist in the
st_contribution_v and sorting in
descending order by st_pcnt. */
create or replace view st_contribution_v as
select sr.idcensus, sr.stcode, stname, sd_name,
to_char((st_rev/totalexp),'9.9999')as st_pcnt
from strev_t sr, school_finance_2010_t s, state_t st
where sr.idcensus=s.idcensus and
      s.stcode=sr.stcode and
      sr.stcode=st.stcode and
      totalexp is not null and
      totalexp <> 0;
select * from st_contribution_v where st_pcnt > 1 order by st_pcnt desc ;


ttitle '******** Step 18C ********' skip 2
/* Find out school districts that received local revenues greater than
the total expense, listing all the columns that exist in the
loc_contribution_v and sorting in
descending order by loc_pcnt. */
create or replace view loc_contribution_v as select l.idcensus, l.stcode,
stname, sd_name, to_char((loc_rev/totalexp),'99.9999') as loc_pcnt
from state_t st,locrev_t l, school_finance_2010_t sf
where l.idcensus=sf.idcensus and
      l.stcode=sf.stcode and
      sf.stcode=st.stcode and
      totalexp is not null and
      totalexp <> 0;
select * from loc_contribution_v where loc_pcnt > 1 order by loc_pcnt desc;


ttitle '******** Step 19.A ********' skip 2
/* create another view called
```

```
fsl_contribution_v, including these columns: idcensus, stcode, sd_name and
the fsl_pcnt (for the

total ratio, which is the sum of fed_pcnt, st_pcnt and loc_pcnt). Keep 4
decimal points.  */

create or replace view fsl_contribution_v as

select f.idcensus, f.stcode, f.sd_name, to_char((fed_pcnt+st_pcnt+loc_pcnt),
'99.9999') as fsl_pcnt

from fed_contribution_v f, st_contribution_v s, loc_contribution_v l

where f.idcensus = s.idcensus

      and s.idcensus = l.idcensus;

/* display the school districts that received total revenues
(federal+state+local) over 3

times of the total amount they actually spent in that year, in descending
order */

select * from fsl_contribution_v where fsl_pcnt > 3 order by fsl_pcnt desc;


/* display the school districts that received total revenues
(federal+state+local) up to 30%

of the total amount they actually spent in that year, in descending order */

ttitle '******** Step 19.B ********' skip 2

select idcensus, stcode, sd_name, to_char(fsl_pcnt,'90.9999')as fsl_pcnt from
fsl_contribution_v where fsl_pcnt<=0.3 order by fsl_pcnt desc;



ttitle '******** Step 25.A ********' skip 2

/* Change the table definitions to make sure they can be joined */

alter table school_finance_2015_t

modify idcensus varchar2(15);

alter table school_finance_2015_t

modify name varchar2(60);


/* display top 5 school districts that had increased total revenues. */

select stcode, stname, idcensus, sd_name, to_char(revdif,'99999999.9') as
revdif, to_char(change_percentage,'999999999999999.9') as change_percentage

from
```

```
(select s2.state as stcode, stname, s2.idcensus, s2.name as sd_name,
(s2.totalrev-s1.totalrev) as revdif,

(100*(s2.totalrev-s1.totalrev)/s1.totalrev) as change_percentage

from school_finance_2010_t s1, school_finance_2015_t s2, state_t s3

where s2.state=s1.stcode

    and s2.state=s3.stcode

    and s1.idcensus=s2.idcensus

    and s1.totalrev <> 0

    order by revdif desc)

where rownum<=5;



ttitle '******** Step 25.B ********' skip 2

/* display top 5 school districts that had decreased total revenues. */

select stcode, stname, idcensus, sd_name, to_char(revdif,'99999999.9') as
revdif, to_char(change_percentage,'99999999999999.9') as change_percentage

from

(select s2.state as stcode, stname, s2.idcensus, s2.name as sd_name,
(s2.totalrev-s1.totalrev) as revdif,

(100*(s2.totalrev-s1.totalrev)/s1.totalrev) as change_percentage

from school_finance_2010_t s1, school_finance_2015_t s2, state_t s3

where s2.state=s1.stcode

    and s2.state=s3.stcode

    and s1.idcensus=s2.idcensus

    and s1.totalrev <>0

    order by revdif)

where rownum<=5;


ttitle '******** Step 25.C ********' skip 2

/* display all school districts whose total revenues stayed the same. */

select stcode, stname, idcensus, sd_name, to_char(revdif,'99999999.9') as
revdif, to_char(change_percentage,'99999999999999.9') as change_percentage

from
```

```
(select s2.state as stcode, stname, s2.idcensus, s2.name as sd_name,
(s2.totalrev-s1.totalrev) as revdif,
((s2.totalrev-s1.totalrev)/s1.totalrev) as change_percentage
from school_finance_2010_t s1, school_finance_2015_t s2, state_t s3
where s2.state=s1.stcode
    and s2.state=s3.stcode
    and s1.idcensus=s2.idcensus
    and s1.totalrev <> 0)
where revdif=0
order by revdif;
```

Python Code Sample:

Sample Code

Laureate Education Lead Scoing Project Complete Code

Yizhou Yao_Intern

Data Processing

Loading the necessary packages to load, manipulate and visualize the data

In [2]:

```
import pandas as pd
import numpy as np
import re
import scipy.stats as sc
import matplotlib.pyplot as plt
%matplotlib inline

import seaborn as sns
sns.set_style("white")
sns.set_context("talk",font_scale=1.5, rc={"lines.linewidth": 2.5})
```

In [3]:

```
with open('Top of Funnel Model Data.csv') as f:
    enc = f.encoding

df = pd.read_csv('Top of Funnel Model Data.csv',encoding=enc)
print(df.shape)
```

```
(928490, 51)
```

Dropping columns with only a single value and dealing with a few anomalies in the data.

In [3]:

```
df.Country_Name.replace(to_replace="0",value="United States of America",inplac
e=True)
df.drop(columns=list(filter(lambda x: len(df[x].unique())== 1, df.columns)),in
place=True)
df.drop(columns = ['ToF_di_decile','OPPID','level','inCounting',\
                   'Neustar_di_decile','OpenAllEmails','ClickAllEmails'],inpla
ce=True)

df = df[df.Lead_Enrollment_Score <= 1]
df = df.loc[(df.Application_Started__c == 0) | (df.Application_Started__c == 1
) ]
df.Qualified[df.Qualified > 1] = 1
print(df.shape)
```

```
(928488, 38)
```

Creating a new feature GapDays and dropping the date columns. Also converting certain values to Nan.

In [4]:

```
categorical = df.columns[df.dtypes == "object"]
dates = list(filter(lambda x: re.findall(pattern="[A-z]*[Dd]ate",string=x)!=
[],categorical))
df[dates] = df[dates].apply(pd.to_datetime)
df.drop(columns="Inq_date",inplace=True)
df["GapDays"] = (df.CreatedDate-df.ContactCreatedDate).dt.days
df.GapDays[df.GapDays < 0] = 0

categorical = df.columns[df.dtypes == "object"]
df[categorical] = df[categorical].replace({'0':np.nan, "NA":np.nan, "Unknown":
np.nan, "None":np.nan})
variables = list(filter(lambda x: df[x].dtype != '<M8[ns]' , df.columns))
df = df[variables]
```

```
C:\Anaconda3\lib\site-packages\ipykernel_launcher.py:6: SettingWithCopyWarnin
g:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/st
able/indexing.html#indexing-view-versus-copy
```

Dropping variables with more than 15% missing values.

```
In [1]: missing = dict(map(lambda x: (x,sum(df[x].isnull())/df.shape[0]),df.columns))
        keep  = list(filter(lambda x: missing[x] <= 0.15,missing.keys()))
        df = df[keep]
        missing = {i:missing[i] for i in keep}
        missing
        print(df.shape)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-1-e9e9bfe48b61> in <module>
----> 1 missing = dict(map(lambda x: (x,sum(df[x].isnull())/df.shape[0]),df.c
olumns))
      2 keep  = list(filter(lambda x: missing[x] <= 0.15,missing.keys()))
      3 df = df[keep]
      4 missing = {i:missing[i] for i in keep}
      5 missing

NameError: name 'df' is not defined
```

```
In [6]: df.Complete90Days.value_counts(normalize=True,dropna=False)
```

```
Out[6]: 0    0.916892
        1    0.083108
        Name: Complete90Days, dtype: float64
```

