SAS® GLOBAL FORUM 2015

The Journey Is Yours

# Implementing a Discrete Event Simulation Using the American Community Survey and SAS® University Edition

2320-2015
by
Michael C. Grierson

SAS GLOBAL FORUM

# Overview of Topics

- Discrete Event Simulators
- SAS® University Edition and Base SAS®
- American Community Survey and the Veterans Population
- Summary

# Discrete Event Simulators defined

- From WikiPedia, “In the field of simulation, a **discrete-event simulation (DES)**, models the operation of a system as a discrete sequence of events in time. Each event occurs at a particular instant in time and marks a change of state in the system.[1] Between consecutive events, no change in the system is assumed to occur; thus the simulation can directly jump in time from one event to the next.”
- Usually implemented with a Graphical User Interface

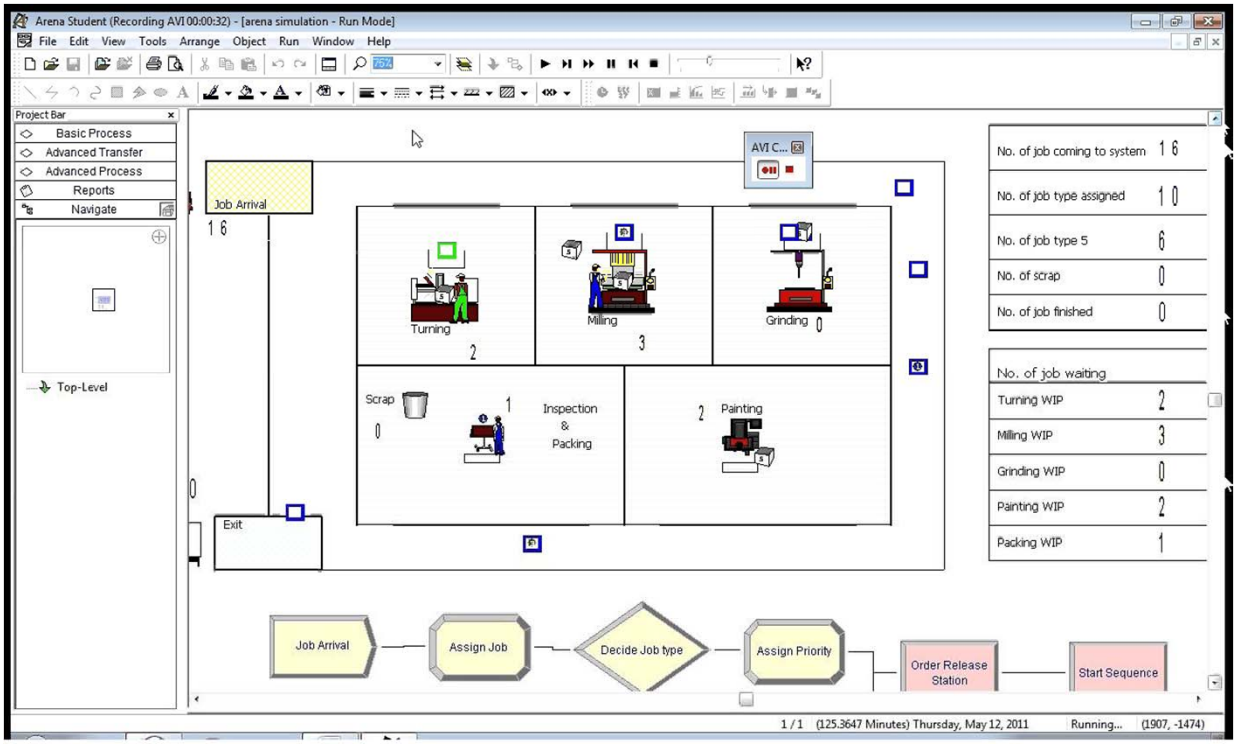
[1] Stewart Robinson (2004). Simulation – The practice of model development and use. Wiley.

# Discrete Event Simulators

## Arena

GUI

Example 1



# Discrete Event Simulators

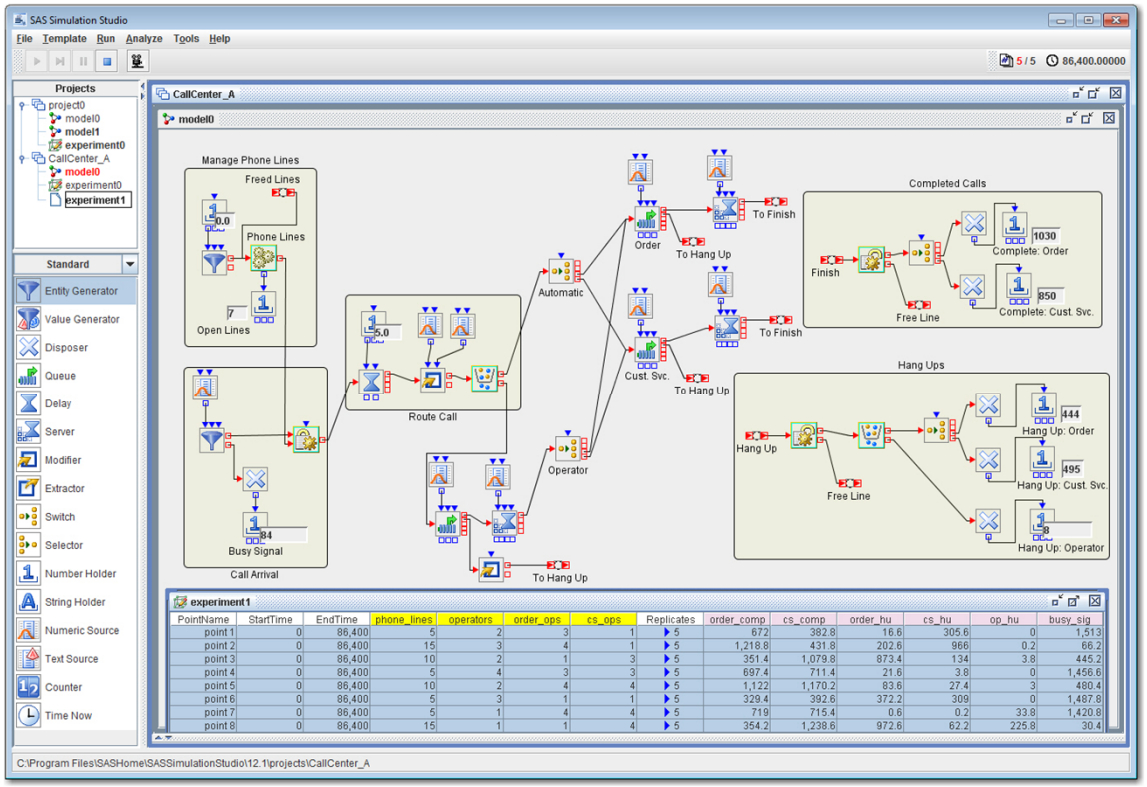
SAS

Simulation

Studio

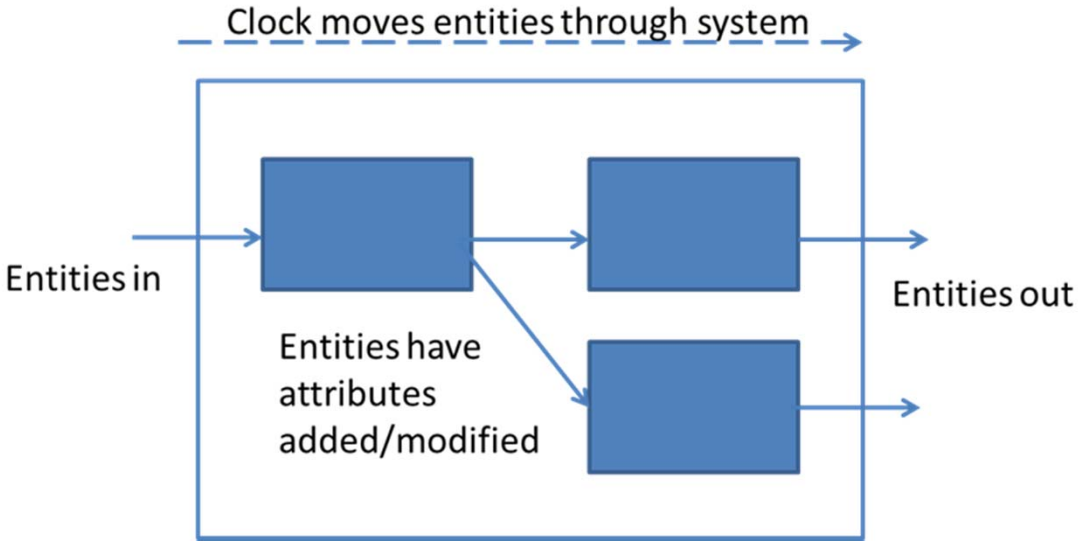
GUI

Example 2



# Discrete Event Simulators

- Simple example, Rental Car Business
  - Usually represent a ‘system’ with a set of blocks.
- Entities
  - Rental cars
  - Use sashelp.cars
- Attributes
  - Model year
- Clock move entities
- Datasets are blocks
- Macro call is the clock



# Discrete Event Simulators

- A Simple Example

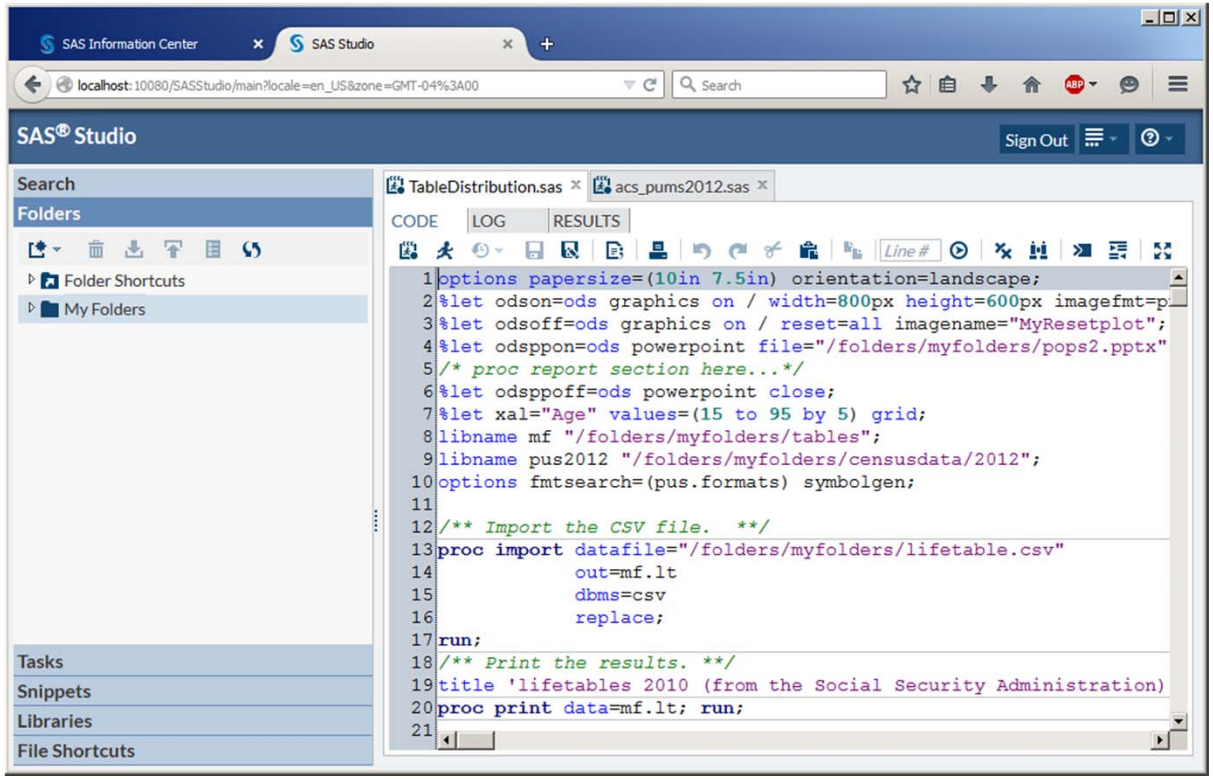
```
libname rentals '/folders/myfolders/RentalCars';

data current_cars;
   set sashelp.cars;
   car_year=2003 ;
run;

data new_cars;
   set sashelp.cars;
run;
```

```
%macro cycle(yr);
  data current_cars cars_to_sell;
     set current_cars new_cars;
     if car_year = . then car_year=&yr;
     if enter = . then enter = &yr;
     yeardiff=&yr-car_year;
     if yeardiff > 3 then do;
        output cars_to_sell;
     end;
     if yeardiff <= 3 then do;
        output current_cars;
     end;
  run;
%mend;
```

```
%cycle(2004);
%cycle(2005);
%cycle(2006);
%cycle(2007);
%cycle(2008);
%cycle(2009);
%cycle(2010);
%cycle(2011);
%cycle(2012);
```

# SAS University Edition

- SAS Studio interface to a local virtual machine.



# SAS University Edition

- Provided for Students.  Free SAS Software…  but….
  - http://www.sas.com/en_us/software/university-edition.html
- Does not include SAS/OR®
- Can read Stratified Surveys

Operating System: LIN X64 .
Product expiration dates:
---Base SAS Software
---SAS/STAT
---SAS/IML
---SAS/Secure 168-bit
---SAS/ACCESS Interface to PC Files
---SAS/ACCESS Interface to ODBC
---SAS/IML Studio
---SAS Workspace Server for Local Access
---SAS Workspace Server for Enterprise Access
---High Performance Suite

# American Community Survey and Veterans

- Provided by the Census Bureau
- Is a Stratified Survey
- Supports Analytics about Communities (like Veterans).