```
In [7]: print("Proportion of Records Incomplete and Removed:",(df.shape[0] - df.dropna
        ().shape[0])/df.shape[0])
        df = df.dropna()
```

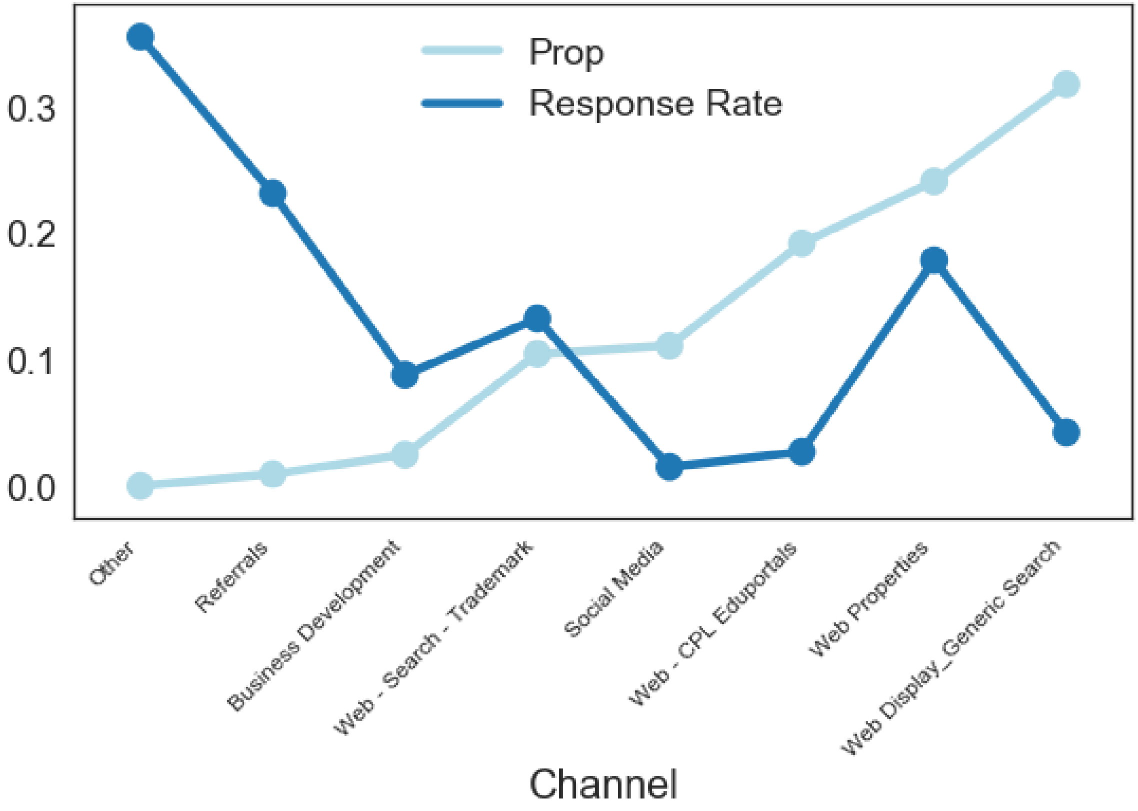
```
Proportion of Records Incomplete and Removed: 0.051747572397273844
```

Data Exploration

Combining levels of Categorical variables and identifying the important levels.

In [8]:
```
a = df.groupby(['Channel'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

df['Channel'] = df.Channel.replace(to_replace=['UMET','Database Marketing'],va
lue='Other')
df['Channel'] = df.Channel.replace(to_replace=['Web - Search - Generic','Web -
Display'],\
                                   value='Web Display_Generic Search')

a = df.groupby(['Channel'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})


plt.figure(figsize=(10,5))
p = sns.pointplot(x = 'Channel', y = 'Prop', data = a.sort_values(by = 'Prop'
),color='lightblue')
sns.pointplot(x = 'Channel',y = 'Response Rate', data = a.sort_values(by = 'Pr
op'),ax = p.axes,ci = None)
p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'font
size': 12})
p.set_ylabel(" ")
p.legend(handles = p.lines[::len(a)+1],labels = ['Prop','Response Rate'])
```

Out[8]:
```
<matplotlib.legend.Legend at 0x278969fbeb8>
```

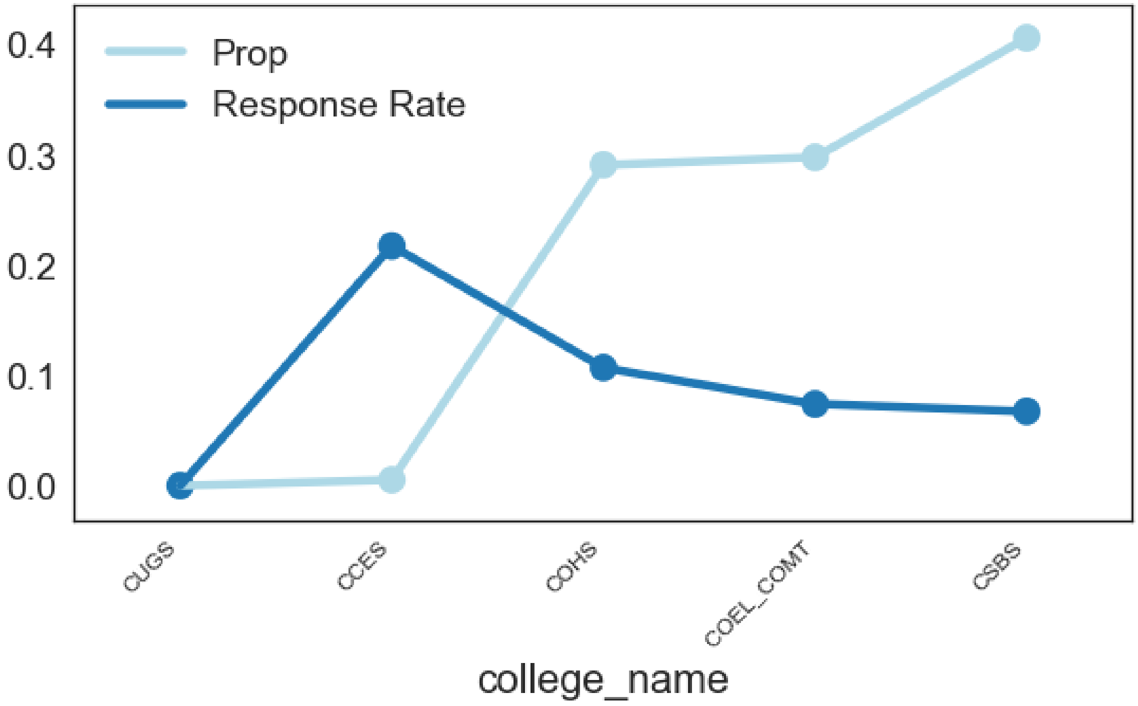


In [9]:

```
a = df.groupby(['college_name'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

df['college_name'] = df.college_name.replace(to_replace=['COEL','COMT'],value=' COEL_COMT')

a = df.groupby(['college_name'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

plt.figure(figsize=(10,5))
p = sns.pointplot(x = 'college_name', y = 'Prop', data = a.sort_values(by = 'Prop'),color='lightblue')
sns.pointplot(x = 'college_name',y = 'Response Rate', data = a.sort_values(by = 'Prop'),ax = p.axes,ci = None)
p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'fontsize': 12})
p.set_ylabel(" ")
p.legend(handles = p.lines[::len(a)+1],labels = ['Prop','Response Rate'])
```

Out[9]:

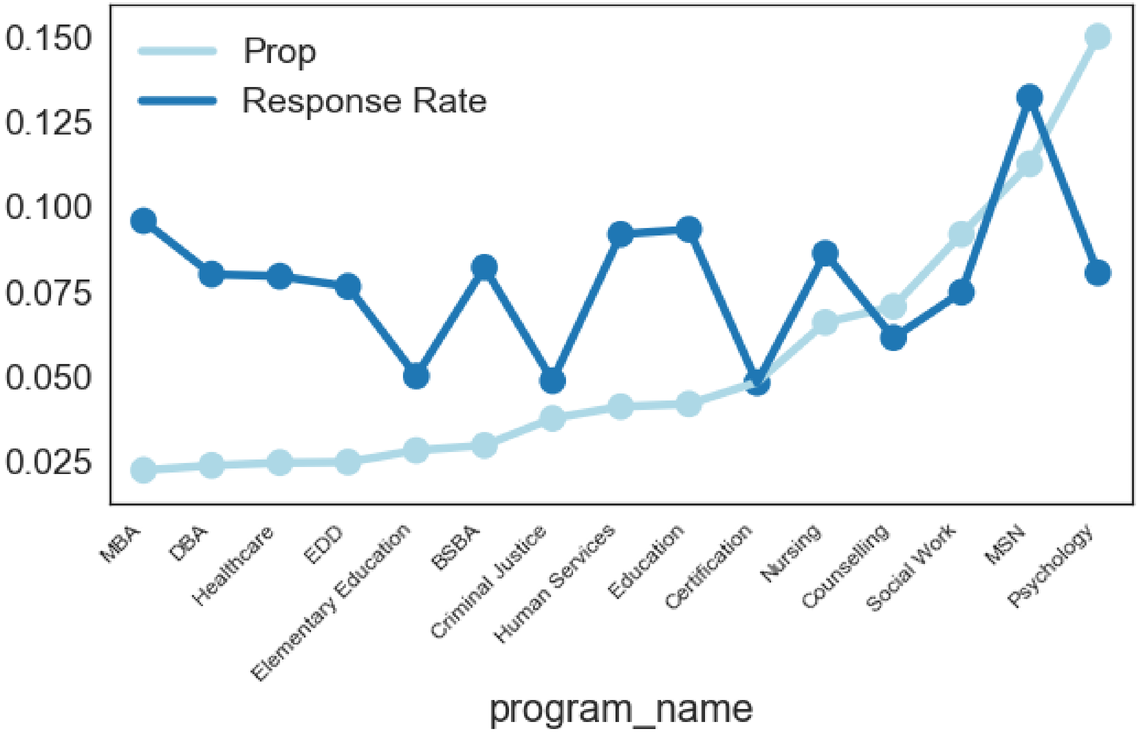
```
<matplotlib.legend.Legend at 0x2788d0cbdd8>
```



In [10]:

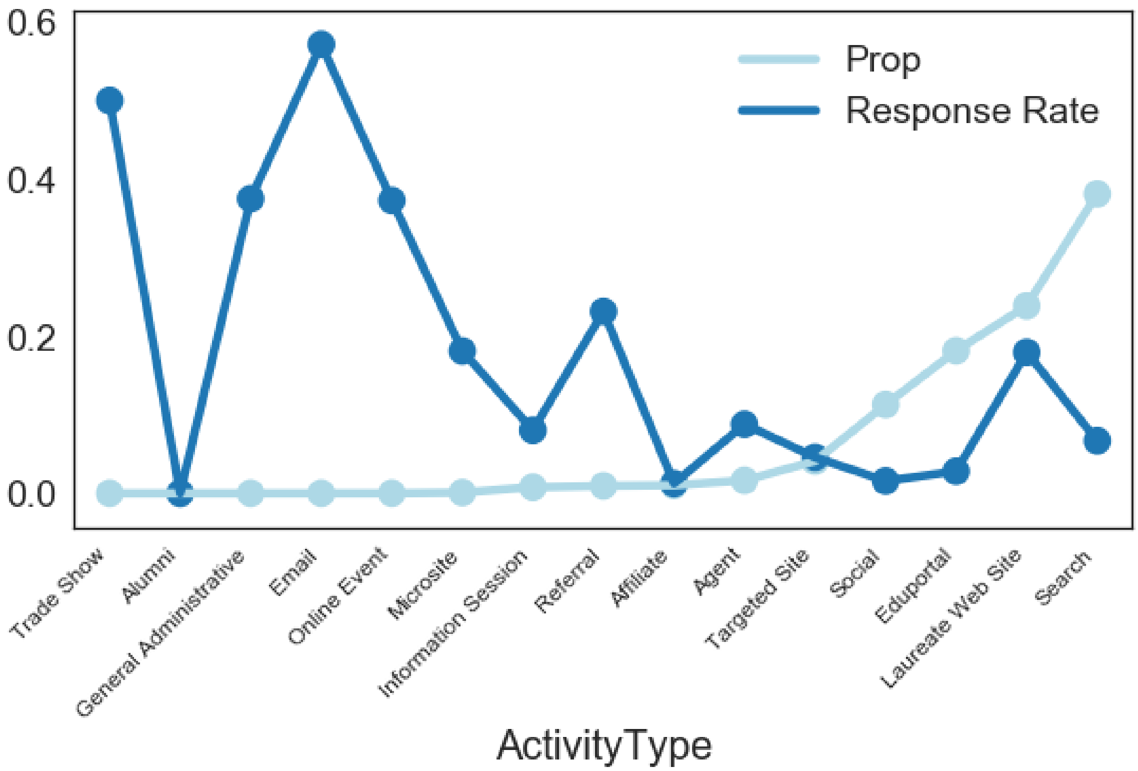
```
df['program_name'] = df.program_name.str.replace(pat = r'-' ,repl = ' ',)
df['program_name'] = df.program_name.str.replace(pat = r'\s?in\s|\s?of\s' ,repl = ' ')
df['program_name'] = df.program_name.str.replace(pat = r'B\.?S\.?\s|Bachelor[s{1}\s]' ,repl = '')
df['program_name'] = df.program_name.str.replace(pat = r'M\.?S\.?\s|Master[s{1}\s]' ,repl = '')
df['program_name'] = df.program_name.str.replace(pat = r'\([A-z]+\)' ,repl = '')
df['program_name'] = df.program_name.str.replace(pat = r'PhD|PHD|Dr[\.\s]|Doctor[\s\.]|Doctorate' ,repl = '')
df['program_name'] = df.program_name.str.replace(pat = r'[^A-z0-9]' ,repl = ' ')
df['program_name'] = df.program_name.str.replace(pat = r'\s+' ,repl = ' ')
df['program_name'] = df.program_name.str.strip()
df['program_name'] = df.program_name.str.replace(pat = "[A-z]+\s?MBA$", repl = "MBA")
df['program_name'] = df.program_name.str.replace(pat = "[A-z]+\sCertificates$", repl = "Certification")
df['program_name'] = df.program_name.str.replace(pat = "Information\sTechnology", repl = "IT")
df['program_name'] = df.program_name.str.replace(pat = "MSW", repl = "Social Work")
df['program_name'] = df.program_name.str.replace(pat = "Psych$|\sPsyc\s", repl = "Psychology")
df['program_name'] = df.program_name.str.replace(pat = r'Counsel[l]?ing|\sCoun$',repl = " Counselling")
df['program_name'] = df.program_name.str.replace(pat = r'\s+' ,repl = ' ')
df['program_name'] = df.program_name.str.replace(pat = r'^Health[a-z]*\s[A-z]+[\sA-z]*',repl = "Healthcare")
df['program_name'] = df.program_name.str.replace(pat = r'[A-z\s]*Counselling', repl = "Counselling")
df['program_name'] = df.program_name.str.replace(pat = r'^Clinical[\sA-z]*',repl = "Clinical")
df['program_name'] = df.program_name.str.replace(pat = r'[A-z\s]*Psychology[\sA-z]*',repl = 'Psychology')
df['program_name'] = df.program_name.str.replace(pat = r'[A-z\s]*Nursing[\sA-z]*',repl = 'Nursing')
df['program_name'] = df.program_name.str.replace(pat = r'[A-z\s]*Communication[\sA-z]*',repl = 'Communication')
df['program_name'] = df.program_name.str.replace(pat = r'Criminal\sJustice[\sA-z]*',repl = 'Criminal Justice')
df['program_name'] = df.program_name.str.replace(pat = r'EDS[\sA-z]*',repl = 'EDS')
df['program_name'] = df.program_name.str.replace(pat = r'MSN[\sA-z]*',repl = 'MSN')
df['program_name'] = df.program_name.str.replace(pat = 'Human Social Services',repl = 'Human Services',regex = False)

a = df.groupby(['program_name'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

plt.figure(figsize=(10,5))
p = sns.pointplot(x = 'program_name', y = 'Prop', data = a.sort_values(by = 'Prop').tail(15),color='lightblue')
sns.pointplot(x = 'program_name',y = 'Response Rate', data = a.sort_values(by
= 'Prop').tail(15),ax = p.axes,ci = None)
p.set_ylabel(" ")
p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'font
size': 12})
p.legend(handles = p.lines[::15+1],labels = ['Prop','Response Rate'])
```

```
Out[10]: <matplotlib.legend.Legend at 0x2789bfd2e80>
```



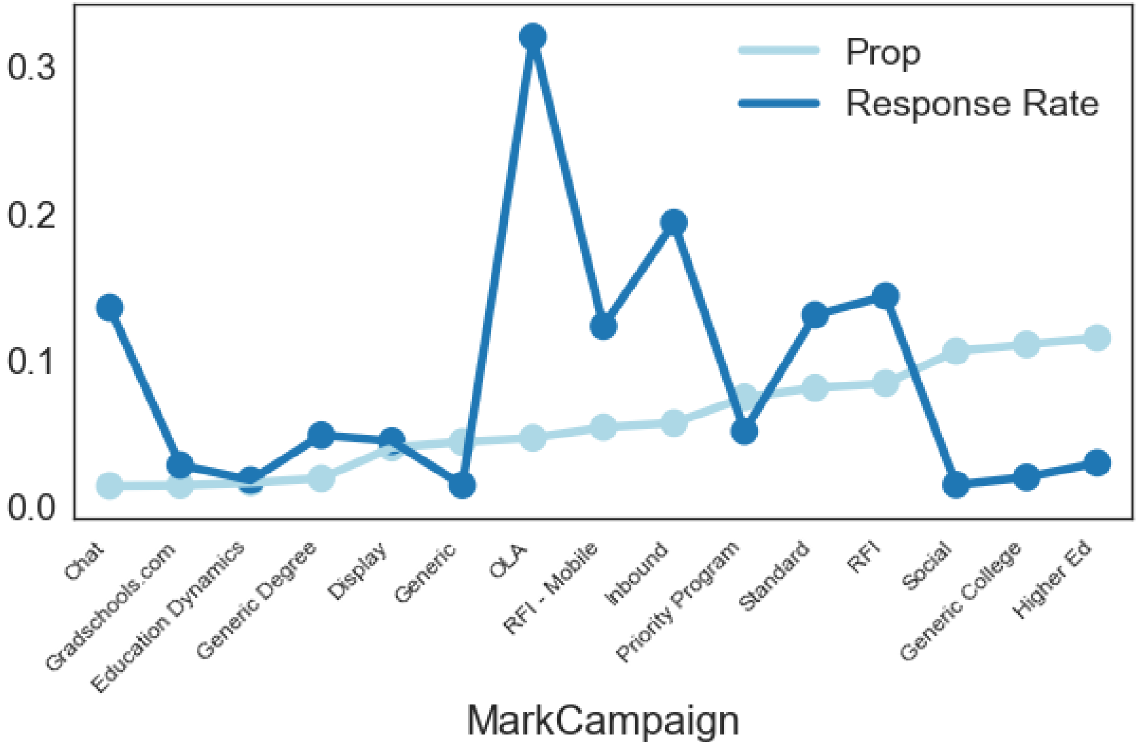
In [11]:
```
a = df.groupby(['ActivityType'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

plt.figure(figsize=(10,5))
p = sns.pointplot(x = 'ActivityType', y = 'Prop', data = a.sort_values(by = 'Prop'),color='lightblue')
sns.pointplot(x = 'ActivityType',y = 'Response Rate', data = a.sort_values(by = 'Prop'),ax = p.axes,ci = None)
p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'fontsize': 12})
p.set_ylabel(" ")
p.legend(handles = p.lines[::len(a)+1],labels = ['Prop','Response Rate'])
```

Out[11]:
```
<matplotlib.legend.Legend at 0x27893cc0e80>
```



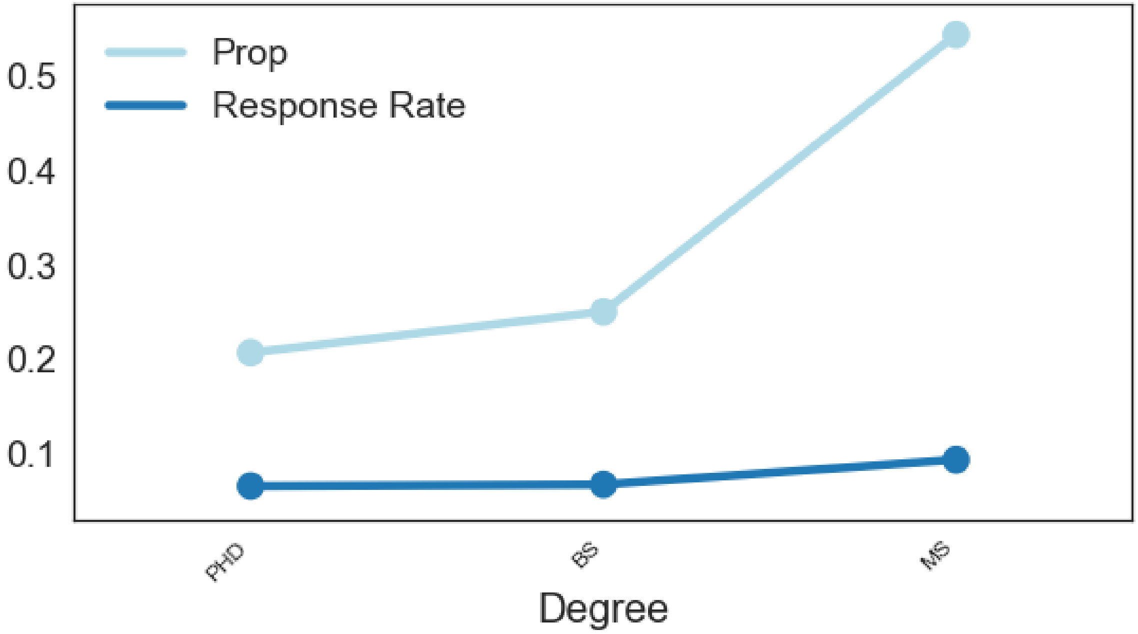
In [12]:
```
a = df.groupby(['MarkCampaign'],as_index = False).Complete90Days.agg(
    {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