**26** **Has this person ever served on active duty in the U.S. Armed Forces, military Reserves, or National Guard?** *Active duty does not include training for the Reserves or National Guard, but DOES include activation, for example, for the Persian Gulf War.*

- ☐ Yes, now on active duty
- ☐ Yes, on active duty during the last 12 months, but not now
- ☐ Yes, on active duty in the past, but not during the last 12 months
- ☐ No, training for Reserves or National Guard only → *SKIP to question 28a*
- ☐ No, never served in the military → *SKIP to question 29a*

**27** **When did this person serve on active duty in the U.S. Armed Forces?** *Mark (X) a box for EACH period in which this person served, even if just for part of the period.*

- ☐ September 2001 or later
- ☐ August 1990 to August 2001 (including Persian Gulf War)
- ☐ September 1980 to July 1990
- ☐ May 1975 to August 1980
- ☐ Vietnam era (August 1964 to April 1975)
- ☐ March 1961 to July 1964
- ☐ February 1955 to February 1961
- ☐ Korean War (July 1950 to January 1955)
- ☐ January 1947 to June 1950
- ☐ World War II (December 1941 to December 1946)
- ☐ November 1941 or earlier

# American Community Survey and Veterans

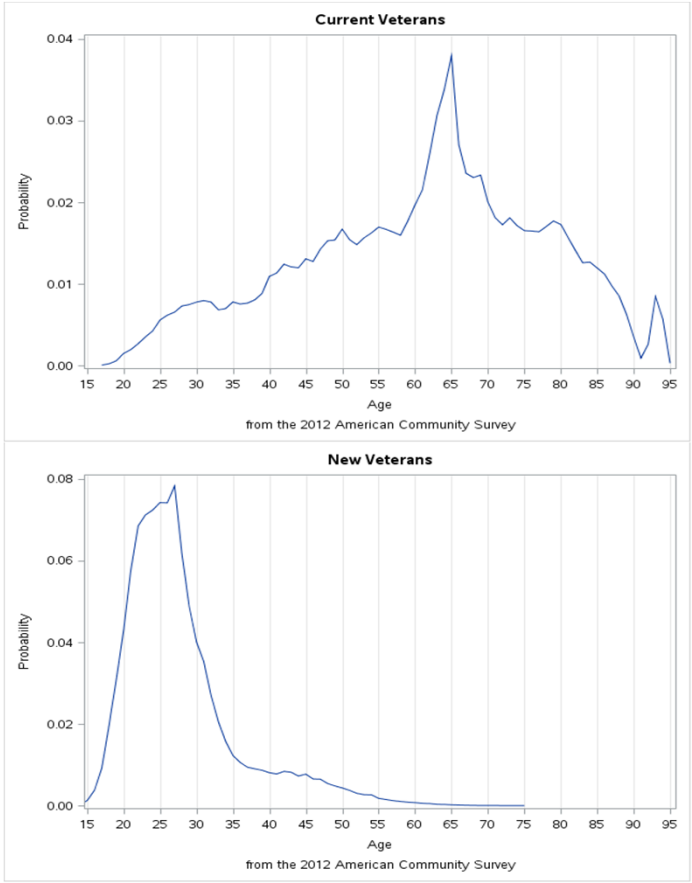
```
data pus.veterans;
  set pus.pus;
  if mil < 2 or mil > 3 then delete;
  if mlpa = 1 then lyms = 2009;
  else if mlpb = 1 then lyms = 2001;
  else if mlpc = 1 then lyms = 1990;
  else if mlpd = 1 then lyms = 1980;
  else if mlpe = 1 then lyms = 1974;
  else if mlpf = 1 then lyms = 1964;
  else if mlpg = 1 then lyms = 1961;
  else if mlph = 1 then lyms = 1954;
  else if mlpi = 1 then lyms = 1950;
  else if mlpj = 1 then lyms = 1946;
  else if mlpk = 1 then lyms = 1941;
  else lyms = . ;
  vetage = agep-(2012-lyms);
run;
```

- Stratified details

```
proc surveyfreq data=pus.veterans ;
  weight pwgtp;
  table agep;
  ods output OneWay=pus.freqoutcv;
run;

proc surveyfreq data=pus.veterans ;
  weight pwgtp;
  table vetage;
  ods output OneWay=pus.freqoutnv;
run;
```

# American Community Survey and Veterans

- Probability Distributions
  - Current Veterans
  - New Veterans



# American Community Survey and Veterans

- Generated Distributions
- Transpose actual distribution to get an array of probabilities

```
proc transpose data=mf.freqoutCV out=mf.vetagepdf_trans(drop=_LABEL_
       rename=(_NAME_=var)) prefix=x;
       var agep percent pb;
```

# American Community Survey and Veterans

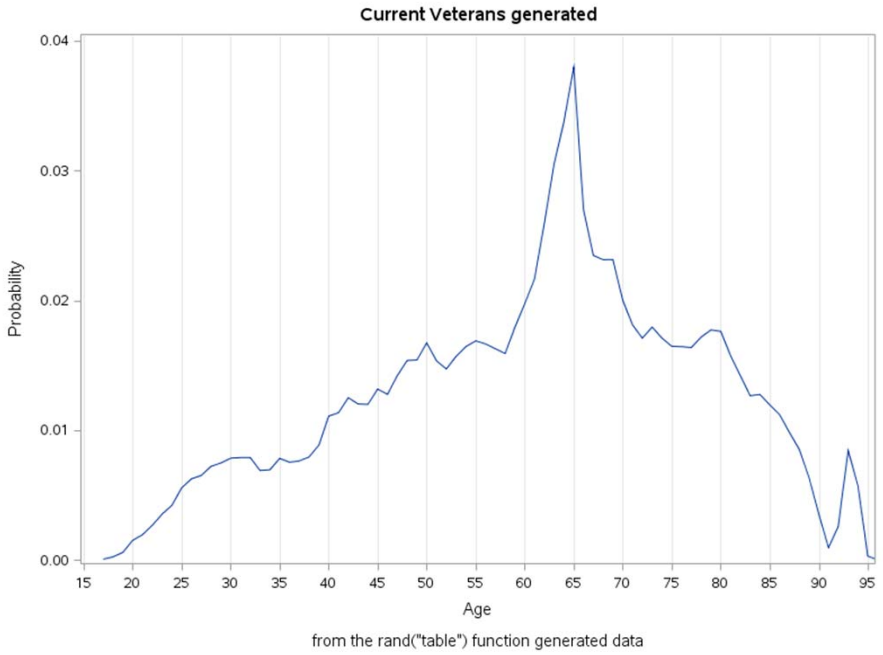
- Generated Current Distribution using rand function

```
%let N=    2200000;
data mf.CurrentGen(keep=x);
call streaminit(3215);
array p[79] _temporary_ (0.000057 0.000226    0.000585    0.001495    0.001964    0.002686    0.003524
           0.00425    0.005592    0.006175    0.006553    0.0073      0.007474    0.007776    0.007957
           0.007778   0.006833    0.006979    0.007792    0.007536    0.007653    0.00805     0.008835
           0.010932   0.011336    0.012419    0.012083    0.011974    0.013082    0.012756    0.014264
           0.015287   0.015392    0.016714    0.015429    0.014817    0.015652    0.016245    0.016967
           0.016689   0.016341    0.015962    0.017712    0.019692    0.021515    0.025923    0.030602
           0.033758   0.037967    0.02707     0.023553    0.023029    0.023335    0.020031    0.018102
           0.017247   0.018098    0.017139    0.016526    0.016478    0.016383    0.017033    0.017713
           0.017295   0.01569     0.014107    0.012599    0.012683    0.011943    0.011209    0.009764
           0.008518   0.006331    0.003533    0.000909    0.002626    0.008474    0.0057      0.000299);
do i = 1 to &N;
  x1 = rand("Table", of p[*]);
  x=x1+16;
  output;
end;
run;
```

SAS GLOBAL FORUM

# American Community Survey and Veterans

- Generated Current Distribution using rand function



# American Community Survey and Veterans

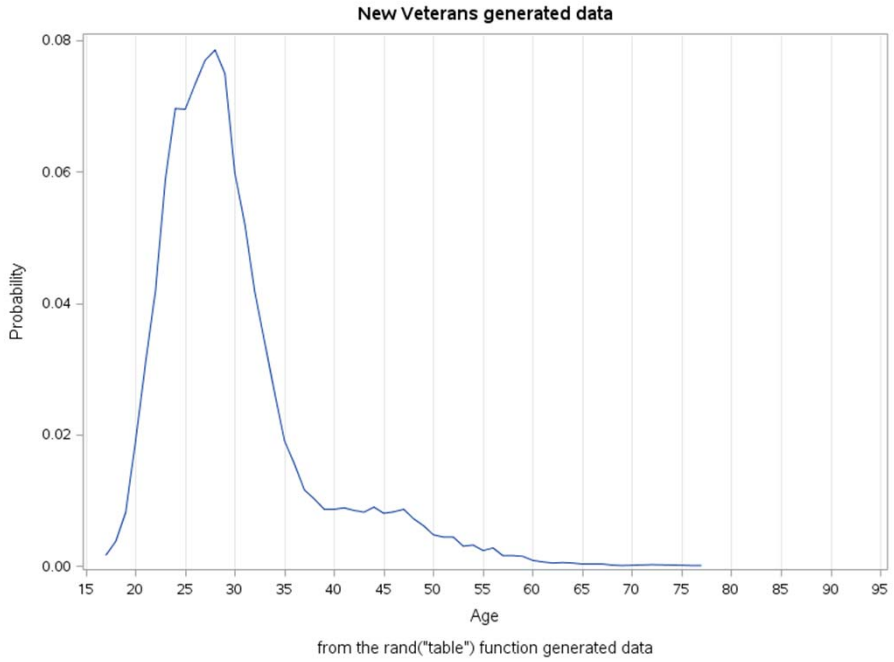
- Generated New Distribution using rand function

```
%macro gennv(N);
data mf.NewGen(keep=x);
  call streaminit(3214);
  array p[61] _temporary_ (0.001447     0.00376     0.009206     0.019647     0.030841     0.042973
                0.057762     0.068525     0.071224     0.072418     0.074236     0.074182     0.07831
                0.061718     0.048805     0.040078     0.035275     0.026973     0.020545     0.015766
                0.012296     0.010566     0.009416     0.009018     0.00867      0.008069     0.007759
                0.008389     0.008165     0.007243     0.007711     0.006531     0.006478     0.005409
                0.004815     0.004326     0.003728     0.00302      0.002665     0.002649     0.001775
                0.001485     0.001217     0.001027     0.000856     0.000728     0.000561     0.000505
                0.000325     0.000283     0.000192     0.00015      0.000095     0.000051     0.000025
                0.000046     0.000035     9.934E-6     2.671E-6     9.418E-6     9.512E-6);
  do i = 1 to &N;
    x = rand("Table", of p[*])+16;
    output;
  end;
run;
%mend;
%gennv(18000);
```

SAS GLOBAL FORUM

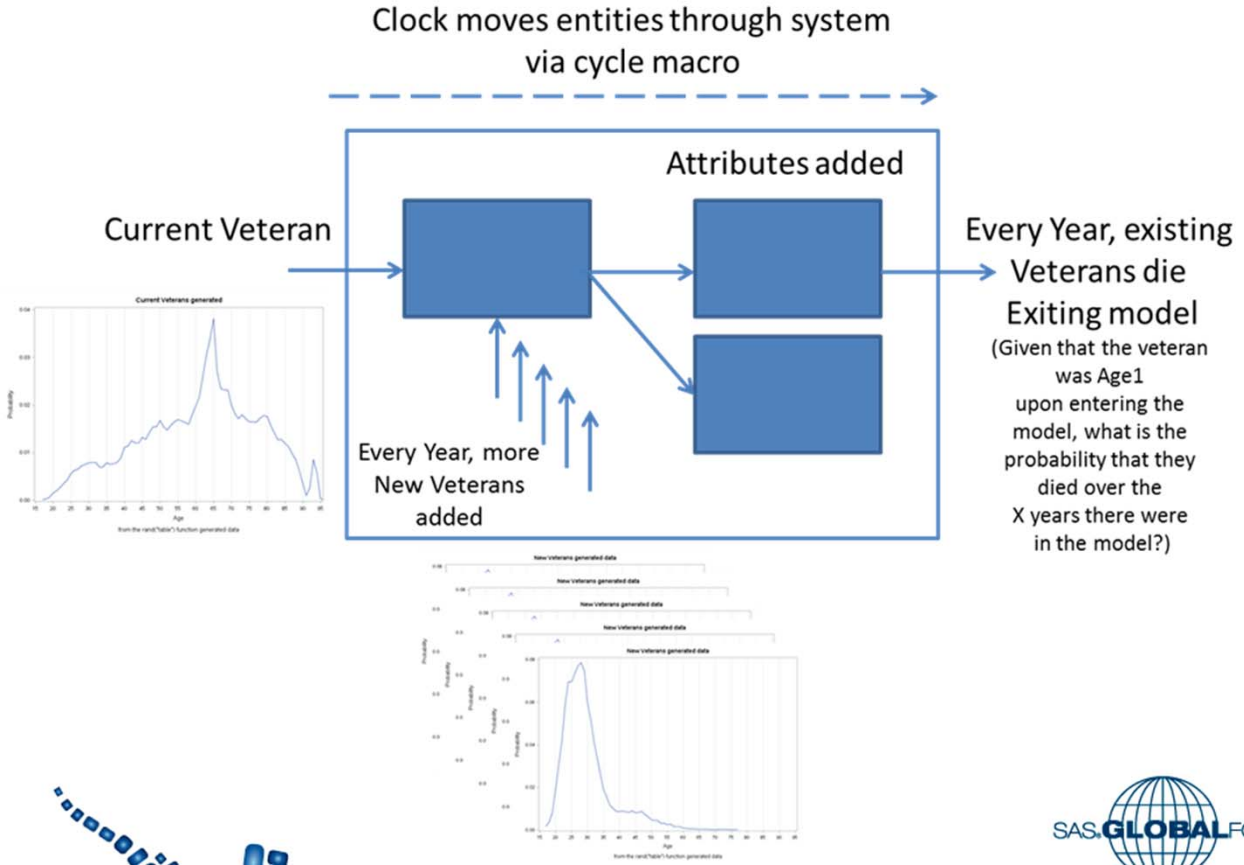
# American Community Survey and Veterans