plt.figure(figsize=(10,5))
p = sns.pointplot(x = 'MarkCampaign', y = 'Prop', data = a.sort_values(by = 'Prop').tail(15),color='lightblue')
sns.pointplot(x = 'MarkCampaign',y = 'Response Rate', data = a.sort_values(by = 'Prop').tail(15),ax = p.axes,ci = None)
p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'fontsize': 12})
p.set_ylabel(" ")
p.legend(handles = p.lines[::15+1],labels = ['Prop','Response Rate'])
```

Out[12]:
```
<matplotlib.legend.Legend at 0x27897ef0f28>
```



```
In [13]: a = df.groupby(['Degree'],as_index = False).Complete90Days.agg(
             {'Response Rate': np.mean, 'Prop':(lambda x: len(x)/df.shape[0])})

         plt.figure(figsize=(10,5))
         p = sns.pointplot(x = 'Degree', y = 'Prop', data = a.sort_values(by = 'Prop').
         tail(15),color='lightblue')
         sns.pointplot(x = 'Degree',y = 'Response Rate', data = a.sort_values(by = 'Pro
         p').tail(15),ax = p.axes,ci = None)
         p.set_xticklabels(p.get_xticklabels(), rotation=45, ha="right",fontdict={'font
         size': 12})
         p.set_ylabel(" ")
         p.legend(handles = p.lines[::len(a)+1],labels = ['Prop','Response Rate'])
```

```
Out[13]: <matplotlib.legend.Legend at 0x27887aa8be0>
```



Based on the above graphs the important levels are selected and converted into indicators for model building.

```
In [14]: imp_levels = {'Degree':df.Degree.unique().tolist()[1:],\
                       'Channel':df.Channel.unique().tolist()[1:],\
                       'college_name': df.college_name.unique().tolist()[1:],\
                       'ActivityType':['Laureate Web Site','Agent','Referral','Trade Sh
         ow','General Administrative'],\
                       'MarkCampaign':['Chat','OLA','Inbound','RFI','Standard'],\
                       'program_name':['MSN','Nursing','BSBA','Education','Human Servic
         es','Social Work']}
```

```
In [15]: for i in imp_levels.keys():
             tmp = pd.get_dummies(df[i])[imp_levels[i]]
             tmp.columns = list(map(lambda x: i+"_"+str(x),tmp.columns))
             df = pd.concat([df,tmp],axis=1)
             df.drop(columns=i,inplace=True)
```

Dropping variables where a single value occurs over 99% of the time.

```
In [16]: num = df.dtypes.where(df.dtypes != 'object').dropna().index.tolist()
         num = list(filter(lambda x: (any(df[x].value_counts(normalize=True)>=0.99)),nu
         m))
         df.drop(columns = num, inplace = True)
```

Summary Statistics

```
In [17]: num = list(filter(lambda x: df[x].dtype != 'O' and len(df[x].unique()) > 2,df.
         columns))
         df[num].describe()[1:].T
```

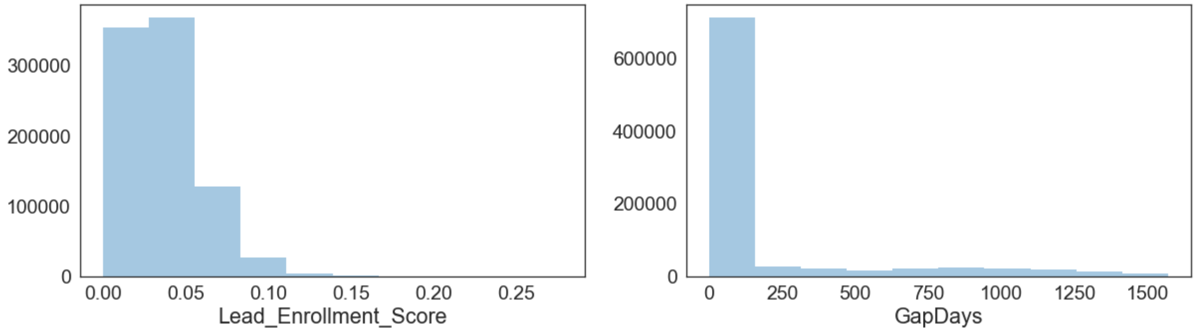
Out[17]:

	mean	std	min	25%	50%	75%	max
ClickEmail	0.033070	0.241368	0.0	0.000000	0.000000	0.000000	32.000000
ClickLink	0.099513	1.358018	0.0	0.000000	0.000000	0.000000	134.000000
ClickSalesEmail	0.029572	0.481459	0.0	0.000000	0.000000	0.000000	265.000000
FillOutForm	0.021310	0.161529	0.0	0.000000	0.000000	0.000000	10.000000
Mailing_City__c	0.753344	0.513693	0.0	0.000000	1.000000	1.000000	7.000000
OpenEmail	0.112695	0.337550	0.0	0.000000	0.000000	0.000000	10.000000
OpenSalesEmail	0.124054	0.384190	0.0	0.000000	0.000000	0.000000	21.000000
www	0.093595	1.324406	0.0	0.000000	0.000000	0.000000	175.000000
Lead_Enrollment_Score	0.036653	0.021897	0.0	0.018945	0.034958	0.048574	0.277582
GapDays	148.582642	342.278797	0.0	0.000000	0.000000	0.000000	1569.000000

In [18]:
```
plt.figure(figsize= (20,5))
plt.subplot(1,2,1)
sns.distplot(a = df.Lead_Enrollment_Score, hist = True, kde = False, bins = 10
)

plt.subplot(1,2,2)
sns.distplot(a = df.GapDays, hist = True, kde = False, bins = 10)
```

```
C:\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning: Th
e 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
C:\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning: Th
e 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
```

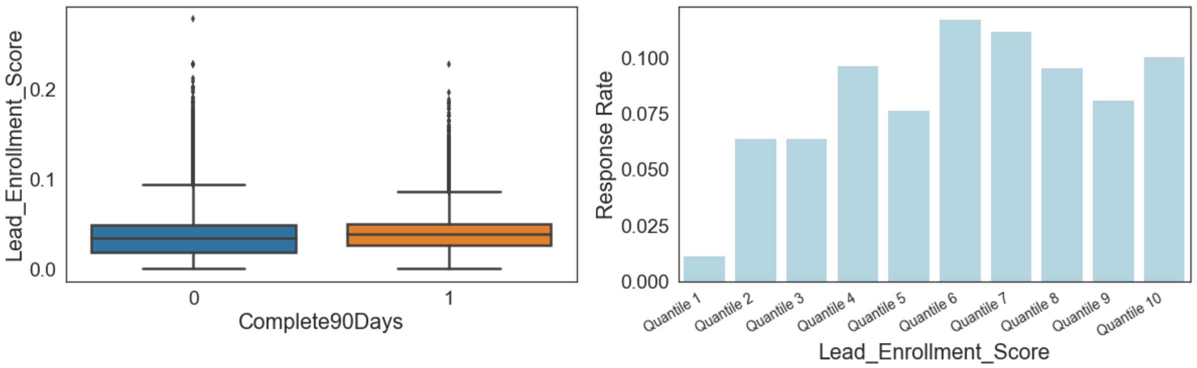
Out[18]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x278a5af7780>
```



In [19]:
```
plt.figure(figsize = (20,5))

plt.subplot(1,2,1)
sns.boxplot(x = df.Complete90Days, y = df.Lead_Enrollment_Score)

plt.subplot(1,2,2)
x = df[['Complete90Days','Lead_Enrollment_Score']]
lab = list(map(lambda x: "Quantile "+str(x),range(1,11)))
x['Lead_Enrollment_Score'] = pd.qcut(x = df.Lead_Enrollment_Score, q = 10,labe
ls=lab)
x = x.groupby(['Lead_Enrollment_Score'],as_index = False).Complete90Days.mean
()
ax = sns.barplot(x = 'Lead_Enrollment_Score', y = 'Complete90Days', data = x,
color = 'lightblue')
ax.set_xticklabels(ax.get_xticklabels(), rotation=30, ha="right", fontsize = 1
4)
ax.set_ylabel('Response Rate')
```

```
C:\Anaconda3\lib\site-packages\ipykernel_launcher.py:9: SettingWithCopyWarnin
g:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/st
able/indexing.html#indexing-view-versus-copy
  if __name__ == '__main__':
```

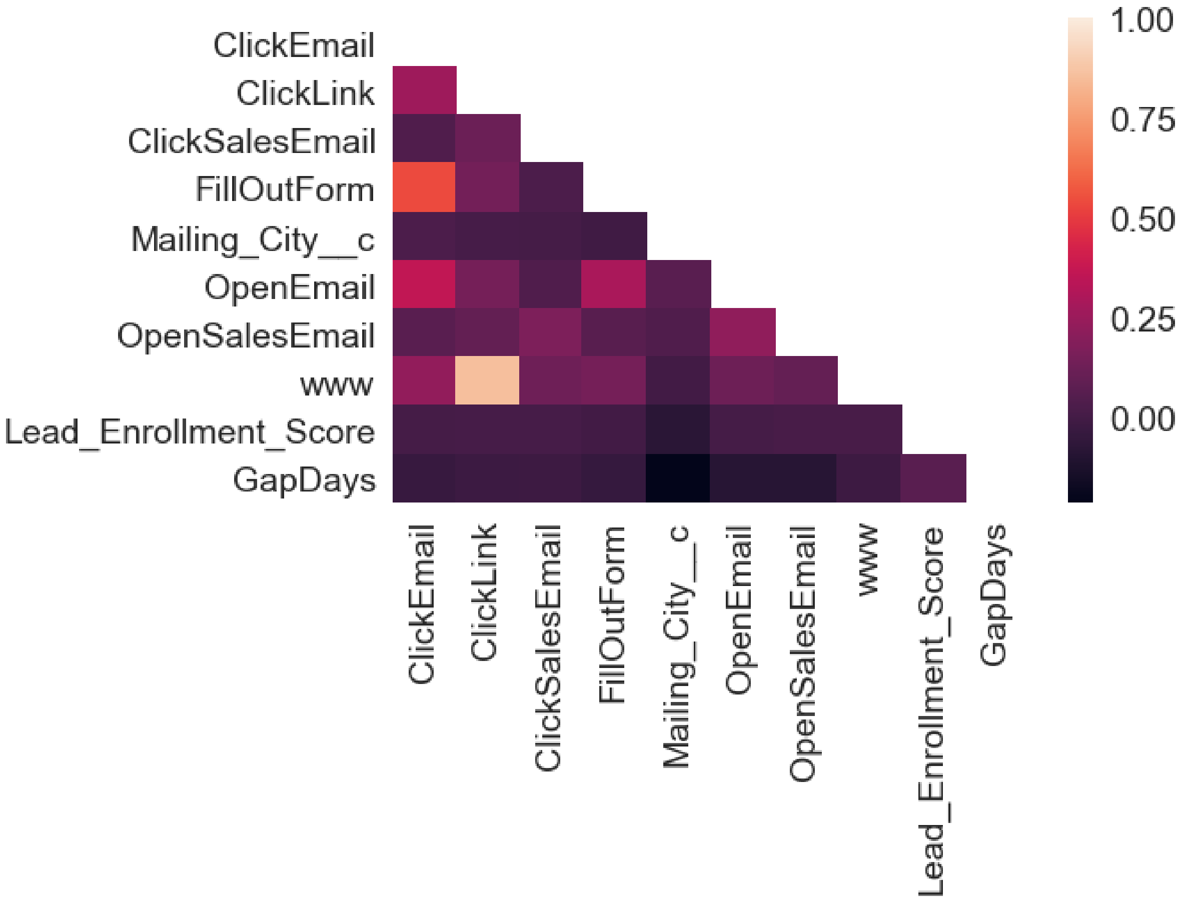
Out[19]:
```
Text(0,0.5,'Response Rate')
```



Correlation Plot

In [20]:
```
plt.figure(figsize=(8,5))
corr = df[num].corr()
mask = np.zeros_like(corr, dtype=np.bool)
mask[np.triu_indices_from(mask)] = True
sns.heatmap(corr,mask=mask)
```

Out[20]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2788e5a48d0>
```



In [21]:
```
print("Proportion of duplicate records:", (len(df)-len(df.drop_duplicates()))/
len(df))
df = df.drop_duplicates()
```

```
Proportion of duplicate records: 0.13168060097155856
```

Modelling

In [22]:
```
labels = df.Complete90Days
features = df.drop(columns = ["Complete90Days"])
print(features.shape)
```

```
(764504, 36)
```

Splitting the Data into Training and Validation Set (70-30) and scaling the features.

In [23]:

```
scale_var = list(filter(lambda x: len(features[x].unique()) > 2,features.colum
ns))
import warnings
warnings.simplefilter(action="ignore")

from sklearn.model_selection import train_test_split

train_features, test_features, train_labels, test_labels = \
    train_test_split(features, labels, test_size = 0.3, random_state = 18)

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
train_features[scale_var] = scaler.fit_transform(train_features[scale_var])
test_features[scale_var] = scaler.transform(test_features[scale_var])
```

In [24]:

```
from sklearn.metrics import accuracy_score, confusion_matrix, roc_auc_score, r
oc_curve
warnings.simplefilter(action="default")
```

Logistic Regression

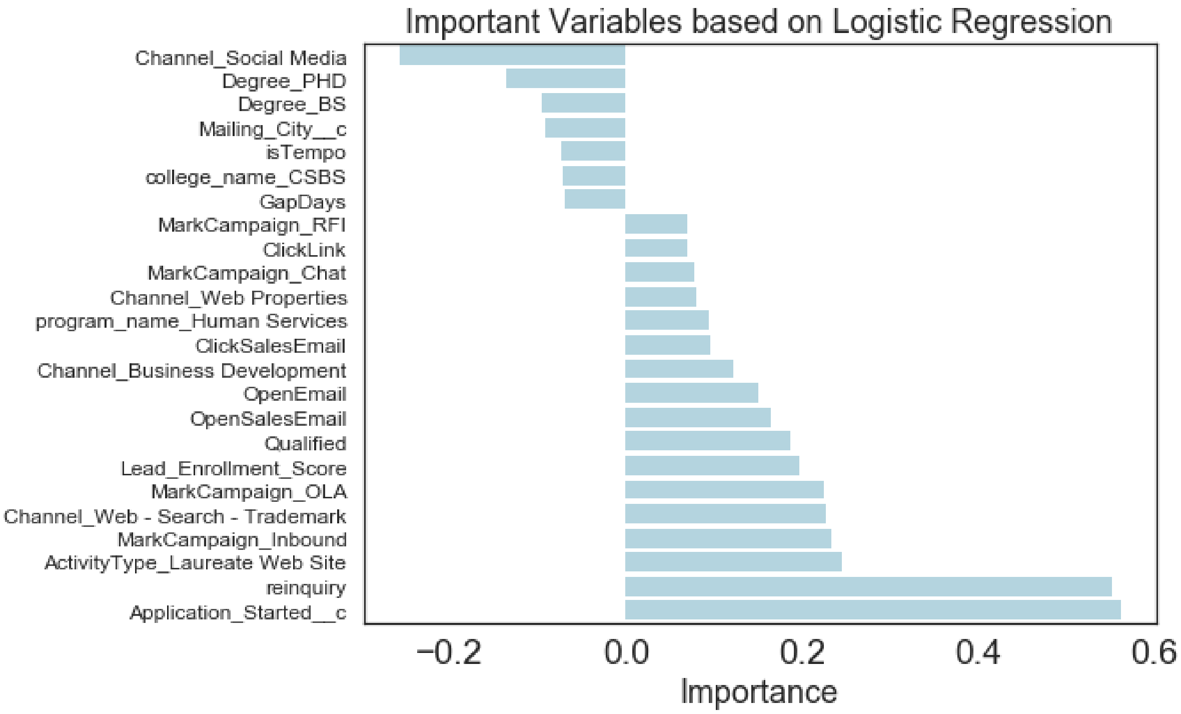
In [57]:

```
from sklearn.linear_model import LogisticRegression

log_model = LogisticRegression(random_state = 10,fit_intercept=True,class_weig
ht='balanced')
log_model.fit(train_features,train_labels)
pred_log = log_model.predict_proba(test_features)[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_log)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_log),"\n")
```

```
C:\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:433: FutureWa
rning: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to
silence this warning.
  FutureWarning)

Gini:  0.666089101915857

AUC:  0.8330445509579285
```

In [59]:
```
plt.figure(figsize = (8,6))
var_imp = dict(zip(features.columns,np.round(np.std(train_features,0).values *
(log_model.coef_)[0,:],4)))
var_log = sorted(var_imp,key = var_imp.get)
var_log = list(filter(lambda x: abs(var_imp[x]) > 0.06, var_log))
ax = sns.barplot(y = var_log, x = list(map(lambda x: var_imp[x],var_log)),colo
r='lightblue')
ax.set_title("Important Variables based on Logistic Regression", fontsize = 18
)
ax.set_yticklabels(var_log,fontsize = 12)
ax.set_xlabel("Importance",fontsize = 18)
```

Out[59]:
```
Text(0.5,0,'Importance')
```



In [27]:
```
log_model = LogisticRegression(random_state = 10,class_weight='balanced',fit_i
ntercept=True)
log_model.fit(train_features[var_log],train_labels)
pred_log = log_model.predict_proba(test_features[var_log])[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_log)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_log),"\n")
print("# of Variables: ",len(var_log))
```

```
C:\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:433: FutureWa
rning: Default solver will be changed to 'lbfgs' in 0.22. Specify a solver to
silence this warning.
  FutureWarning)