- Generated New Distribution using rand function



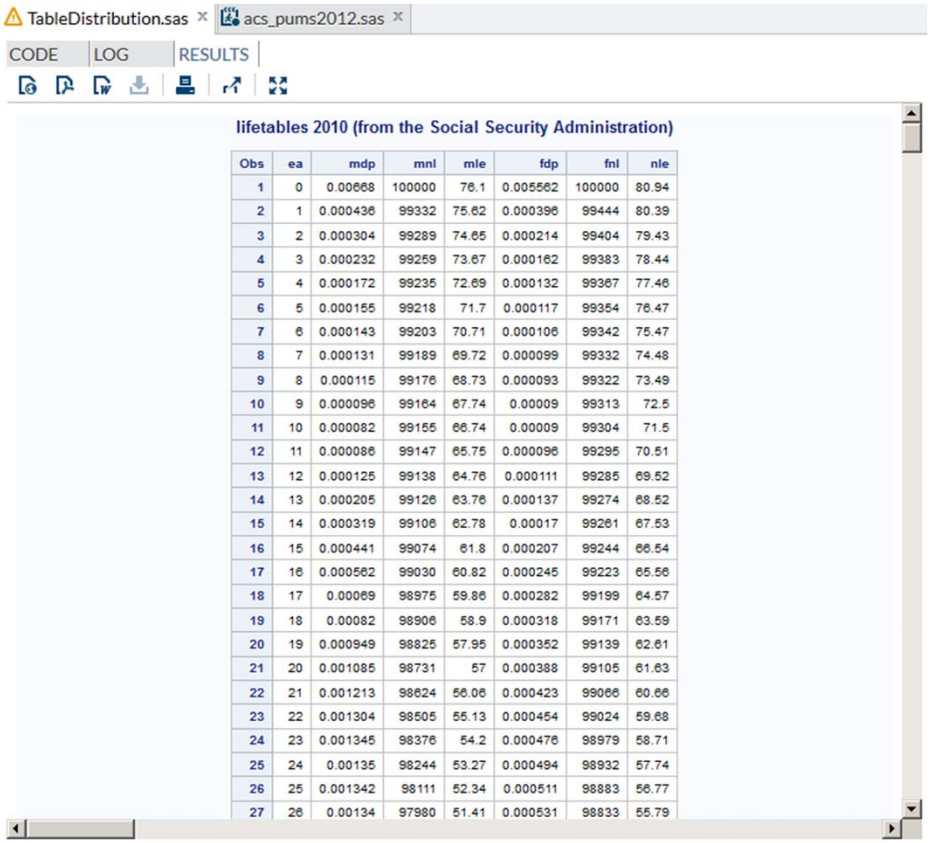
# Discrete Event Simulator for Veterans Population

- Add Current + new
- then every year, add new,
- Tick Tock the clock



# Removing Entities

- Social Security Administrations 2010 Period of Life Tables
- Conditional probability
- Given age and time in model, get probability of death (exit model)



TableDistribution.sas × acs_pums2012.sas ×

CODE | LOG | RESULTS

**lifetables 2010 (from the Social Security Administration)**

| Obs | ea | mdp | mnl | mle | fdp | fnl | nle |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0.00668 | 100000 | 76.1 | 0.005562 | 100000 | 80.94 |
| 2 | 1 | 0.000436 | 99332 | 75.62 | 0.000396 | 99444 | 80.39 |
| 3 | 2 | 0.000304 | 99289 | 74.65 | 0.000214 | 99404 | 79.43 |
| 4 | 3 | 0.000232 | 99259 | 73.67 | 0.000162 | 99383 | 78.44 |
| 5 | 4 | 0.000172 | 99235 | 72.69 | 0.000132 | 99367 | 77.46 |
| 6 | 5 | 0.000155 | 99218 | 71.7 | 0.000117 | 99354 | 76.47 |
| 7 | 6 | 0.000143 | 99203 | 70.71 | 0.000106 | 99342 | 75.47 |
| 8 | 7 | 0.000131 | 99189 | 69.72 | 0.000099 | 99332 | 74.48 |
| 9 | 8 | 0.000115 | 99176 | 68.73 | 0.000093 | 99322 | 73.49 |
| 10 | 9 | 0.000096 | 99164 | 67.74 | 0.00009 | 99313 | 72.5 |
| 11 | 10 | 0.000082 | 99155 | 66.74 | 0.00009 | 99304 | 71.5 |
| 12 | 11 | 0.000086 | 99147 | 65.75 | 0.000096 | 99295 | 70.51 |
| 13 | 12 | 0.000125 | 99138 | 64.76 | 0.000111 | 99285 | 69.52 |
| 14 | 13 | 0.000205 | 99126 | 63.76 | 0.000137 | 99274 | 68.52 |
| 15 | 14 | 0.000319 | 99106 | 62.78 | 0.00017 | 99261 | 67.53 |
| 16 | 15 | 0.000441 | 99074 | 61.8 | 0.000207 | 99244 | 66.54 |
| 17 | 16 | 0.000562 | 99030 | 60.82 | 0.000245 | 99223 | 65.56 |
| 18 | 17 | 0.00069 | 98975 | 59.86 | 0.000282 | 99199 | 64.57 |
| 19 | 18 | 0.00082 | 98906 | 58.9 | 0.000318 | 99171 | 63.59 |
| 20 | 19 | 0.000949 | 98825 | 57.95 | 0.000352 | 99139 | 62.61 |
| 21 | 20 | 0.001085 | 98731 | 57 | 0.000388 | 99105 | 61.63 |
| 22 | 21 | 0.001213 | 98624 | 56.06 | 0.000423 | 99066 | 60.66 |
| 23 | 22 | 0.001304 | 98505 | 55.13 | 0.000454 | 99024 | 59.68 |
| 24 | 23 | 0.001345 | 98376 | 54.2 | 0.000476 | 98979 | 58.71 |
| 25 | 24 | 0.00135 | 98244 | 53.27 | 0.000494 | 98932 | 57.74 |
| 26 | 25 | 0.001342 | 98111 | 52.34 | 0.000511 | 98883 | 56.77 |
| 27 | 26 | 0.00134 | 97980 | 51.41 | 0.000531 | 98833 | 55.79 |

# Removing Entities

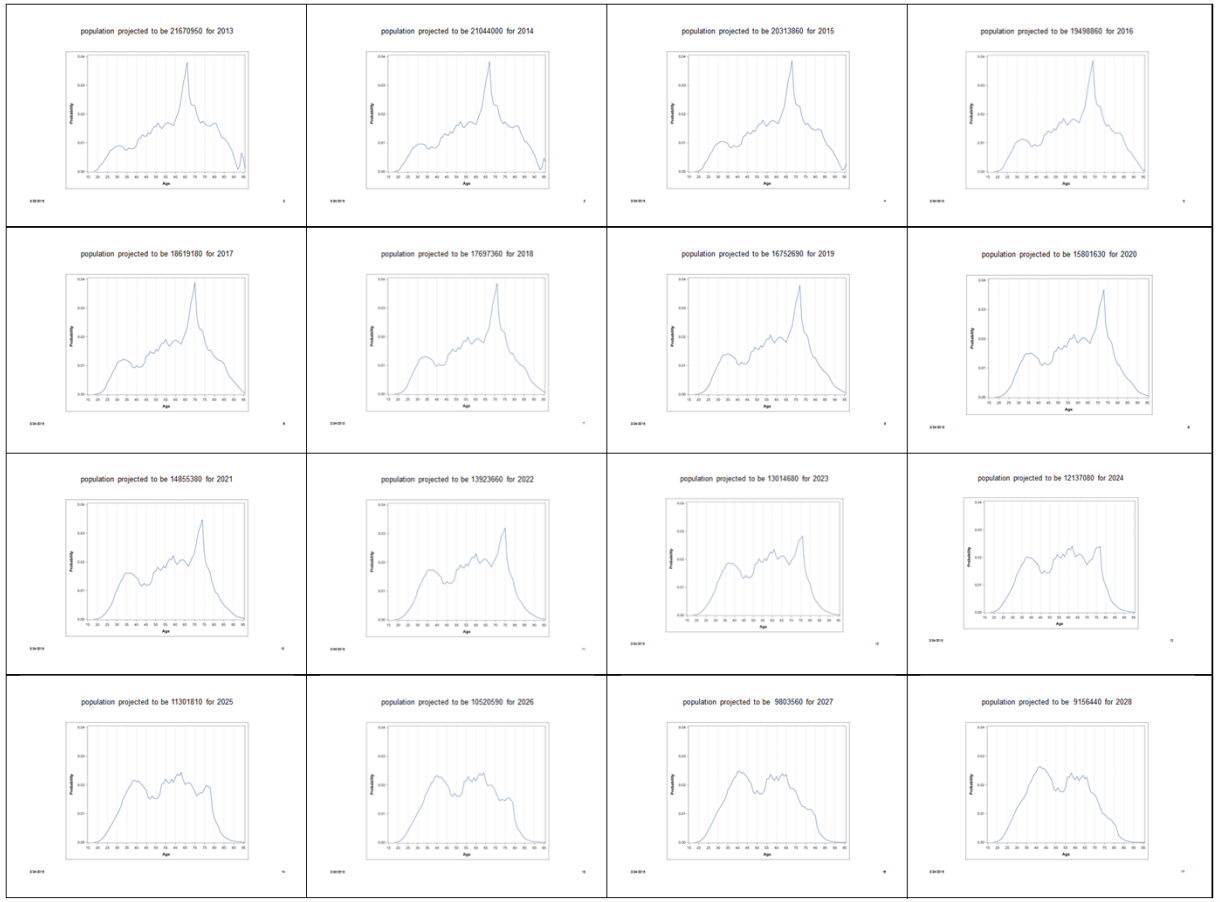
- PROC FCMP
- Create a probability of death function for pairs of age values

```
options cmplib=work.ds;

%macro getnol;
%global RC;
%let RC=;
%let inreturned=;
proc sql noprint;
  select mnl into :inret
    from mf.lt where ea = &a ;
  select 1-mnl/&inret into :p
    from mf.lt where ea = &b ;
quit;
%mend getnol;

proc fcmp outlib = work.ds.functions;
function getnol_macro(a, b);
  rc = run_macro('getnol', a, b, p);
  if rc eq 0 then return(p);
    else
  return(.);
endsub;
run;
```

# Graphical outputs

- Here, SGPlot and ODS.
- Make a PowerPoint slide deck for each discrete point in time.
- See this paper or source code for examples of using ODS PowerPoint http://support.sas.com/resources/papers/proceedings13/041-2013.pdf and many other papers
- The result is a ‘slideshow’ of a time sequence

# Show Slide Show



# Summary

- SAS University Edition with Base SAS can be used to teach the Operations Research course on Discrete Event simulations
- Along with GLPK*, it can be used to teach the optimization courses in the Operations Research curriculum
- SAS University Edition makes stratified survey data (like the American Community Survey) a viable option for coursework

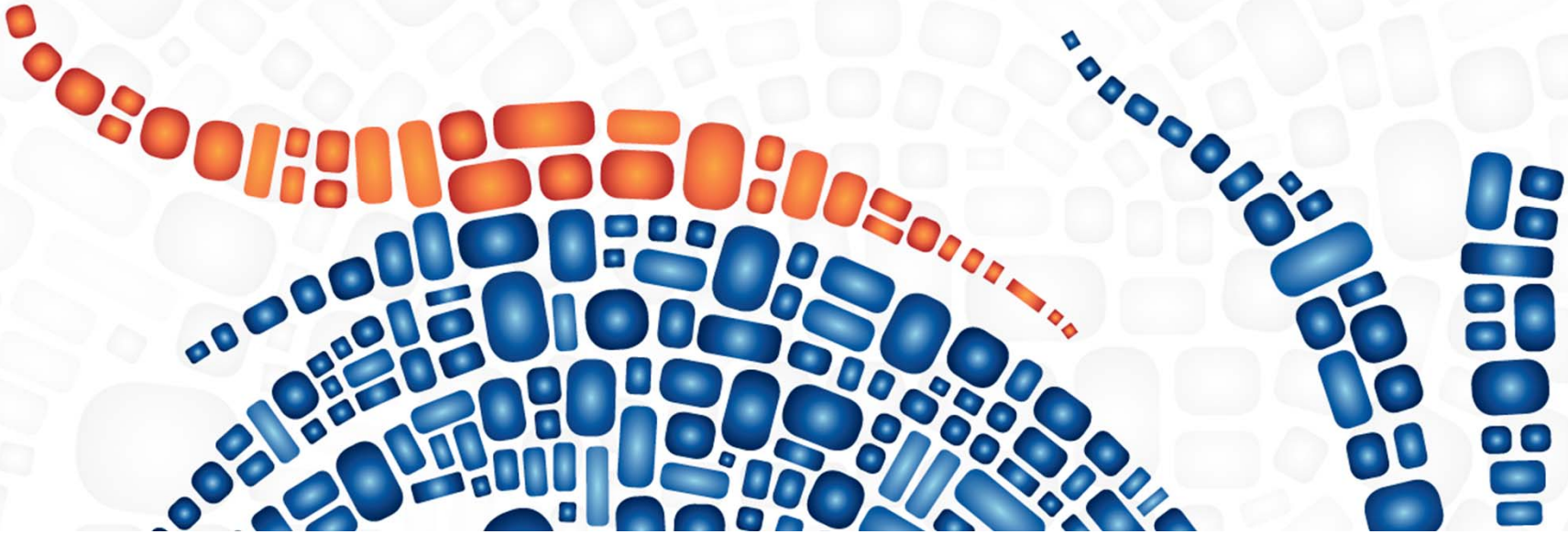
*https://www.**gnu**.org/software/**glpk**/

# Session ID 2320

SAS GLOBAL FORUM

SAS® GLOBAL FORUM

April 26-29
Dallas, TX



# Population Distributions of Veterans

## Projected forward by using SAS University Edition

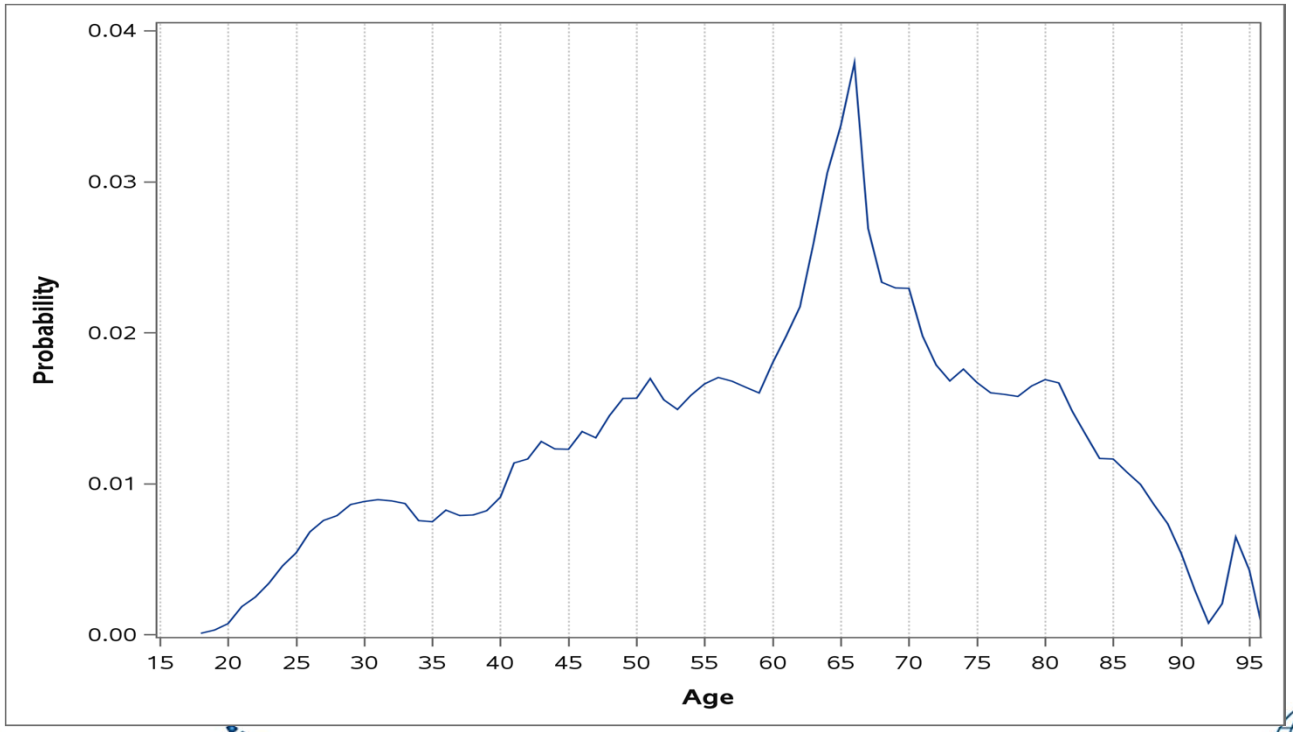


From the American Community Survey 2012 and the Social Security Administrations Period of Life tables 2010

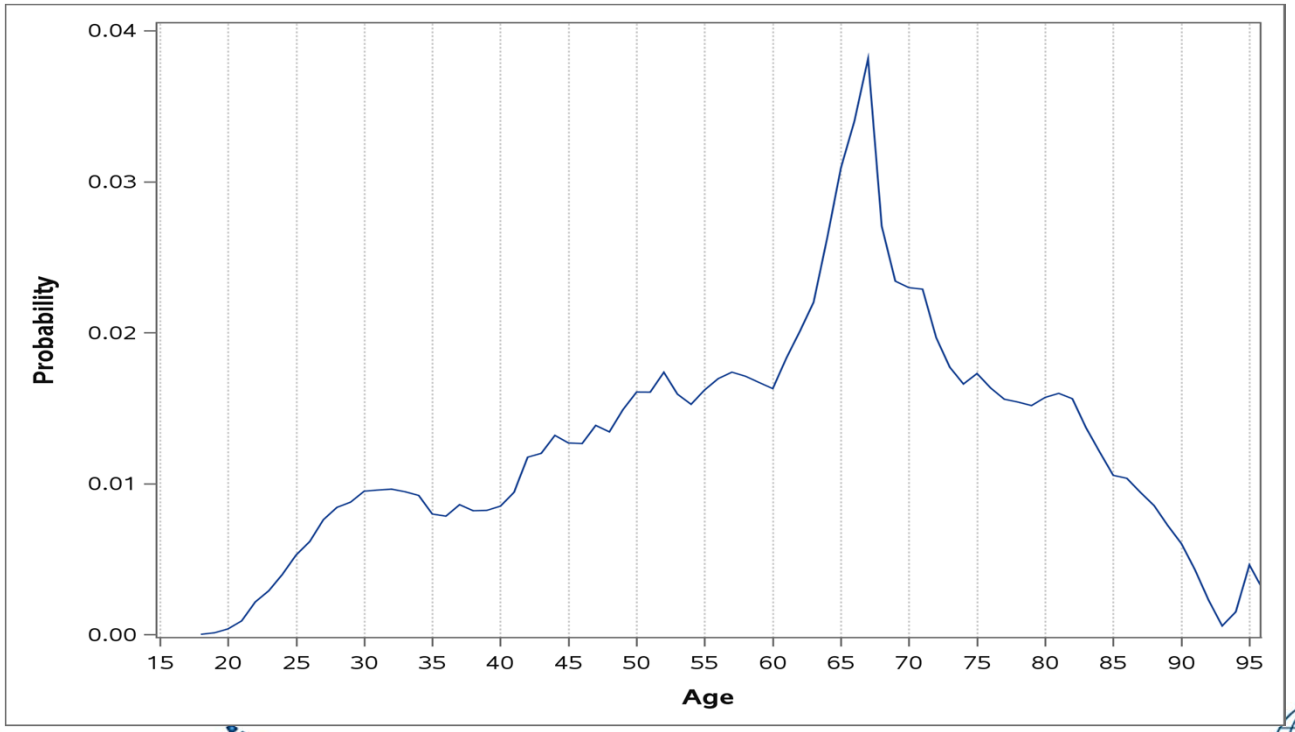


26

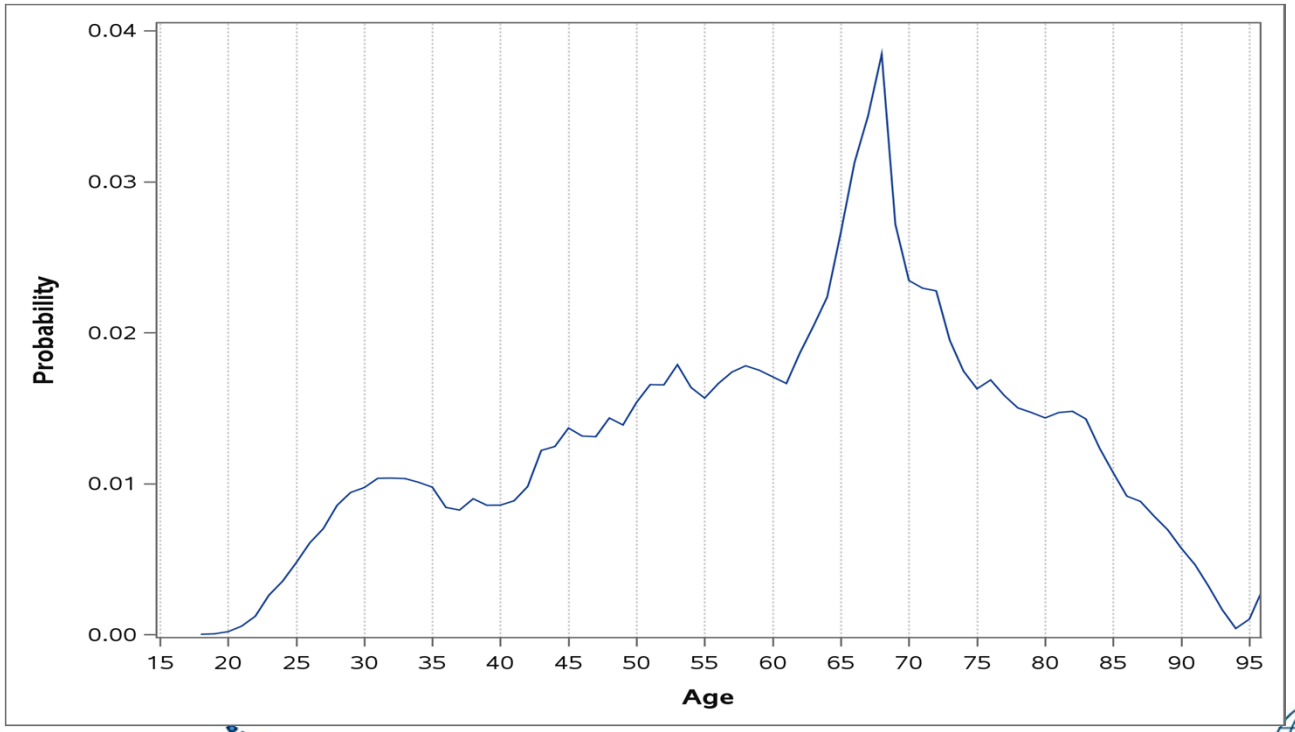
population projected to be 21670950 for 2013



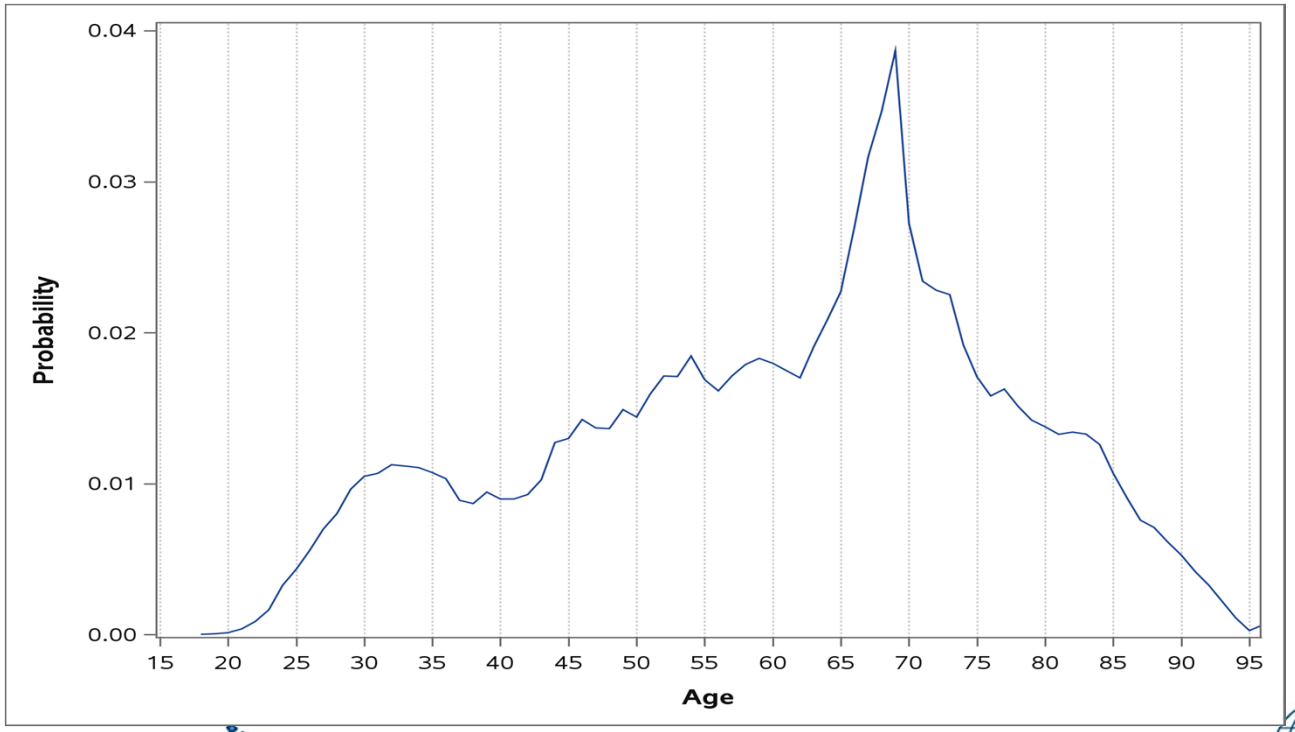
population projected to be 21044000 for 2014



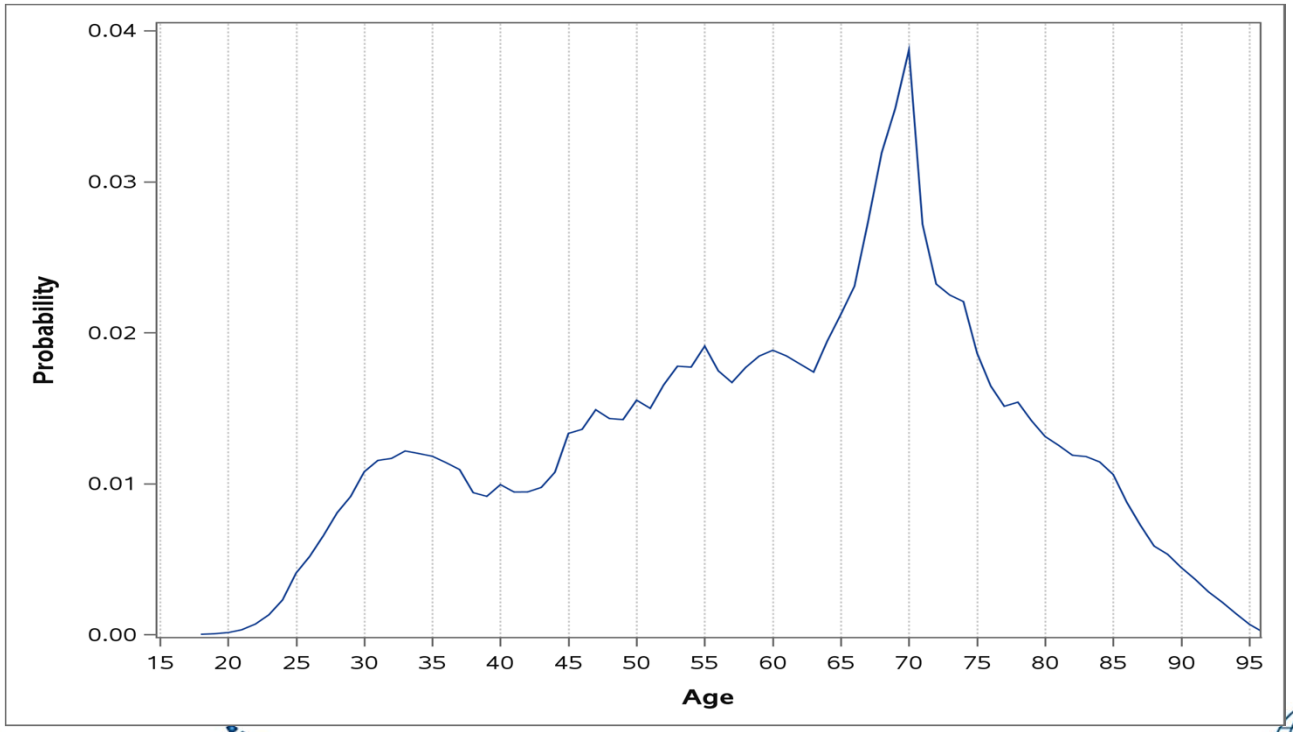
population projected to be 20313860 for 2015



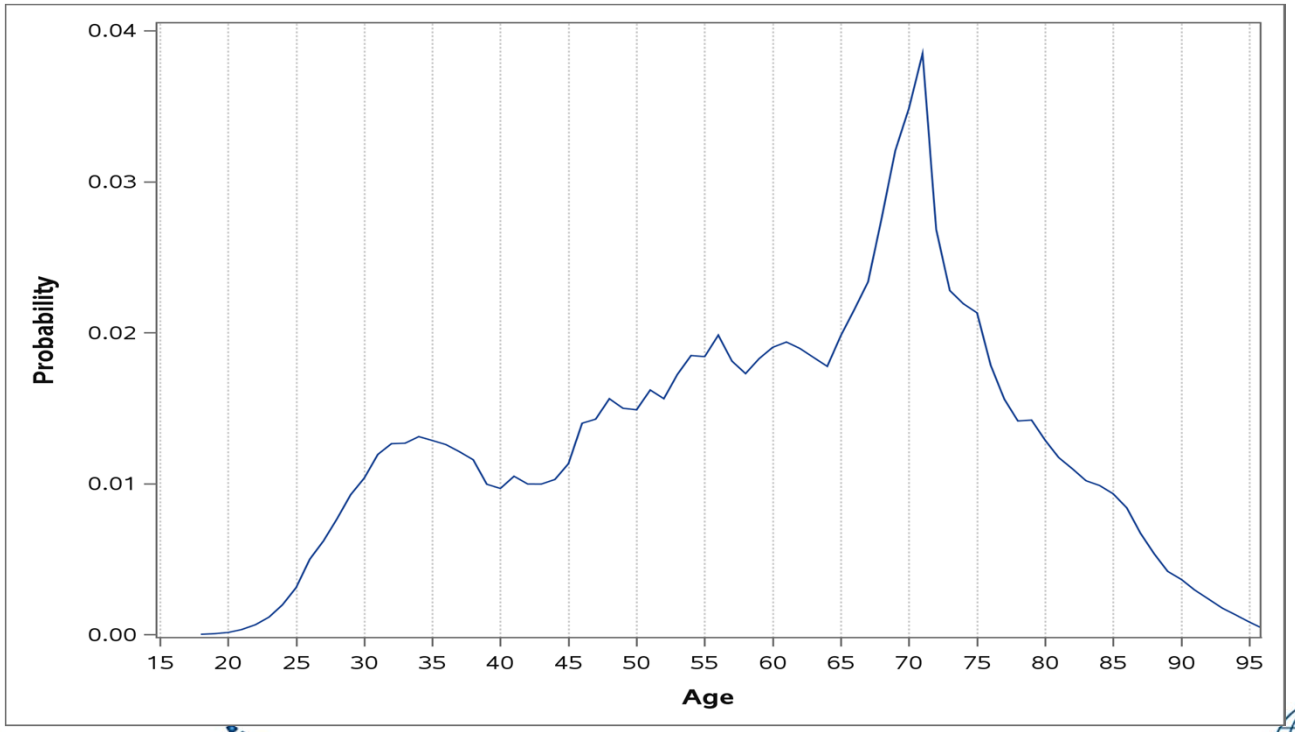
population projected to be 19498860 for 2016



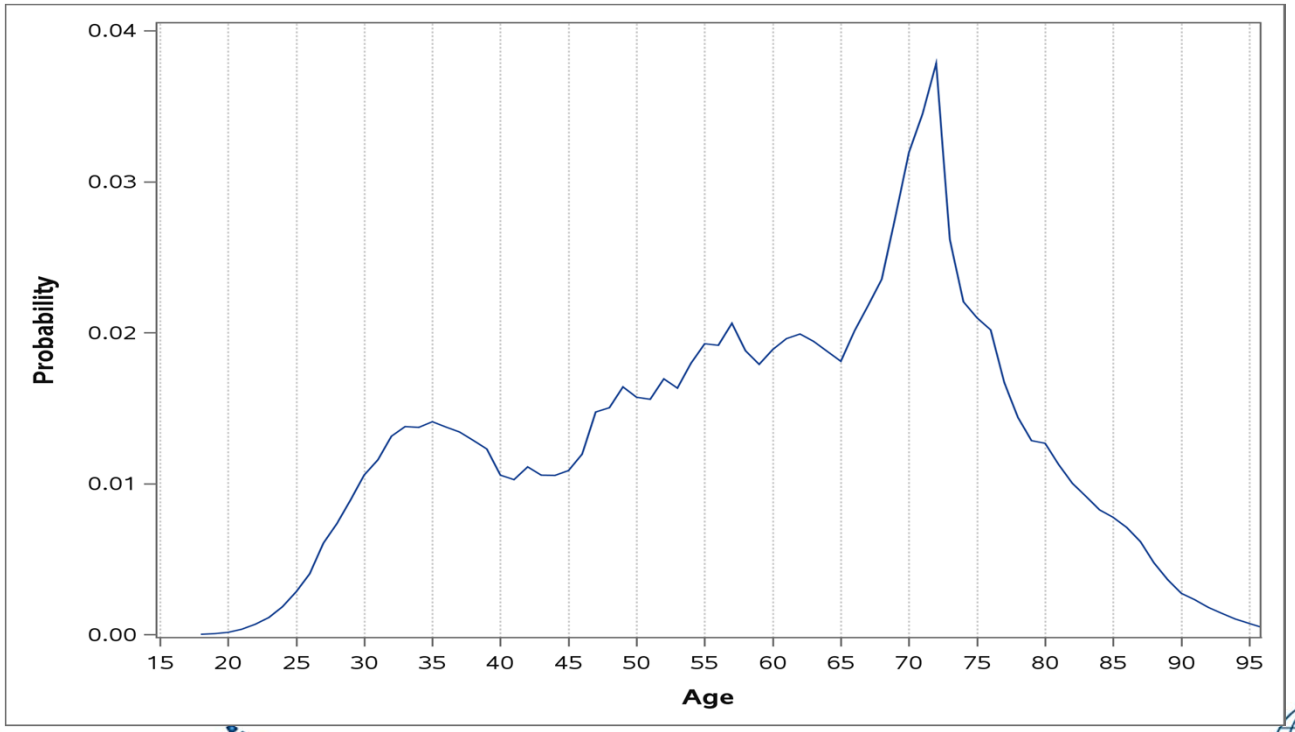
population projected to be 18619180 for 2017



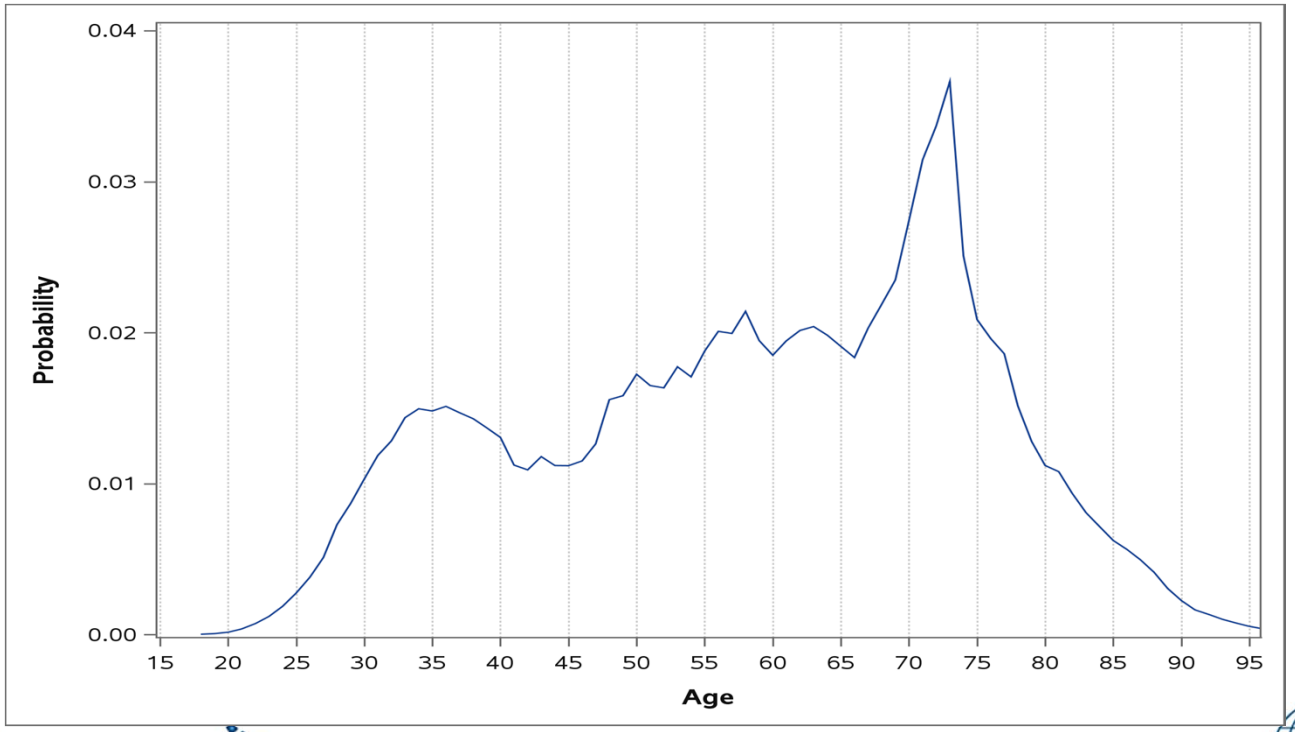
population projected to be 17697360 for 2018



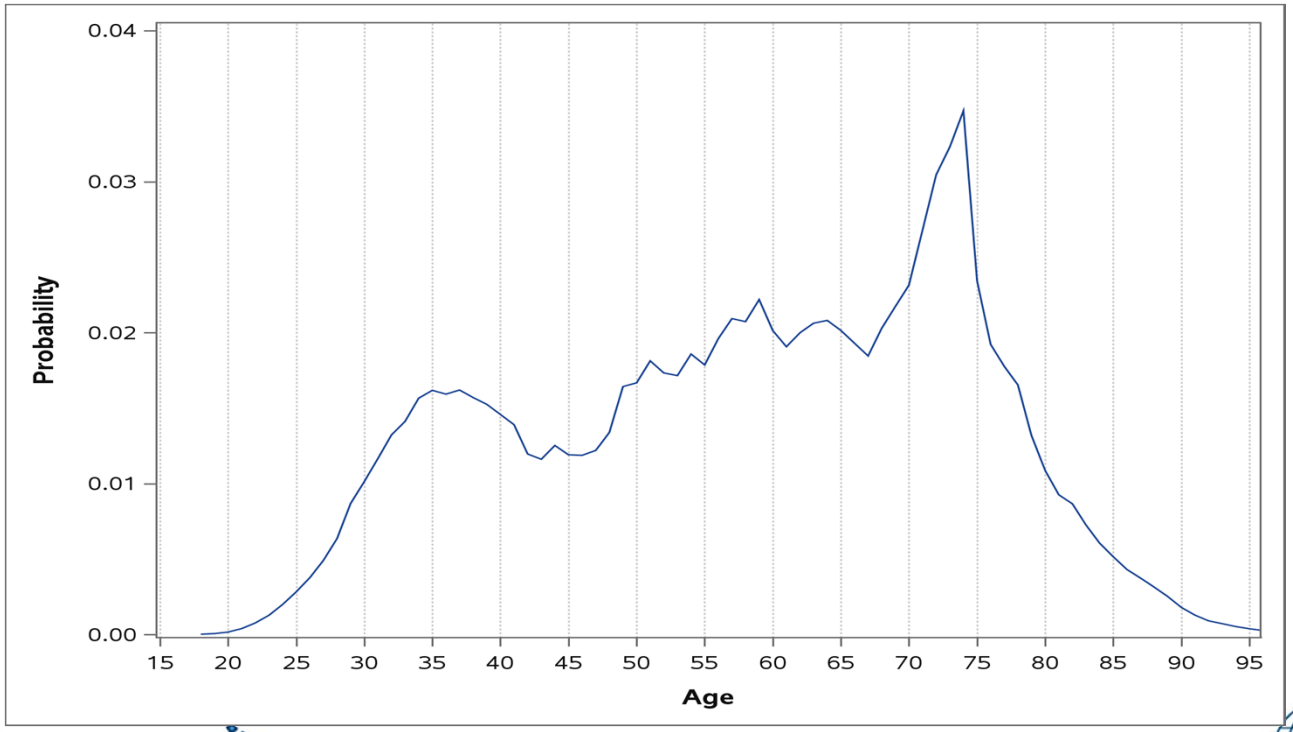
population projected to be 16752690 for 2019



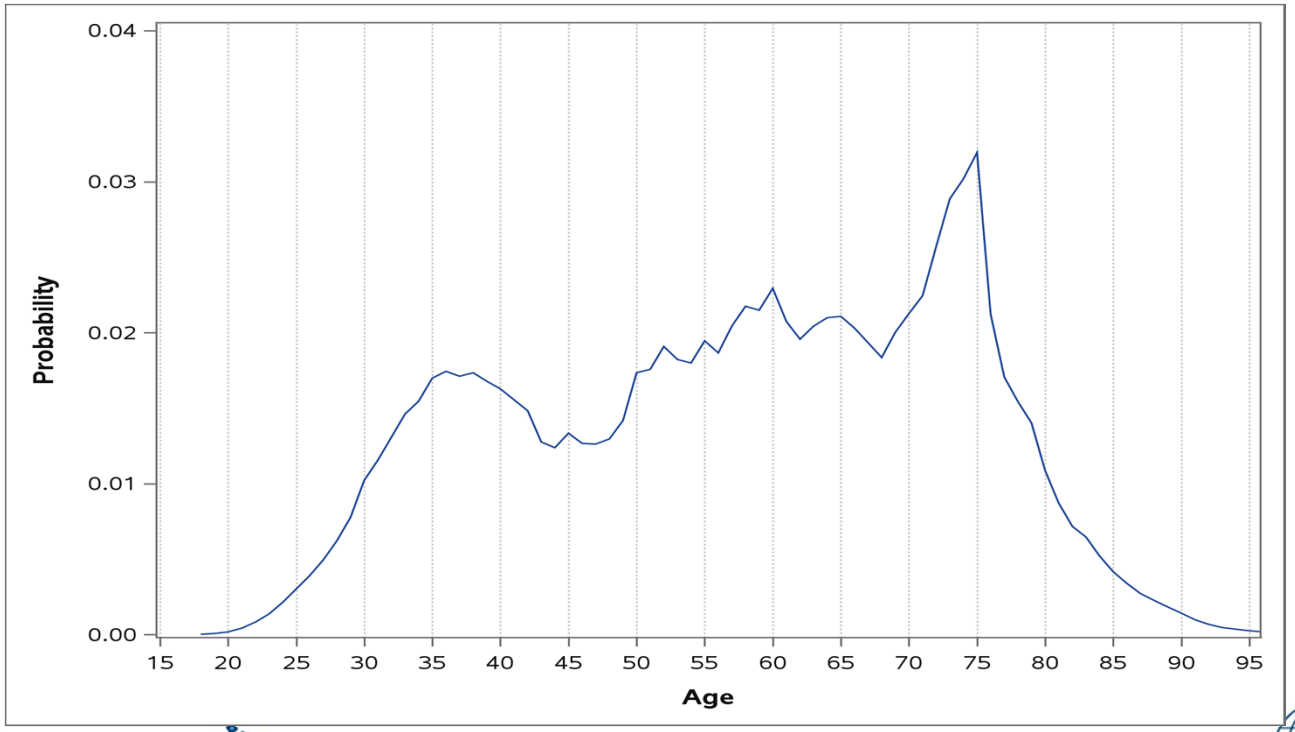
population projected to be 15801630 for 2020



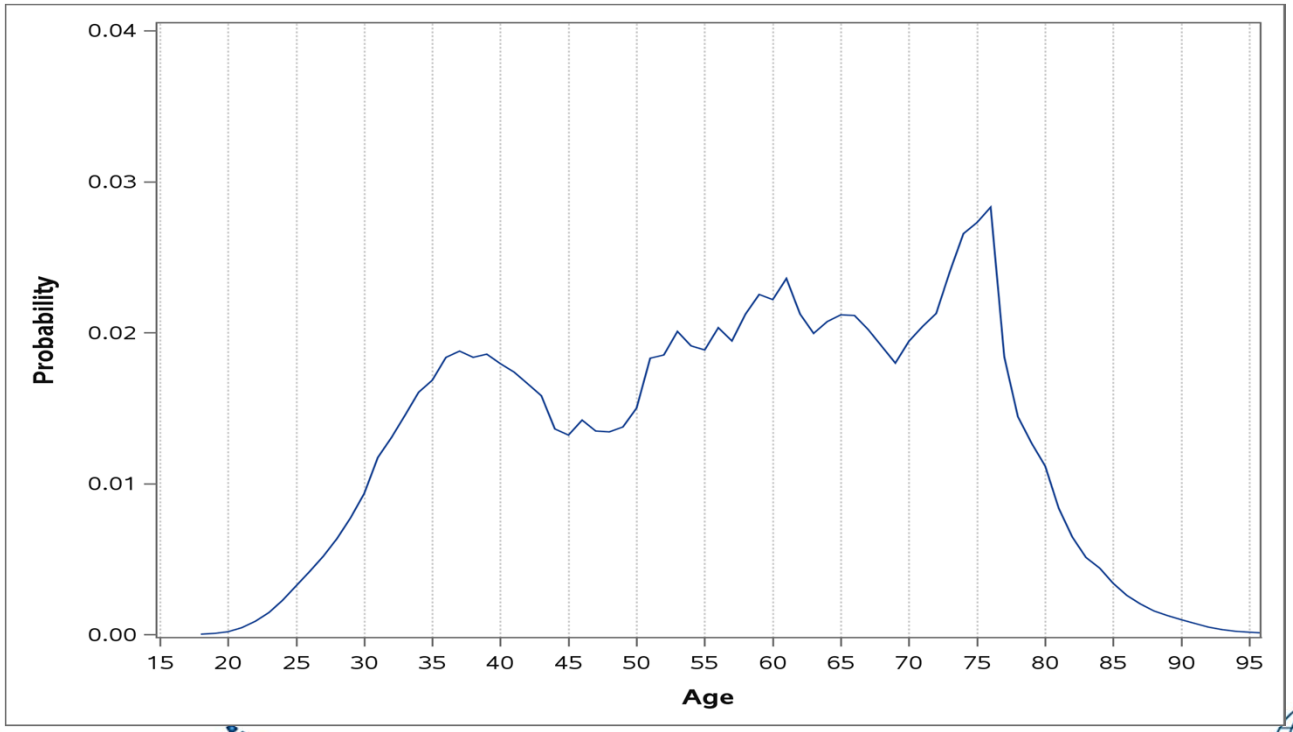
population projected to be 14855380 for 2021



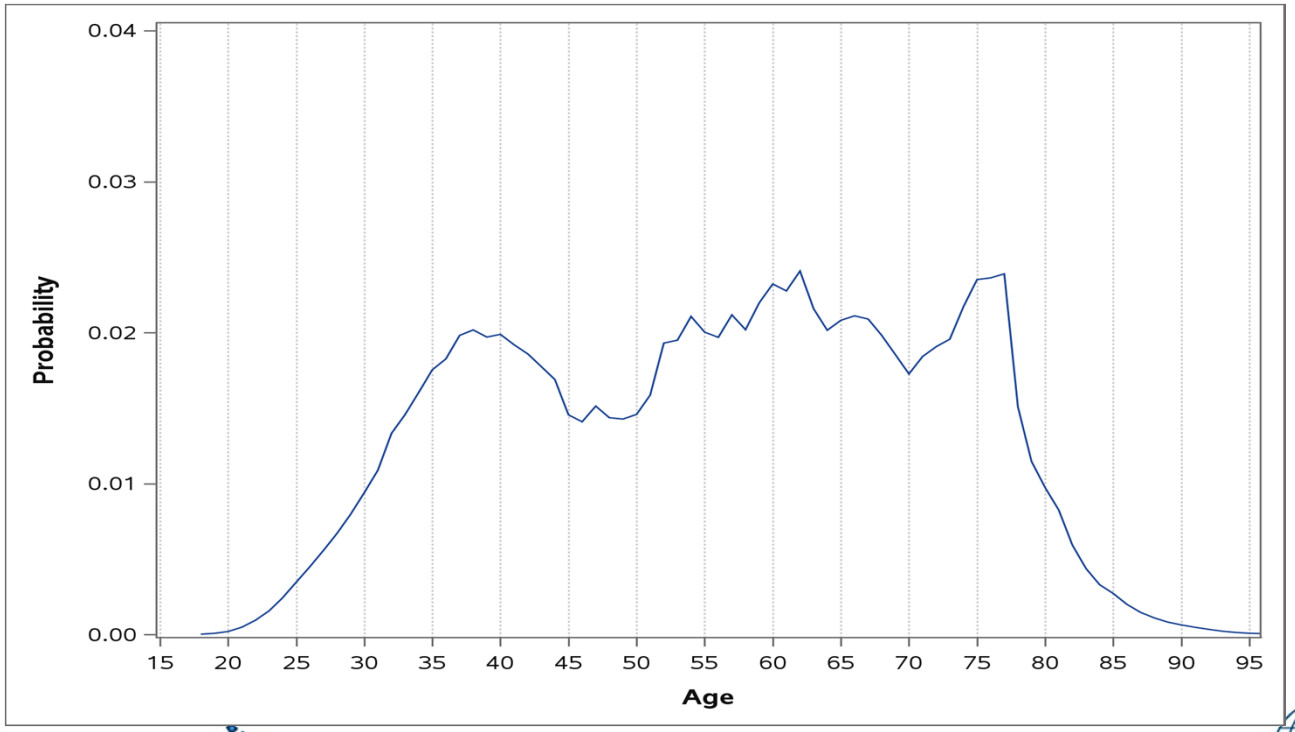
population projected to be 13923660 for 2022



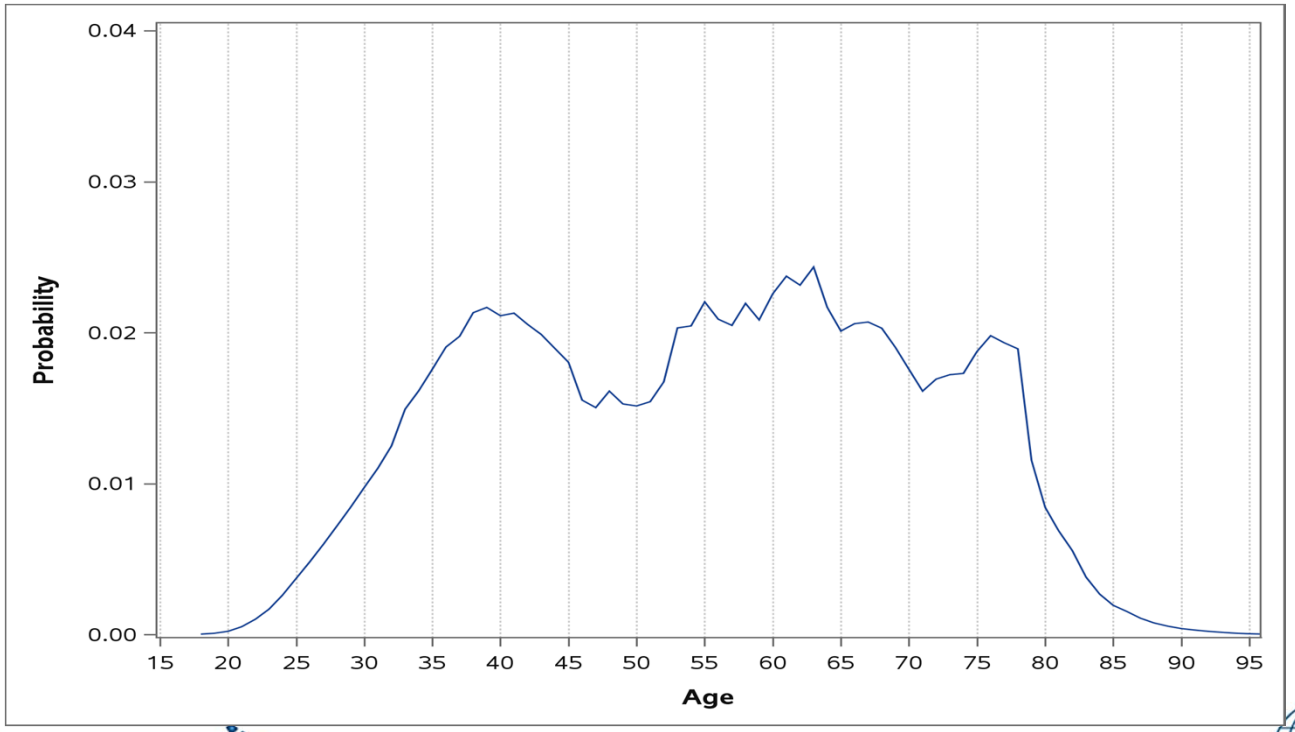
population projected to be 13014680 for 2023



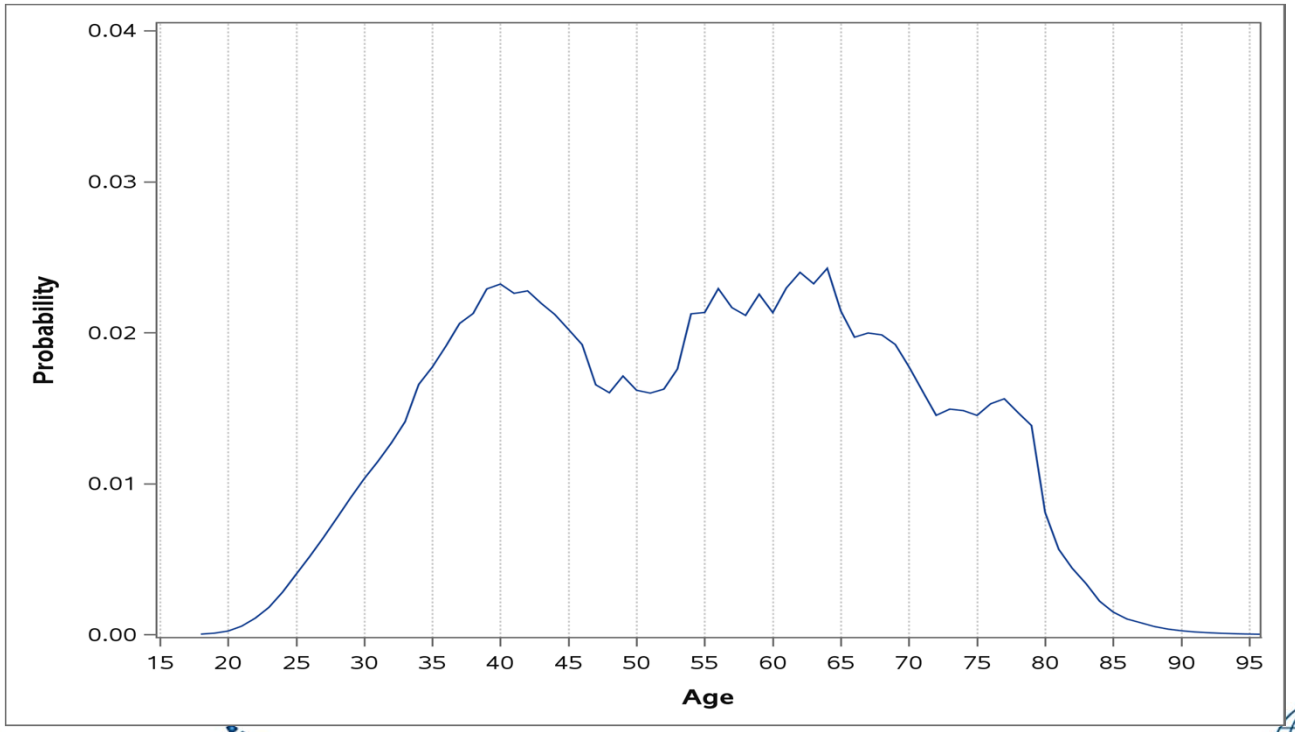
population projected to be 12137080 for 2024



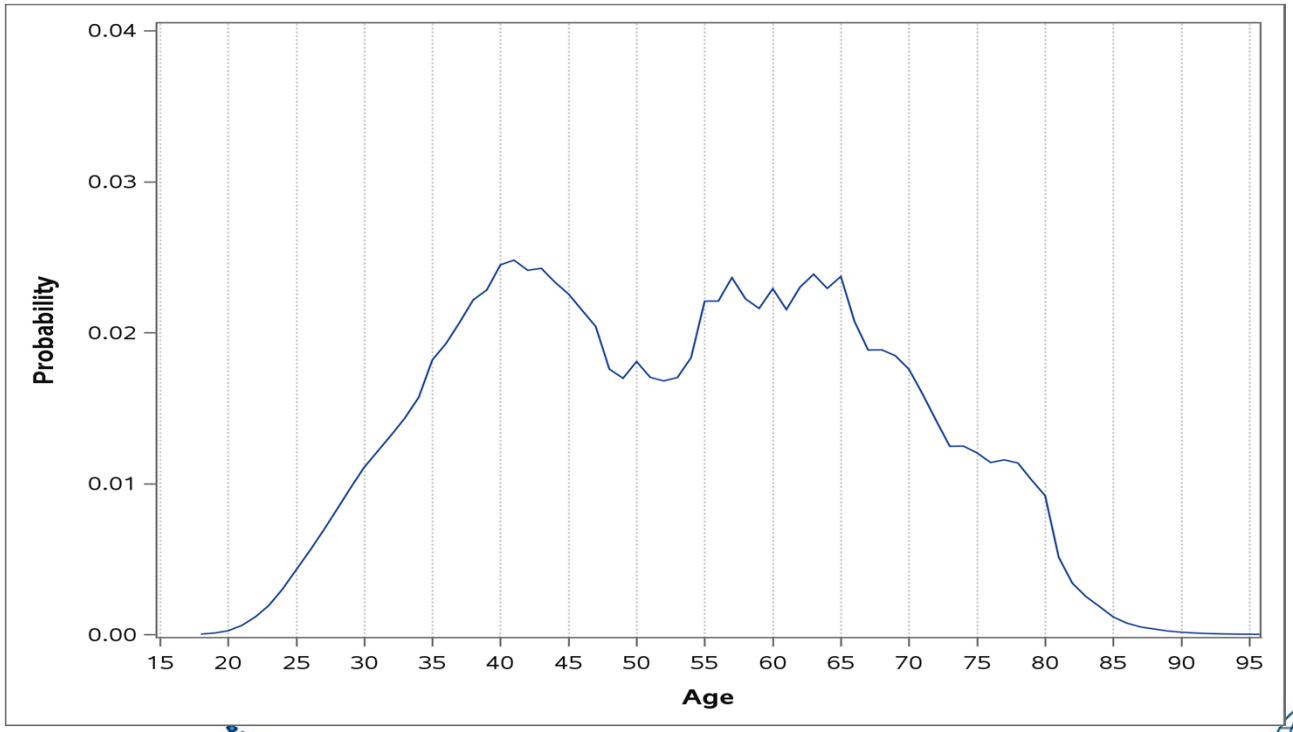
population projected to be 11301810 for 2025



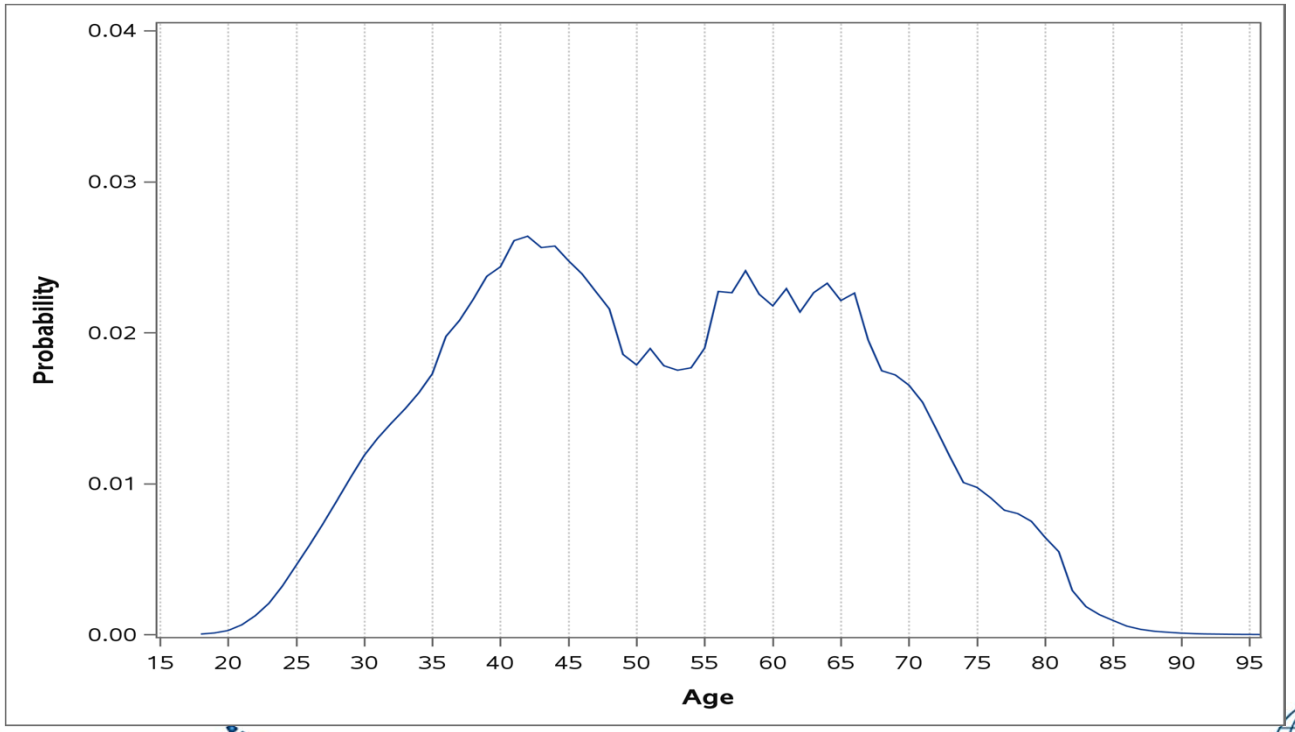
population projected to be 10520590 for 2026



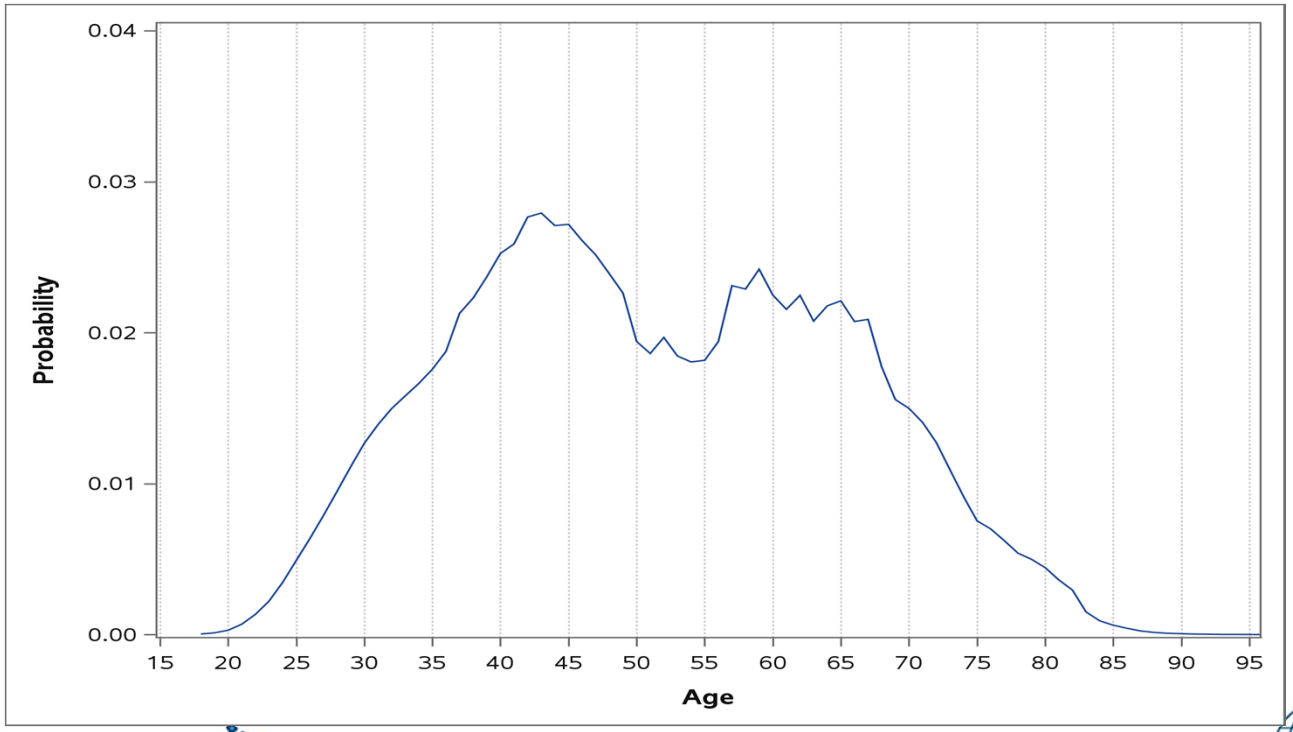
population projected to be 9803560 for 2027



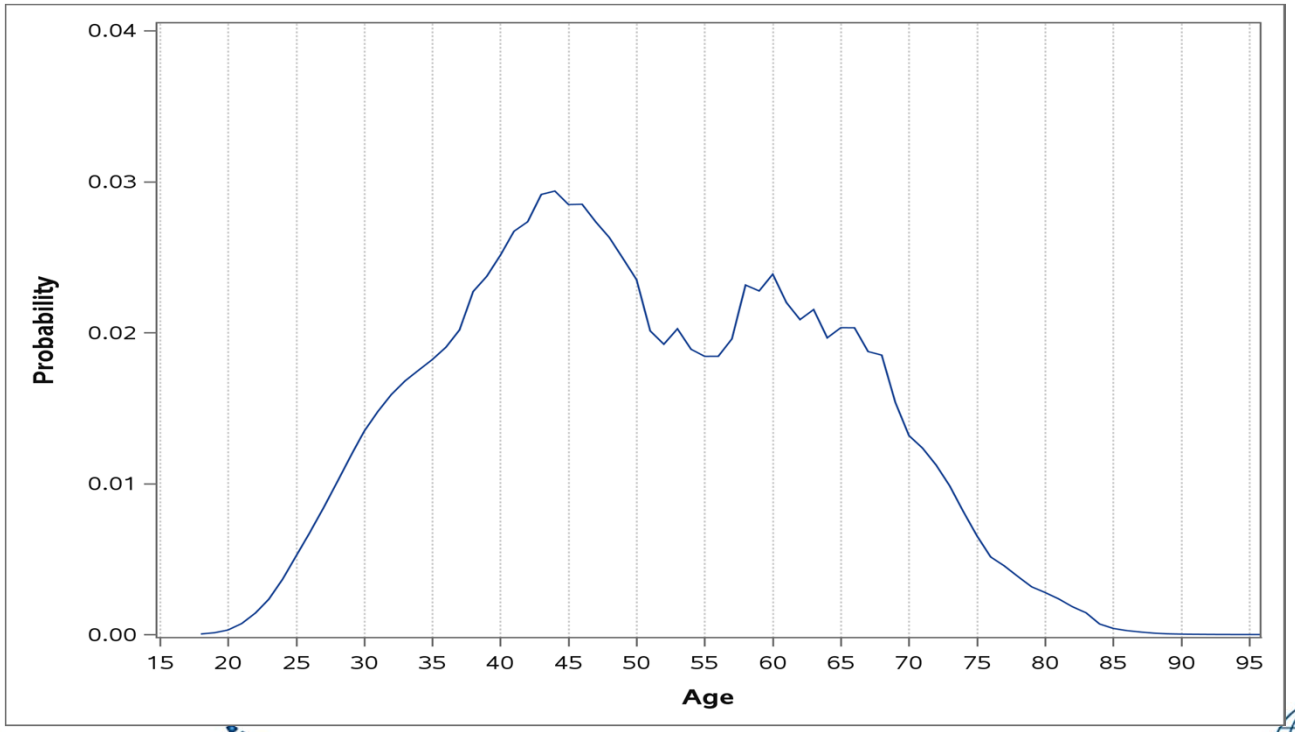
population projected to be 9156440 for 2028



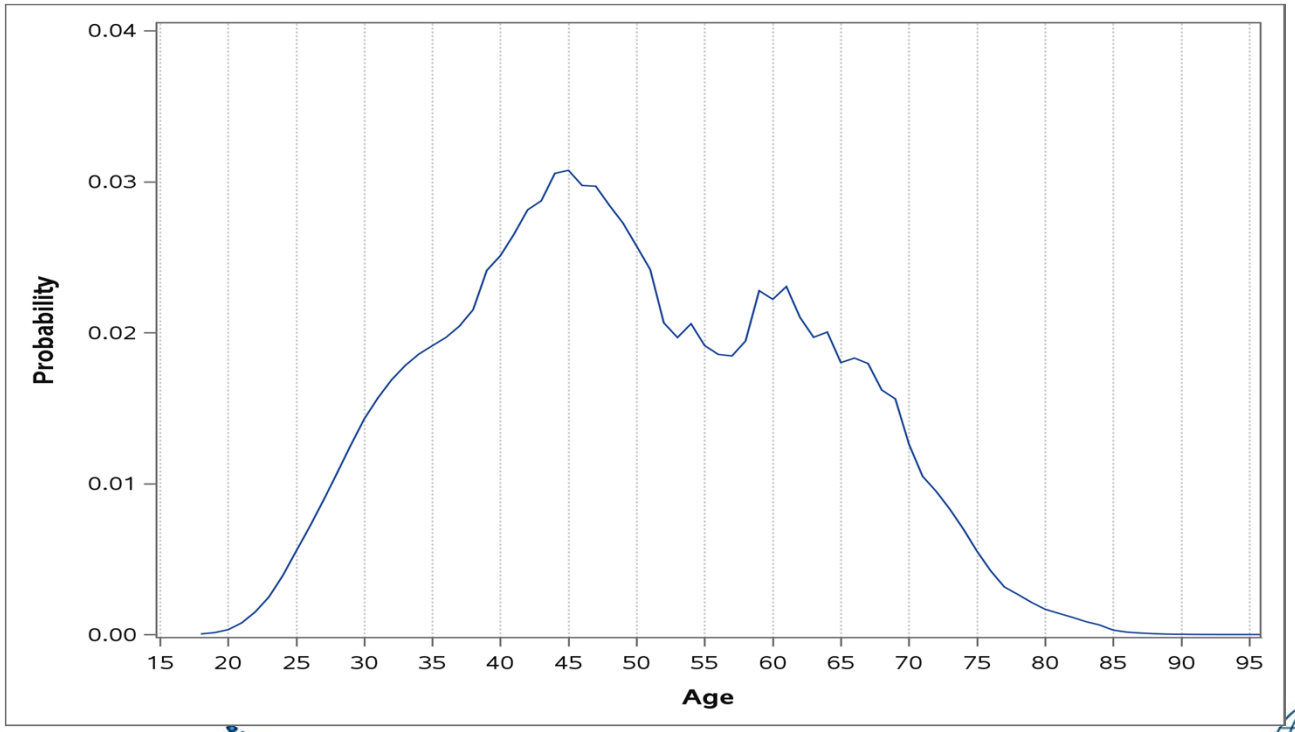
population projected to be 8579120 for 2029



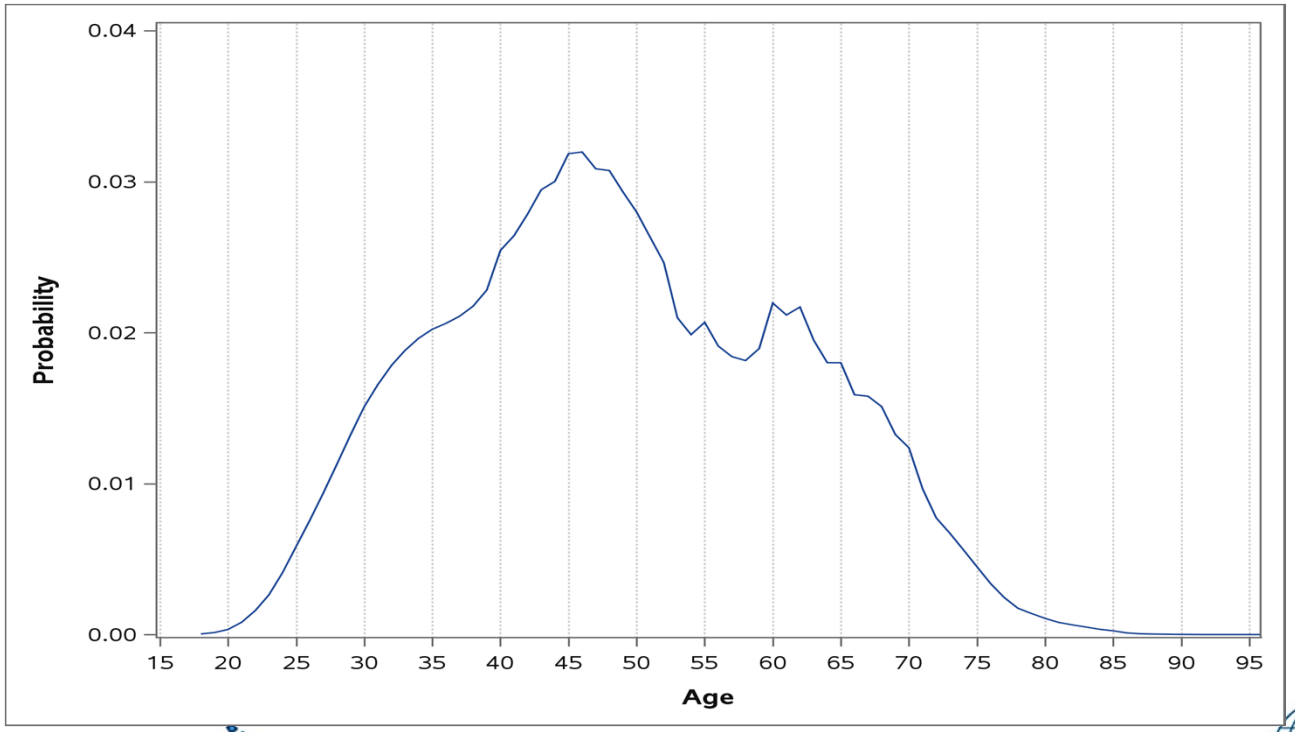
population projected to be 8065930 for 2030



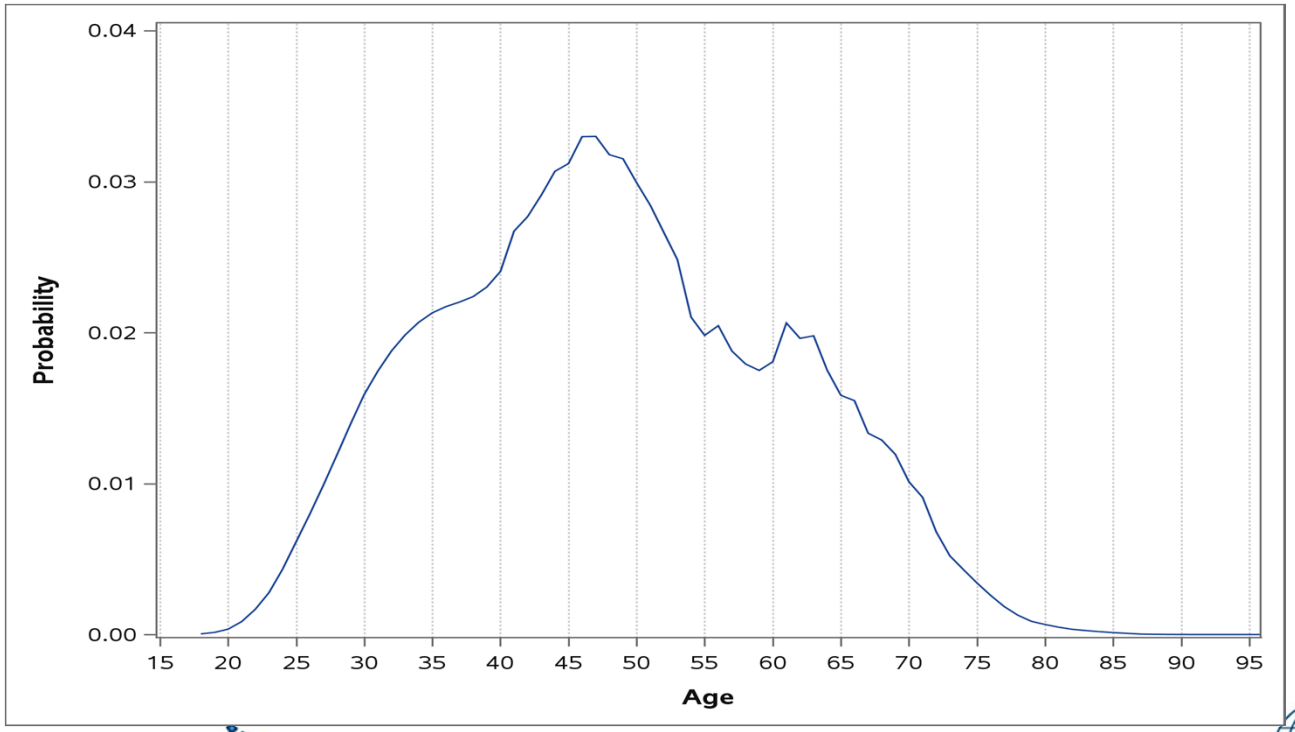
population projected to be 7608340 for 2031



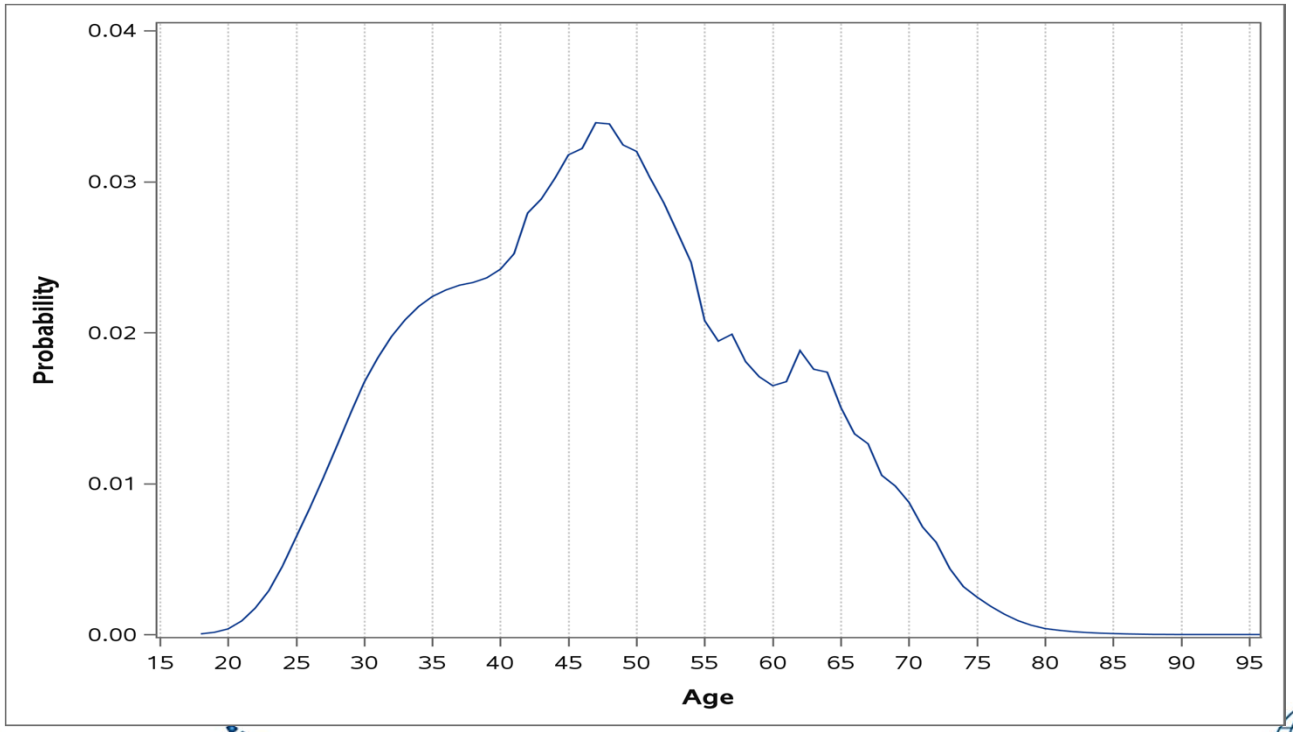
population projected to be 7198480 for 2032



population projected to be 6830580 for 2033



population projected to be 6500690 for 2034



# Veteran Population trend