Gini:  0.6646191616278507

AUC:  0.8323095808139254

# of Variables:  24
```

Random Forest

In [28]:

```
from sklearn.ensemble import RandomForestClassifier

rf = RandomForestClassifier(n_estimators = 100, random_state = 0,max_depth=10,
\
                            criterion="gini",n_jobs = -1, class_weight = 'bala
nced_subsample')
rf.fit(train_features,train_labels)
pred_rf = rf.predict_proba(test_features)[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_rf)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_rf),"\n")

imp = pd.DataFrame([train_features.columns,rf.feature_importances_]).T
imp.columns = ["Var","Importance"]
imp.sort_values(by = "Importance",ascending=False, inplace=True)
```

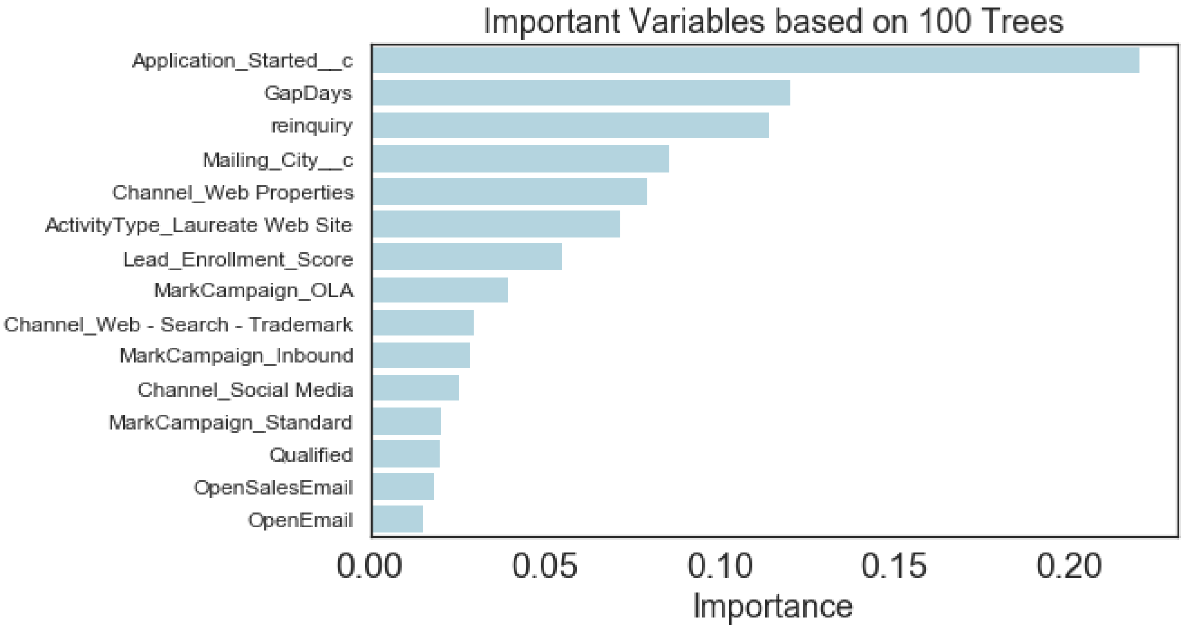
```
C:\Anaconda3\lib\importlib\_bootstrap.py:219: RuntimeWarning: numpy.ufunc siz
e changed, may indicate binary incompatibility. Expected 216, got 192
  return f(*args, **kwds)
C:\Anaconda3\lib\importlib\_bootstrap.py:219: ImportWarning: can't resolve pa
ckage from __spec__ or __package__, falling back on __name__ and __path__
  return f(*args, **kwds)

Gini:  0.6806977365324682

AUC:  0.8403488682662341
```

In [56]:

```
plt.figure(figsize = (8,5))
ax = sns.barplot(x = "Importance", y = "Var", data = imp.head(15), color = "lightblue")
ax.set_yticklabels(imp[imp.Importance > 0.002].Var,fontsize = 12)
ax.set_xlabel("Importance",fontsize = 18)
ax.set_title("Important Variables based on 100 Trees", fontsize = 18)
ax.set_yticklabels(ax.get_yticklabels(),fontsize = 12)
ax.set_xlabel("Importance",fontsize = 18)
ax.set_ylabel("")
```

Out[56]:

```
Text(0,0.5,'')
```



In [30]:

```
var_rf = imp.Var[imp.Importance > 0.002].to_list()

rf = RandomForestClassifier(n_estimators = 100, random_state = 0,max_depth=10, \
                            criterion="gini",n_jobs = -1,class_weight = 'balanced_subsample')

rf.fit(train_features[var_rf],train_labels)
pred_rf = rf.predict_proba(test_features[var_rf])[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_rf)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_rf),"\n")
print("# of Features: ", len(var_rf))
```

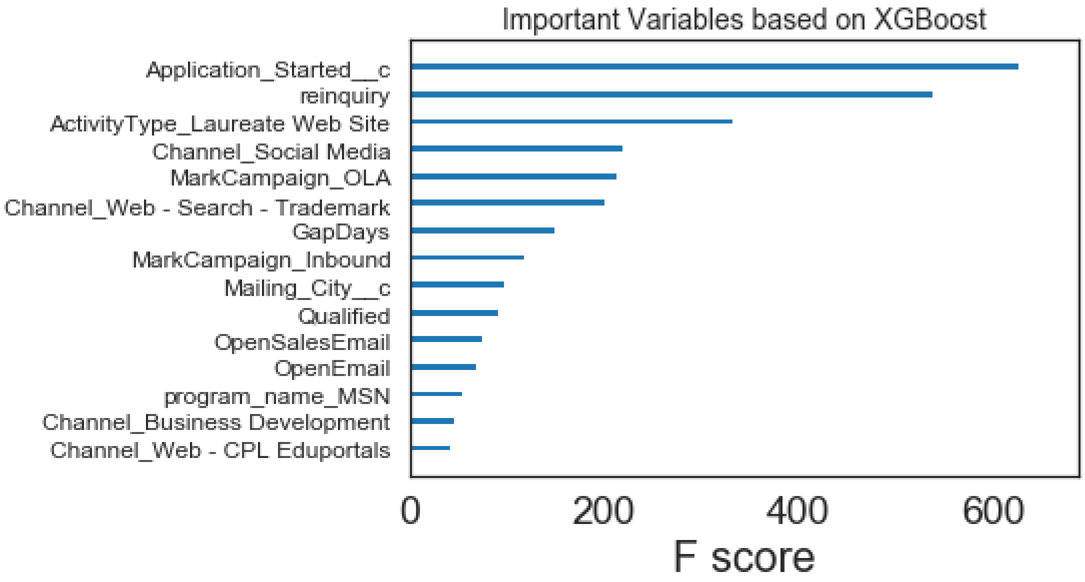
```
Gini:  0.680519724750273

AUC:  0.8402598623751365

# of Features:  25
```

Extreme Gradient Boosting

In [53]:
```python
import xgboost as xgb

xgb_mod = xgb.XGBClassifier(max_depth=5,n_estimators= 100,n_jobs=-1,random_sta
te=18,eval_mertic = "auc")
xgb_mod.fit(X = train_features, y = train_labels)
pred_xgb = xgb_mod.predict_proba(test_features)[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_xgb)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_xgb),"\n")

ax = xgb.plot_importance(xgb_mod,max_num_features=15,importance_type='gain',sh
ow_values=False,grid=False)
ax.set_yticklabels(ax.get_yticklabels(),fontdict= {'fontsize':12})
ax.set_title("Important Variables based on XGBoost",fontdict= {'fontsize':14})
ax.set_ylabel("")
```

```
Gini:  0.6973268920056543

AUC:  0.8486634460028272
```

Out[53]:
```
Text(0,0.5,'')
```



In [51]:
```python
xgb_imp = pd.DataFrame([train_features.columns,xgb_mod.feature_importances_]).
T
xgb_imp.columns = ["Var","Importance"]
xgb_imp.sort_values(by = "Importance",ascending=False, inplace=True)
xgb_var = xgb_imp.Var[xgb_imp.Importance > 0.01].values.tolist()
```

In [52]:
```
xgb_mod = xgb.XGBClassifier(max_depth=5,n_estimators=100,n_jobs=-1,random_stat
e=18,eval_metric = "auc")
xgb_mod.fit(X = train_features[xgb_var], y = train_labels)
pred_xgb = xgb_mod.predict_proba(test_features[xgb_var])[:,1]

print("Gini: ", 2*roc_auc_score(test_labels,pred_xgb)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_xgb),"\n")
print("# of features: ", len(xgb_var))
```

```
Gini:  0.6932916901877153

AUC:  0.8466458450938577

# of features:  19
```

Neural Networks

In [37]:
```
import tensorflow as tf
from keras import models
from keras import layers
```

```
C:\Anaconda3\lib\site-packages\tensorflow\python\keras\backend.py:5201: Resou
rceWarning: unclosed file <_io.TextIOWrapper name='C:\\Users\\Nikhil John Tho
mas\\.keras\\keras.json' mode='r' encoding='cp1252'>
  _config = json.load(open(_config_path))
C:\Anaconda3\lib\importlib\_bootstrap.py:219: ImportWarning: can't resolve pa
ckage from __spec__ or __package__, falling back on __name__ and __path__
  return f(*args, **kwds)
C:\Anaconda3\lib\site-packages\h5py\__init__.py:36: FutureWarning: Conversion
of the second argument of issubdtype from `float` to `np.floating` is depreca
ted. In future, it will be treated as `np.float64 == np.dtype(float).type`.
  from ._conv import register_converters as _register_converters
C:\Anaconda3\lib\importlib\_bootstrap.py:219: RuntimeWarning: numpy.ufunc siz
e changed, may indicate binary incompatibility. Expected 192 from C header, g
ot 216 from PyObject
  return f(*args, **kwds)
Using TensorFlow backend.
```

In [38]:

```
from keras import backend as K

def auc(y_true, y_pred):
    auc = tf.metrics.auc(y_true, y_pred)[1]
    K.get_session().run(tf.local_variables_initializer())
    return auc

network = models.Sequential()

##hidden layer
network.add(layers.Dense(units = 15,activation='relu',input_dim = train_featur
es.shape[1]))
##output layer
network.add(layers.Dense(units = 1, activation='sigmoid'))

network.compile(loss='binary_crossentropy', optimizer='adam', metrics=[auc])

network.fit(x = train_features,y = train_labels,
            batch_size = 64, epochs = 5,verbose = 1,
            validation_data=(test_features, test_labels),
           class_weight = dict(zip([0,1],train_features.shape[0]/(2 * np.binco
unt(train_labels)))))


pred_nn = network.predict(test_features)

print("\n \n")

print("Gini: ", 2*roc_auc_score(test_labels,pred_nn)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_nn),"\n")
```

```
WARNING:tensorflow:From C:\Anaconda3\lib\site-packages\tensorflow\python\fram
ework\op_def_library.py:263: colocate_with (from tensorflow.python.framework.
ops) is deprecated and will be removed in a future version.
Instructions for updating:
Colocations handled automatically by placer.
```

```
C:\Anaconda3\lib\site-packages\numpy\lib\type_check.py:546: DeprecationWarnin
g: np.asscalar(a) is deprecated since NumPy v1.16, use a.item() instead
  'a.item() instead', DeprecationWarning, stacklevel=1)
```

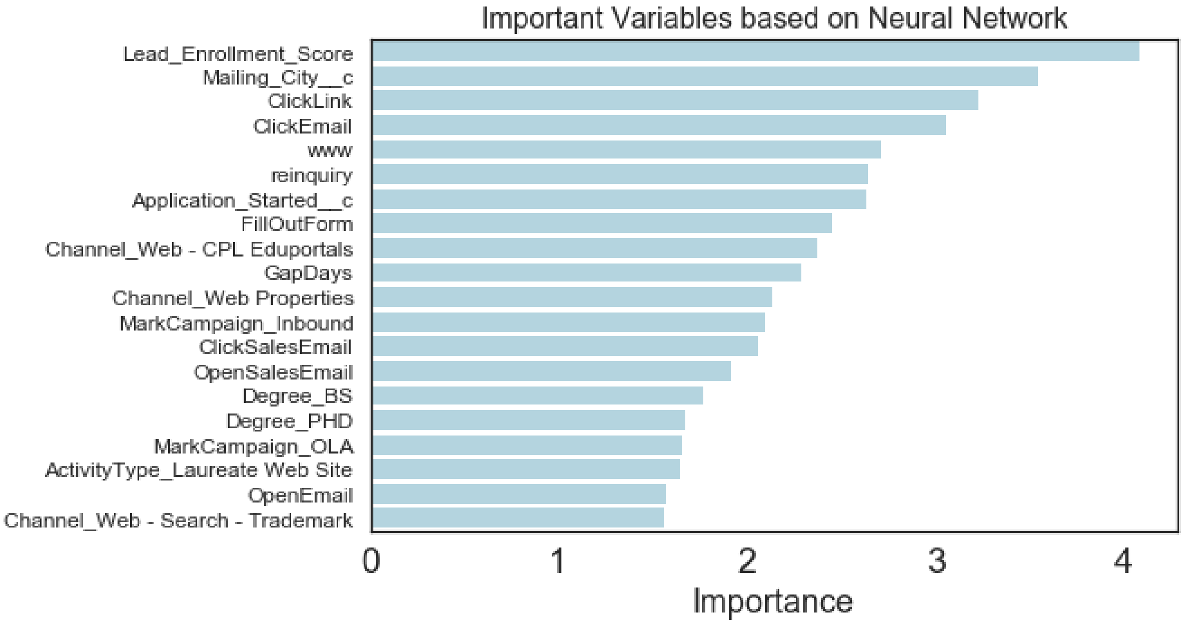
```
WARNING:tensorflow:From C:\Anaconda3\lib\site-packages\tensorflow\python\ops
\metrics_impl.py:526: to_float (from tensorflow.python.ops.math_ops) is depre
cated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
WARNING:tensorflow:From C:\Anaconda3\lib\site-packages\tensorflow\python\ops
\metrics_impl.py:788: div (from tensorflow.python.ops.math_ops) is deprecated
and will be removed in a future version.
Instructions for updating:
Deprecated in favor of operator or tf.math.divide.
WARNING:tensorflow:From C:\Anaconda3\lib\site-packages\tensorflow\python\ops
\math_ops.py:3066: to_int32 (from tensorflow.python.ops.math_ops) is deprecat
ed and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
Train on 535152 samples, validate on 229352 samples
Epoch 1/5
535152/535152 [==============================] - 28s 52us/step - loss: 0.5029
- auc: 0.8149 - val_loss: 0.5092 - val_auc: 0.8352
Epoch 2/5
535152/535152 [==============================] - 23s 44us/step - loss: 0.4893
- auc: 0.8382 - val_loss: 0.4908 - val_auc: 0.8398
Epoch 3/5
535152/535152 [==============================] - 29s 55us/step - loss: 0.4873
- auc: 0.8409 - val_loss: 0.4797 - val_auc: 0.8416
Epoch 4/5
535152/535152 [==============================] - 24s 46us/step - loss: 0.4862
- auc: 0.8421 - val_loss: 0.4699 - val_auc: 0.8426
Epoch 5/5
535152/535152 [==============================] - 24s 45us/step - loss: 0.4856
- auc: 0.8430 - val_loss: 0.4682 - val_auc: 0.8433
```

```
Gini:  0.6916260115858661
```

```
AUC:  0.8458130057929331
```

In [39]:
```
imp_nn = pd.DataFrame(np.std(train_features,0) * np.sum(np.abs(network.get_wei
ghts()[0]),axis = 1))
imp_nn.reset_index(inplace=True)
imp_nn.columns = ['Var','Importance']
imp_nn.sort_values(by = 'Importance',ascending = False,inplace=True)

plt.figure(figsize=(8,5))
ax = sns.barplot(y = 'Var', x = 'Importance', data = imp_nn.head(20) , color =
"lightblue")
ax.set_yticklabels(ax.get_yticklabels(),fontsize = 12)
ax.set_xlabel("Importance",fontsize = 18)
ax.set_title("Important Variables based on Neural Network", fontsize = 16)
ax.set_ylabel("")
```

Out[39]:
```
Text(0,0.5,'')
```



In [45]:

```
var_nn = imp_nn.Var[imp_nn.Importance > 1.2]

network = models.Sequential()

##hidden layer
network.add(layers.Dense(units = 10,activation='relu',input_dim = train_featur
es[var_nn].shape[1]))
##output layer
network.add(layers.Dense(units = 1, activation='sigmoid'))

network.compile(loss='binary_crossentropy', optimizer='adam', metrics=[auc])

network.fit(x = train_features[var_nn],y = train_labels,
            batch_size = 64, epochs = 5,verbose = 1,
            validation_data=(test_features[var_nn], test_labels),
           class_weight = dict(zip([0,1],train_features.shape[0]/(2 * np.binco
unt(train_labels)))))


pred_nn = network.predict(test_features[var_nn])

print("\n \n")

print("Gini: ", 2*roc_auc_score(test_labels,pred_nn)-1,"\n")
print("AUC: ", roc_auc_score(test_labels,pred_nn),"\n")
print("# of features: ", len(var_nn))
```

```
C:\Anaconda3\lib\site-packages\numpy\lib\type_check.py:546: DeprecationWarnin
g: np.asscalar(a) is deprecated since NumPy v1.16, use a.item() instead
  'a.item() instead', DeprecationWarning, stacklevel=1)

Train on 535152 samples, validate on 229352 samples
Epoch 1/5
535152/535152 [==============================] - 12s 23us/step - loss: 0.5133
- auc: 0.8084 - val_loss: 0.5083 - val_auc: 0.8275
Epoch 2/5
535152/535152 [==============================] - 12s 22us/step - loss: 0.5008
- auc: 0.8306 - val_loss: 0.5104 - val_auc: 0.8318
Epoch 3/5
535152/535152 [==============================] - 12s 22us/step - loss: 0.4991
- auc: 0.8328 - val_loss: 0.4909 - val_auc: 0.8335
Epoch 4/5
535152/535152 [==============================] - 12s 22us/step - loss: 0.4983
- auc: 0.8339 - val_loss: 0.5245 - val_auc: 0.8344
Epoch 5/5
535152/535152 [==============================] - 12s 22us/step - loss: 0.4977
- auc: 0.8348 - val_loss: 0.5109 - val_auc: 0.8350



Gini:  0.6752063023409276

AUC:  0.8376031511704638

# of features:  22
```

Model Prediction - Comparisions

In [41]:

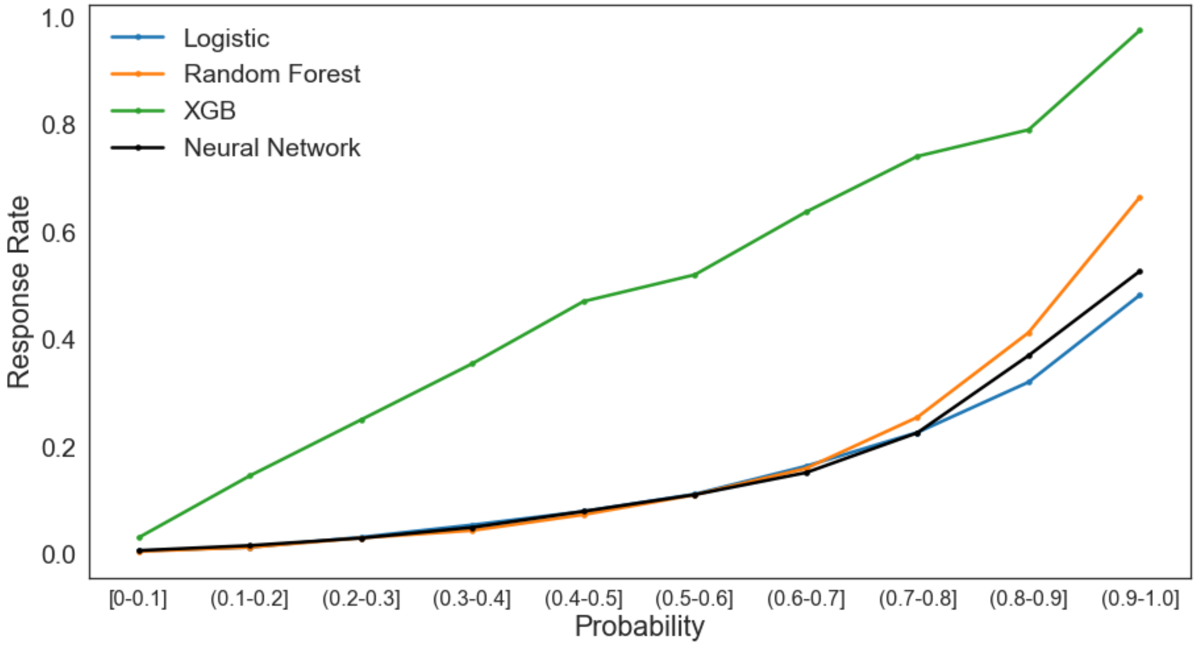
```
def prob_bin(labels, prob):
    x = pd.DataFrame(data = np.transpose(np.array([labels,np.round(prob,4)])), columns = ['Label','Probability'])
    cutpoints = np.round(np.arange(0,1.1,0.1),1).tolist()
    x['Probability'] = pd.cut(x = x.Probability, bins = cutpoints,include_lowest=True)
    x = x.groupby(['Probability'],as_index = False).Label.mean()
    return(x.Label.values)
```

In [42]:

```
plt.figure(figsize=(15,8))
x = np.round(np.arange(0.1,1.1,0.1),1).tolist()
labs = ['[0-0.1]','(0.1-0.2]','(0.2-0.3]','(0.3-0.4]','(0.4-0.5]',\
        '(0.5-0.6]','(0.6-0.7]','(0.7-0.8]','(0.8-0.9]','(0.9-1.0]',]

X = test_features
# X[scale_var] = scaler.transform(X[scale_var])
y = test_labels

pred_log = log_model.predict_proba(X[var_log])[:,1]
pred_rf = rf.predict_proba(X[var_rf])[:,1]
pred_xgb = xgb_mod.predict_proba(X[xgb_var])[:,1]
pred_nn = network.predict(X[var_nn])

plt.plot(x,prob_bin(y,pred_log),label = 'Logistic',marker = '.')
plt.plot(x,prob_bin(y,pred_rf),label = 'Random Forest',marker = '.')
plt.plot(x,prob_bin(y,pred_xgb),label = 'XGB',marker = '.')
plt.plot(x,prob_bin(y,pred_nn.flatten()),label = 'Neural Network',marker = '.'
,color = 'black')
plt.legend()
plt.xticks(np.arange(0.1,1.1,0.1), labs, fontsize = 16, rotation = 0)
plt.xlabel('Probability')
plt.ylabel('Response Rate')
```

Out[42]:

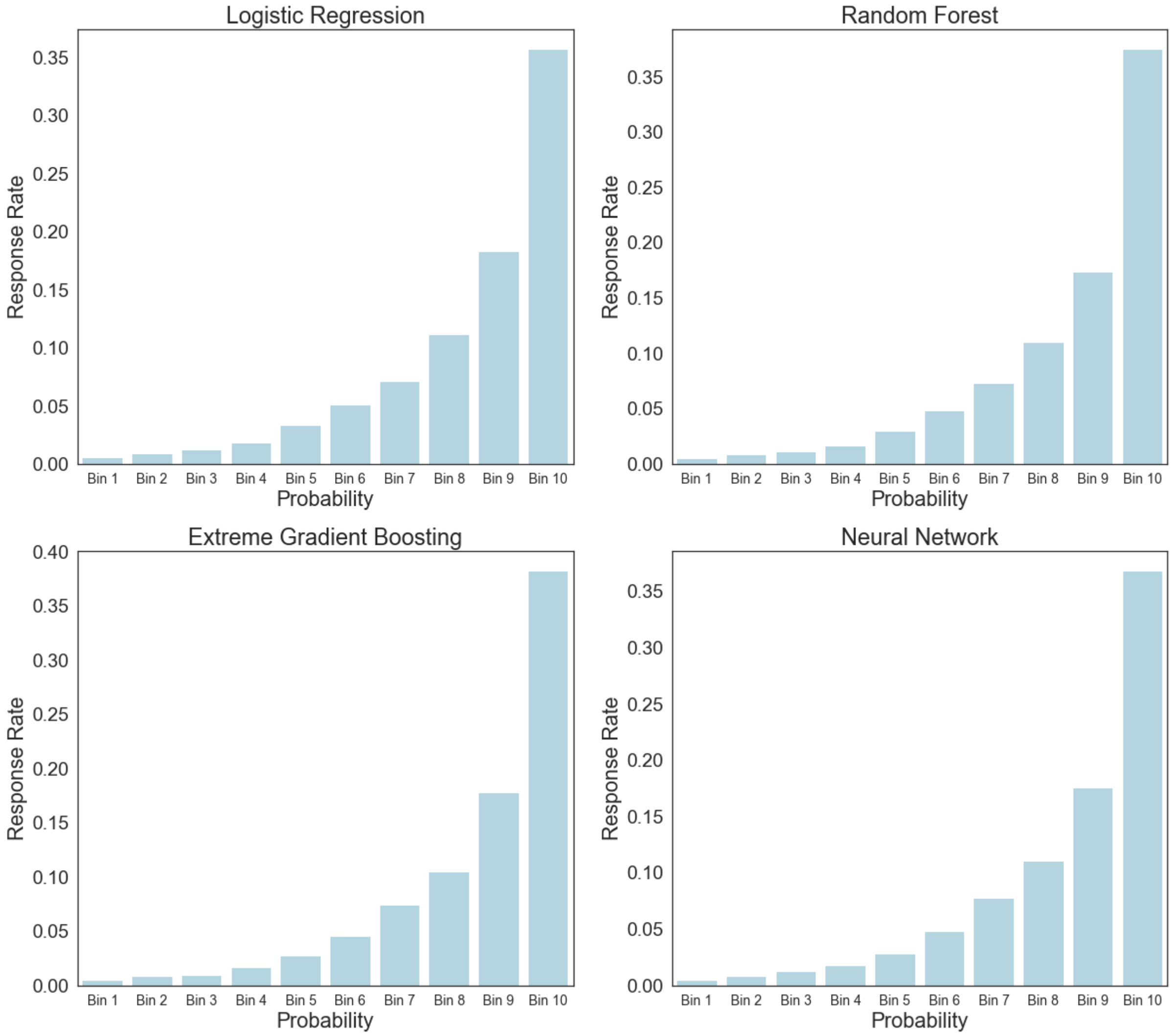
```
Text(0,0.5,'Response Rate')
```



In [43]:

```
def quantile_prob_bin(labels, prob):
    x = pd.DataFrame(data = np.transpose(np.array([labels,np.round(prob,4)])),
columns = ['Label','Probability'])
    x['Probability'] = pd.qcut(x = x.Probability, q = 10, duplicates = "drop")
    return(x.groupby(['Probability'],as_index = False).Label.mean())

plt.figure(figsize=(20,18))
plt.subplot(2,2,1)
a = quantile_prob_bin(y,pred_log)
ax = sns.barplot(x = 'Probability',y = 'Label', data = a, color = 'lightblue')
lab = list(map(lambda x: "Bin "+str(x),np.arange(1,len(a)+1)))
ax.set_xticklabels(lab,fontdict = {'fontsize':14,'rotation':0,'ha':'center'})
ax.set_xlabel('Probability')
ax.set_ylabel('Response Rate')
ax.set_title('Logistic Regression')

plt.subplot(2,2,2)
a = quantile_prob_bin(y,pred_rf)
ax = sns.barplot(x = 'Probability',y = 'Label', data = a, color = 'lightblue')
lab = list(map(lambda x: "Bin "+str(x),np.arange(1,len(a)+1)))
ax.set_xticklabels(lab,fontdict = {'fontsize':14,'rotation':0,'ha':'center'})
ax.set_xlabel('Probability')
ax.set_ylabel('Response Rate')
ax.set_title('Random Forest')

plt.subplot(2,2,3)
a = quantile_prob_bin(y,pred_xgb)
ax = sns.barplot(x = 'Probability',y = 'Label', data = a, color = 'lightblue')
lab = list(map(lambda x: "Bin "+str(x),np.arange(1,len(a)+1)))
ax.set_xticklabels(lab,fontdict = {'fontsize':14,'rotation':0,'ha':'center'})
ax.set_xlabel('Probability')
ax.set_ylabel('Response Rate')
ax.set_title('Extreme Gradient Boosting')

plt.subplot(2,2,4)
a = quantile_prob_bin(y,pred_nn.flatten())
ax = sns.barplot(x = 'Probability',y = 'Label', data = a, color = 'lightblue')
lab = list(map(lambda x: "Bin "+str(x),np.arange(1,len(a)+1)))
ax.set_xticklabels(lab,fontdict = {'fontsize':14,'rotation':0,'ha':'center'})
ax.set_xlabel('Probability')
ax.set_ylabel('Response Rate')
ax.set_title('Neural Network')
```

```
Out[43]: Text(0.5,1,'Neural Network')
```



```
In [44]: def compute_lift(labels,prob):
             tmp = pd.DataFrame(data = np.stack([labels,prob],axis=1), columns=['Label','Probability'])
             tmp.sort_values(by = 'Probability', ascending = False, inplace = True)
             tmp = pd.concat([pd.qcut(x = pd.Series(np.arange(1,len(tmp)+1)), q = 10, labels = np.arange(1,11)),tmp],axis = 1)
             tmp.columns = ['Bin','Label','Probability']

             tmp = pd.crosstab(tmp.Bin,tmp.Label,normalize = 'columns')
             tmp.reset_index(inplace = True)
             tmp.columns = ['Pop Prop','Bad','Good']
             tmp['Cumulative Response Rate'] = np.cumsum(tmp.Good)
             tmp['Pop Prop'] = tmp['Pop Prop'].astype(int) * 1.0 / 10
             tmp['Lift'] = tmp['Cumulative Response Rate'] * 1.0 / tmp['Pop Prop']
             tmp.drop(columns = ['Bad','Good'], inplace=True)

             tmp = pd.DataFrame(np.vstack([np.zeros((1,3)),tmp.values]),columns=tmp.columns)
             return(tmp)
```

In [63]:

```
### Common Variables in all 4 Models
set(var_log).intersection(var_rf).intersection(var_nn).intersection(xgb_var)
```

Out[63]:

```
{'ActivityType_Laureate Web Site',
 'Application_Started__c',
 'Channel_Social Media',
 'Channel_Web - Search - Trademark',
 'ClickSalesEmail',
 'Degree_PHD',
 'GapDays',
 'Lead_Enrollment_Score',
 'Mailing_City__c',
 'MarkCampaign_Inbound',
 'MarkCampaign_OLA',
 'OpenEmail',
 'OpenSalesEmail',
 'reinquiry'}
```

In [ ]: