

Actuarial Risk Analysis using Predictive Analytics, Segmentation and Decomposition Techniques

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May 10, 2018



The Society of Actuaries



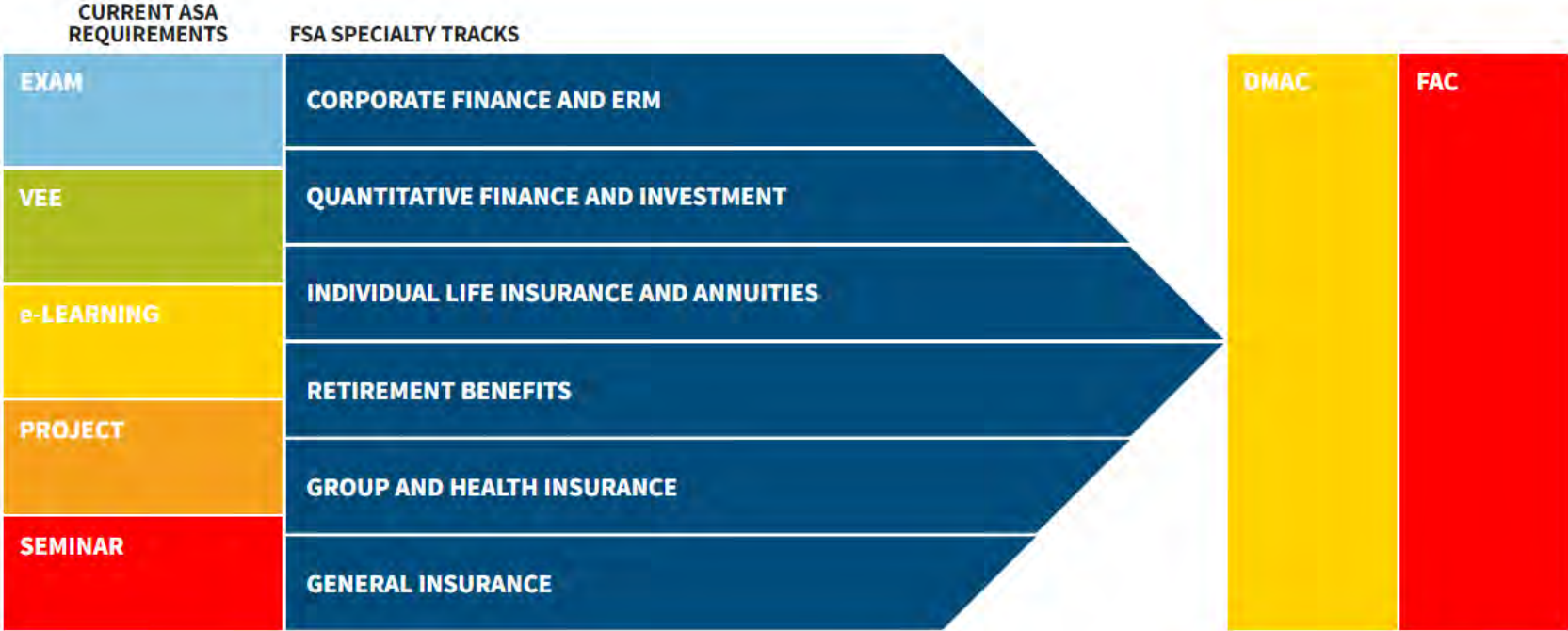
Society of Actuaries

- Mission: Through education and research, the SOA advances actuaries as leaders in measuring and managing risk to improve financial outcomes for individuals, organizations, and the public.
- Vision: Actuaries are highly sought-after professionals who develop and communicate solutions for complex financial issues.
- Professional association serving 30,000 global members

Society of Actuaries Education: ASA

INTRODUCTORY I	INTRODUCTORY II	ACTUARIAL	ADVANCED	PROFESSIONALISM
<p>VEE ECONOMICS</p>	<p>EXAM INVESTMENT AND FINANCIAL MARKETS</p>	<p>EXAM LONG-TERM ACTUARIAL MATHEMATICS</p>	<p>e-LEARNING FUNDAMENTALS OF ACTUARIAL PRACTICE</p>	<p>SEMINAR ASSOCIATESHIP PROFESSIONALISM COURSE</p>
<p>VEE ACCOUNTING AND FINANCE</p>		<p>EXAM SHORT-TERM ACTUARIAL MATHEMATICS</p>		
<p>EXAM FINANCIAL MATHEMATICS</p>	<p>VEE MATHEMATICAL STATISTICS</p>	<p>EXAM STATISTICS FOR RISK MODELING</p>	<p>PROJECT PREDICTIVE ANALYTICS</p>	
<p>EXAM PROBABILITY</p>				

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Future Actuaries | Education & Exams | Professional Development | **Research** | Professional Sections | Tools & Resources | About SOA

About SOA Research

- Strategic Research Programs
- Trending SOA Research
- Research in Progress
- Research Newsletter
- Actuarial Research Clearing House (ARCH)

Research by Topic

- Aging & Post-Retirement
- Climate
- Disability
- Finance & Investment
- General Insurance
- Health
- International

Research by Topic (continued)

- Life & Annuities
- Long-Term Care
- Pensions
- Predictive Analytics & Modeling
- Risk Management
- U.S Population
- Valuation/Illustrations

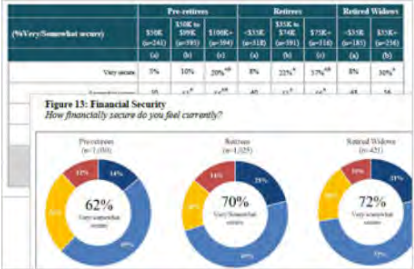
Research Opportunities

- Requests For Proposals
- Requests For Data
- Calls For Papers
- Funding & Grants
- Competitions & Awards

Tables, Calculators & Modeling Tools

You might like: Topics in the News The Actuary Magazine

Customer Service



Access findings from the SOA's various research studies, papers, essays and more.

Actuarial Risk Analysis



Actuarial Risk Analysis

- *“Right Price for Right Risk”*
- Predictive Analytics techniques have emerged to be lead tools in the assessment of insurance risk
- Data science has evolved... but so has data value and computing power
- Not uncommon for insurance rating filings to use techniques such as generalized linear models

Actuarial Risk Analysis

- Generalized Linear Models
- Target = $b_0 + b_1 x_{i1} + b_2 x_{i2} + \dots + b_p x_{ip}$
- Explanatory / predictor variables
- Target often a value used in ratemaking for insurance products
 - Claims per unit exposure
 - Dollars per claim
 - Pure Premium
 - Loss Ratio

Variable Selection Using Parallel Random Forest for Mortality Prediction in Highly Imbalanced Data, Mahmoud Shehadeh, Rebecca Kokes, and Guizhou Hu, 2016, Society of Actuaries

Generalized Linear Models for Insurance Rating, Mark Goldburd, Anand Khare, and Dan Tevet, 2016, Casualty Actuarial Society

Actuarial Risk Analysis

- Predictive analytic techniques helping increase the number, usefulness and types of variables being used to assess insurance risk
- Across all lines of business
 - Property/Casualty: Auto, Home, Business
 - Health: Medical, Disability, Long Term Care
 - Life Insurance: Mortality, Policyholder Behavior

Living to 100: January 2017

- Analysis of historical trends in variables used to predict life insurance mortality
- “Each of us is merely a small instrument; all of us, after accomplishing our mission, will disappear.”

Mother Teresa

- “To understand the future, we have to go back in time.”

Pitbull

History of US Life Insurance Valuation Mortality

1941 VBT & CSO by
AIA/ASA
"1 Table"
Minimum Age: 1
Maximum Age: 100

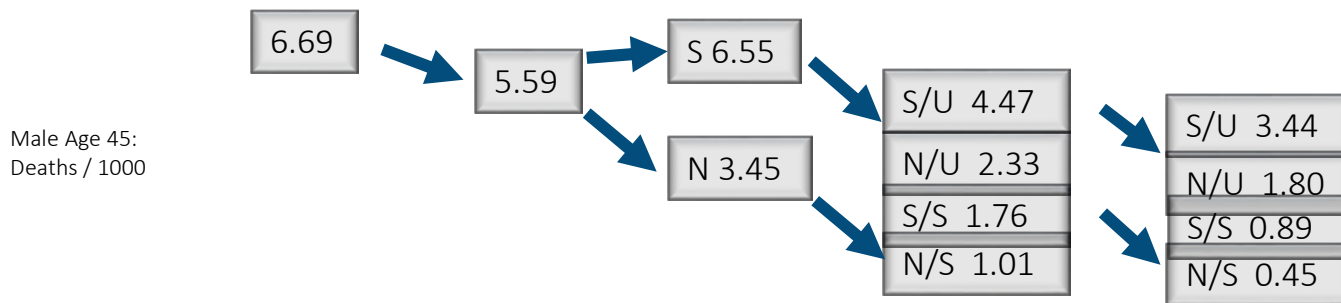
1958 CSO
4 Tables:
2 Gender *
2 ANB/ALB
Maximum Age:
Male 99
Female 102

1980 CSO
12 Tables:
2 Gender *
3 Smoker *
2 ANB/ALB
Max Age 99

2001 CSO
S & U
56 Tables (+VBT)
Max Age: 120

2015 VBT / 2017 CSO
132 tables
Max Attained Age: 120
Max Issue Age: 95

8



Relative Risk Mortality Assessment

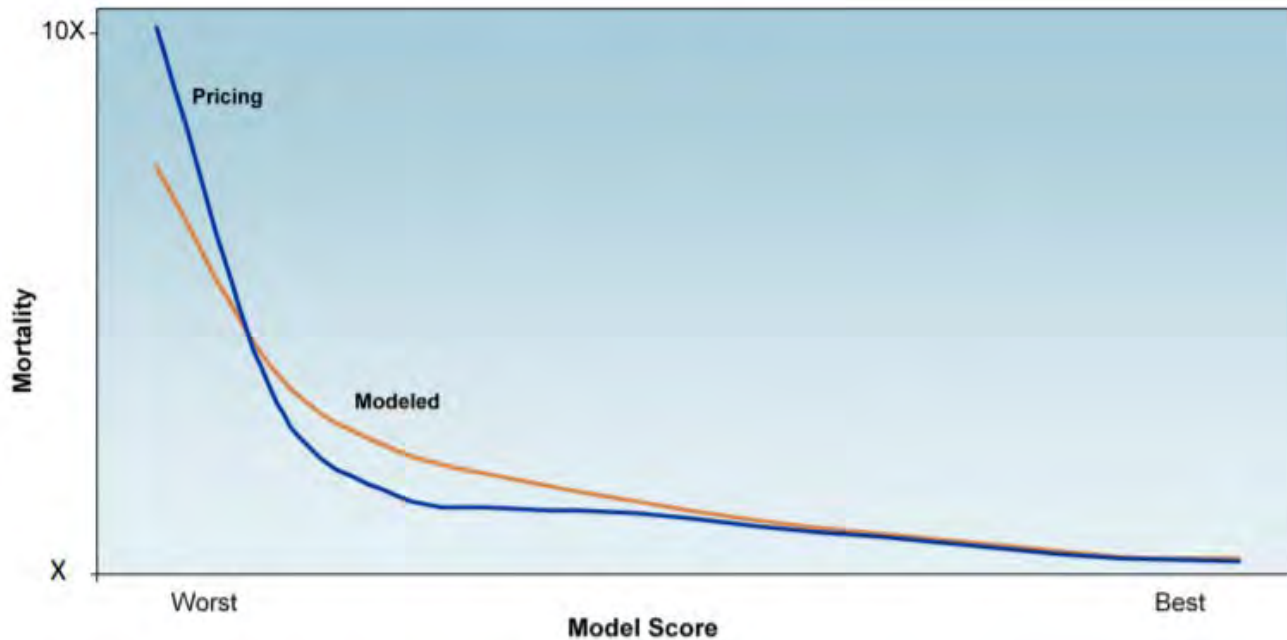
- High end use of predictive analytics models to differentiate risks
- “Predictive Modeling for Life Insurance”
 - Mike Batty, FSA, CERA, et al., Deloitte, 2010
- Overview of modeling and differentiating mortality risks through data-driven processes
- *“Can non-invasive underwriting techniques work?”*

Relative Risk Mortality Assessment

- Data-driven, predictive analytics based, underwriting assessment tools have increased in recent years
 - Medical Information Bureau (MIB)
 - Motor Vehicle Record (MVR)
 - Electronic Prescription Profile (“Script Checks”)
 - Electronic Health Records (HER)
 - Consumer Credit Data
 - Third party marketing datasets
 - Social media information

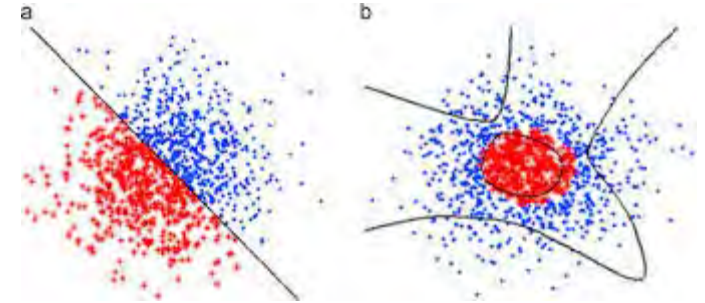
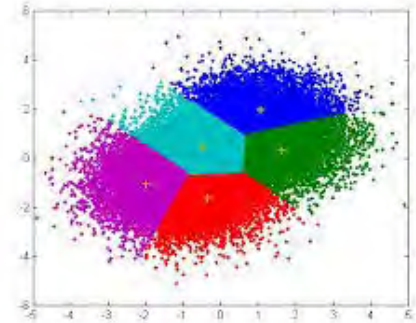
Relative Risk Mortality Assessment

Figure 1: Mortality of Predictive Model vs. Full Underwriting



Actuarial Risk Analysis

- K-Means Clustering
 - Marketing Segmentation; Risk Segmentation
- Support Vector Machine
 - Machine learning / classification
 - Example: BMI



Actuarial Risk Analysis

- Use in SOA Experience Studies
 - Evolution from “tables” to “models”
 - 2017: Group LTD Recovery using Tree Models
 - 2015: Long Term Care Experience Basic Table Development
 - 2015: Lapsation for Post-Level Term Period

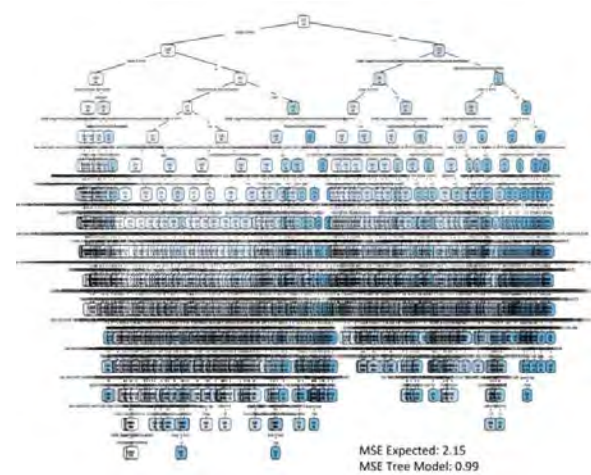
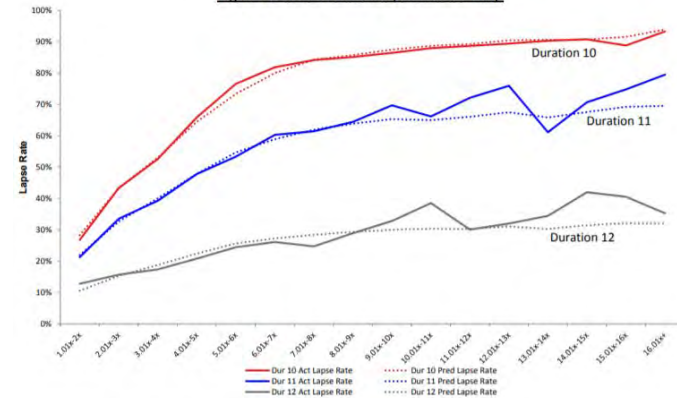


Figure 3: Model Results by Premium Jump



Actuarial Risk Analysis

- Regulator involvement
 - Marketing Segmentation
 - Insurance rating
- Big Data commonly discussed topic at National Association of Insurance Commissioners (“NAIC”) meetings

Actuarial Risk Analysis

- 2018 Charges of NAIC Big Data (EX) Working Group
 - *“Review current regulatory frameworks used to oversee insurers' use of consumer and non-insurance data”*
 - *“...provide resources and allow the states to share resources to facilitate their ability to conduct technical analysis of, and data collection related to, the review of complex models used by insurers for underwriting, rating and claims.”*
- Price optimization

Decomposition and Attribution in Population Mortality Statistics



Decomposition and Attribution in Population Mortality Statistics

- SOA work with Human Mortality Database
- www.mortality.org
 - Wide variety of tables, statistics, analysis on full populations across 30+ countries
 - Notable differences in comes countries, like US, between population and insured mortality
 - Helpful application to pension mortality trends

Decomposition and Attribution in Population Mortality Statistics

- Expansion of work in 2017 to Causes of Death
- 8 high income populations where consistency of cause and use of International Statistical Classification of Diseases and Related Health Problems (ICD)
- Coming soon in 2018: State-based mortality tables in US

Decomposition and Attribution in Population Mortality Statistics

- Trends often described in Life Expectancy from birth
- Data from Human Mortality Database highlights trends on Total Populations
 - England and Wales: 1841 – 2013
 - e_0 : 1841: 41.6 2013: 81.1
 - Canada: 1921 – 2011
 - e_0 : 1921: 57.0 2011: 81.7
 - USA: 1933 – 2015
 - e_0 : 1933: 60.9 2015: 79.0
 - Taiwan: 1970 – 2014
 - e_0 : 1970: 68.7 2014: 79.6

Decomposition and Attribution in Population Mortality Statistics

- Decomposition Algorithms
- Andreev, Shkolnikov and Begun (2002)
 - Attribute change in e_0 over time to each age or age group
 - Example:
 - Change in e_0 from year 1 to year 2; Attribution of change to each age x

$$\delta_x^{2-1} = l_x^2(e_x^2 - e_x^1) - l_{x+1}^2(e_{x+1}^2 - e_{x+1}^1)$$

$$e_0^2 - e_0^1 = \sum_{x=0}^{\omega} \delta_x^{2-1}$$

- Decomposition from year 2 to year 1 can also be calculated
- Final evaluation as average of two decompositions

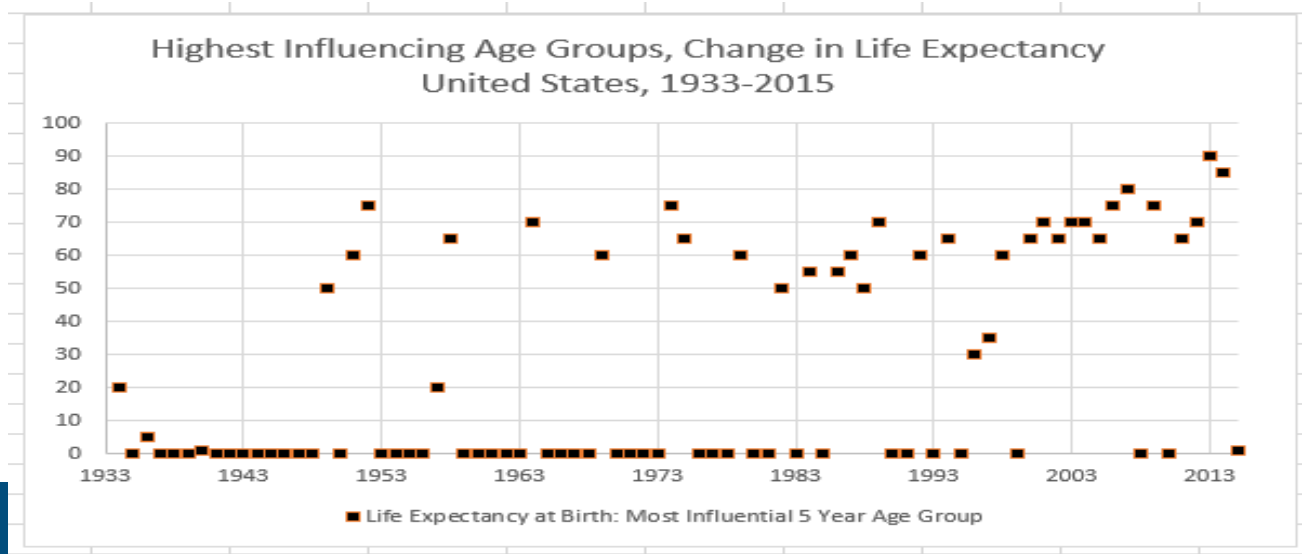
Decomposition and Attribution in Population Mortality Statistics

- Change in EAW e_0 over 5 year time span, attributed to age groups

	All Ages	0	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85+	
1970	0.36	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
1975	0.76	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
1980	0.94	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
1985	0.92	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
1990	1.21	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
1995	0.88	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2000	1.26	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2005	1.27	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##
2010	1.29	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##	##

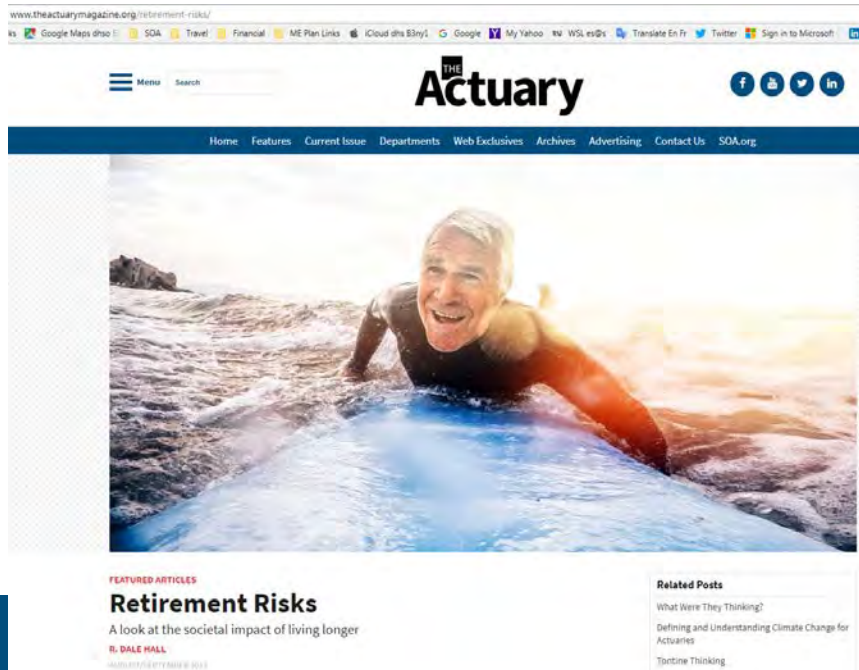
Decomposition and Attribution in Population Mortality Statistics

- While life expectancy important, at times historically becomes more of an “age 0” question
- BUT.... Changing in recent years



Decomposition and Attribution in Population Mortality Statistics

- Recent years focus on Ages 65+



...change the public's vocabulary to switch from "expectancy from birth" to "retirement preparedness."

...A life preparancy age might be commonly defined as the age to which 10 percent of a population that has already reached age 65 is expected to live in the future.

Decomposition and Attribution in Population Mortality Statistics

- Life Preparancy Age: survival to retirement age r , z th percentile of survivors (Probability of survival = $1-z$)

$$\lambda_{r,z}$$

- Attribute change in $\lambda_{r,z}$ over time to each age x

$$\delta_x^{2-1} = l_x^2(\lambda_{r,z_x}^2 - \lambda_{r,z_x}^1) - l_{x+1}^2(\lambda_{r,z_{x+1}}^2 - \lambda_{r,z_{x+1}}^1)$$

$$\lambda_{r,z}^2 - \lambda_{r,z}^1 = \sum_{x=r}^{\omega} \delta_x^{2-1}$$

- Decomposition from year 2 to year 1 can also be calculated
- Final evaluation as average of two decompositions

Decomposition and Attribution in Population Mortality Statistics

- Attribute each “age attribution” to causes of death chapters, y

1	Certain infectious diseases	11	Respiratory diseases
2	Malignant neoplasm	12	Diseases of the digestive system
3	Other neoplasms	13	Diseases of the skin and subcutaneous tissue
4	Diseases of the blood and blood-forming organs	14	Diseases of the musculoskeletal system/connective tissue
5	Endocrine, nutritional and metabolic diseases	15	Diseases of the genitourinary system
6	Mental and behavioral disorders	16	Complications of pregnancy, childbirth and puerperium
7	Diseases of the nervous system and the sense organs	17	Certain conditions originating in the perinatal period
8	Heart disease	18	Congenital malformations/anomalies
9	Cerebrovascular disease	19	Ill-defined or unknown
10	Other and unspecified disorders of the circulatory system	20	External causes (MVA, Accident, Poisoning, Suicide, Homicide)
		21	All Causes

Decomposition and Attribution in Population Mortality Statistics

- Attribute each “age attribution” to causes of death chapters, y
- Let $q_{x,y}$ be the cause of death due to chapter y for age x

$$\delta_x = \frac{\delta_x^{2-1} - \delta_x^{1-2}}{2}$$

$$\delta_{x,y} = \delta_x \frac{q_{x,y}}{q_x}$$

$$\delta_x = \sum_{y=1}^{20} \delta_{x,y}$$

$$\lambda_{r,z}^2 - \lambda_{r,z}^1 = \sum_{x=r}^{\omega} \sum_{y=1}^{20} \delta_{x,y}$$

Decomposition and Attribution in Population Mortality Statistics

- US Total Life Preparancy Age (65, 90) in 2003 = 94.17
- US Total Life Preparancy Age (65, 90) in 2008 = 95.03
- Change over 5 year period is 0.86 years

- What Age Groups and Causes of Death are attributing to that change in Life Preparancy Age?
 - Determine Annual Attribution to each Age and Year
 - Bundle to Age Groups and Years

Change in Life Preparancy at Age 65 over last 5 Years											
Total US population											
Attributed by age group and COD											
2008											
	All Ages	65	70	75	80	85	90	95	100	105	110
1 Certain infectious diseases	-0.01										
2 Malignant neoplasm	0.16	###	###	###	###	###	###	###			
3 Other neoplasms	0.00										
4 Diseases of the blood and blood-forming organs	0.00										
5 Endocrine, nutritional and metabolic diseases	0.04	###	###	###	###	###					
6 Mental and behavioural disorders	-0.16		###	###	###	###	###	###	###	###	###
7 Diseases of the nervous system and the sense organs	-0.05		###	###	###	###	###	###	###	###	###
8 Heart disease	0.58	###	###	###	###	###	###	###	###	###	###
9 Cerebrovascular disease	0.16	###	###	###	###	###	###	###	###	###	###
10 Other and unspecified disorders of the circulatory system	0.06	###	###	###	###	###	###	###	###	###	###
11 Respiratory diseases	0.05	###			###	###	###	###	###	###	###
12 Diseases of the digestive system	0.02	###	###	###	###	###	###	###	###	###	###
13 Diseases of the skin and subcutaneous tissue	0.00										
14 Diseases of the musculoskeletal system/connective tissue	0.01										
15 Diseases of the genitourinary system	0.01					###	###	###	###	###	###
16 Complications of pregnancy, childbirth and puerperium	0.00										
17 Certain conditions originating in the perinatal period	0.00										
18 Congenital malformations/anomalies	0.00										
19 Ill-defined or unknown	-0.02			###	###	###	###	###	###	###	###
20 External causes (MVA, Accident, Poisoning, Suicide, Homicide)	-0.01										
21 All Causes	0.86	###	###	###	###	###	###	###	###	###	###

Change in Life Preparancy at Age 65 over last 5 Years												
Total US population												
Attributed by age group and COD												
	2014											
		All Ages	65	70	75	80	85	90	95	100	105	110
1	Certain infectious diseases	0.02										
2	Malignant neoplasm	0.22	###	###	###	###	###	###	###			
3	Other neoplasms	0.00							###	###		
4	Diseases of the blood and blood-forming organs	0.00										
5	Endocrine, nutritional and metabolic diseases	-0.01				###						
6	Mental and behavioural disorders	-0.27		###	###	###	###	###	###	###	###	
7	Diseases of the nervous system and the sense organs	-0.11		###	###	###	###	###	###	###	###	
8	Heart disease	0.43	###	###	###	###	###	###	###	###	###	###
9	Cerebrovascular disease	0.08										
10	Other and unspecified disorders of the circulatory system	0.04										
11	Respiratory diseases	0.06	###									
12	Diseases of the digestive system	0.02	###	###								
13	Diseases of the skin and subcutaneous tissue	0.00										
14	Diseases of the musculoskeletal system/connective tissue	0.01							###	###		
15	Diseases of the genitourinary system	0.05		###	###	###	###	###	###	###		
16	Complications of pregnancy, childbirth and puerperium	0.00										
17	Certain conditions originating in the perinatal period	0.00										
18	Congenital malformations/anomalies	0.00										
19	Ill-defined or unknown	0.07						###	###	###	###	###
20	External causes (MVA, Accident, Poisoning, Suicide, Homicide)	-0.04	###	###	###	###	###	###	###	###	###	###
21	All Causes	0.56	###	###	###	###	###	###	###	###	###	###

Change in Life Preparancy at Age 65 over last 5 Years											
Total CAN population											
Attributed by age group and COD											
2002											
	All Ages	65	70	75	80	85	90	95	100	105	110
1 Certain infectious diseases	-0.02	###	###	###	###	###	###				
2 Malignant neoplasm	0.00	###	###			###	###				
3 Other neoplasms	-0.01						###				
4 Diseases of the blood and blood-forming organs	0.00										
5 Endocrine, nutritional and metabolic diseases	-0.06	###	###	###	###	###	###				
6 Mental and behavioural disorders	0.02				###	###					
7 Diseases of the nervous system and the sense organs	-0.10	###	###	###	###	###	###	###			
8 Heart disease	0.44	###	###	###	###	###	###				
9 Cerebrovascular disease	0.12	###	###	###	###	###	###				
10 Other and unspecified disorders of the circulatory system	0.05	###	###	###	###	###	###				
11 Respiratory diseases	0.21	###	###	###	###	###	###	###			
12 Diseases of the digestive system	0.02			###	###	###					
13 Diseases of the skin and subcutaneous tissue	0.00										
14 Diseases of the musculoskeletal system/connective tissue	-0.01						###	###			
15 Diseases of the genitourinary system	-0.01					###	###	###			
16 Complications of pregnancy, childbirth and puerperium	0.00										
17 Certain conditions originating in the perinatal period	0.00										
18 Congenital malformations/anomalies	0.00										
19 Ill-defined or unknown	0.01	###	###	###	###	###	###				
20 External causes (MVA, Accident, Poisoning, Suicide, Homicide)	0.00				###	###	###				
21 All Causes	0.66	###	###	###	###	###	###	###			

Change in Life Preparancy at Age 65 over last 5 Years

Total CAN population

Attributed by age group and COD

	2008	All Ages	65	70	75	80	85	90	95	100	105	110
1 Certain infectious diseases	-0.02											
2 Malignant neoplasm	0.12											
3 Other neoplasms	0.01											
4 Diseases of the blood and blood-forming organs	0.01											
5 Endocrine, nutritional and metabolic diseases	0.07											
6 Mental and behavioural disorders	-0.14											
7 Diseases of the nervous system and the sense organs	0.00											
8 Heart disease	0.41											
9 Cerebrovascular disease	0.16											
10 Other and unspecified disorders of the circulatory system	0.07											
11 Respiratory diseases	0.05											
12 Diseases of the digestive system	0.02											
13 Diseases of the skin and subcutaneous tissue	0.00											
14 Diseases of the musculoskeletal system/connective tissue	0.01											
15 Diseases of the genitourinary system	0.01											
16 Complications of pregnancy, childbirth and puerperium	0.00											
17 Certain conditions originating in the perinatal period	0.00											
18 Congenital malformations/anomalies	0.00											
19 Ill-defined or unknown	0.03											
20 External causes (MVA, Accident, Poisoning, Suicide, Homicide)	0.01											
21 All Causes	0.77											

Change in Life Preparancy at Age 65 over last 5 Years												
Total E&W population												
Attributed by age group and COD												
	2006											
		All Ages	65	70	75	80	85	90	95	100	105	110
1	Certain infectious diseases	-0.06										
2	Malignant neoplasm	0.07										
3	Other neoplasms	0.01										
4	Diseases of the blood and blood-forming organs	0.00										
5	Endocrine, nutritional and metabolic diseases	0.01										
6	Mental and behavioural disorders	0.00										
7	Diseases of the nervous system and the sense organs	0.00										
8	Heart disease	0.51										
9	Cerebrovascular disease	0.23										
10	Other and unspecified disorders of the circulatory system	0.06										
11	Respiratory diseases	0.05										
12	Diseases of the digestive system	-0.01										
13	Diseases of the skin and subcutaneous tissue	-0.01										
14	Diseases of the musculoskeletal system/connective tissue	0.01										
15	Diseases of the genitourinary system	-0.04										
16	Complications of pregnancy, childbirth and puerperium	0.00										
17	Certain conditions originating in the perinatal period	0.00										
18	Congenital malformations/anomalies	0.00										
19	Ill-defined or unknown	0.06										
20	External causes (MVA, Accident, Poisoning, Suicide, Homicide)	0.00										
21	All Causes	0.91										

Change in Life Preparancy at Age 65 over last 5 Years												
Total E&W population												
Attributed by age group and COD												
	2011											
		All Ages	65	70	75	80	85	90	95	100	105	110
1	Certain infectious diseases	0.06	###	###	###	###	###					
2	Malignant neoplasm	0.06	###	###	###	###	###					
3	Other neoplasms	0.00										
4	Diseases of the blood and blood-forming organs	0.00										
5	Endocrine, nutritional and metabolic diseases	0.02	###	###	###	###	###					
6	Mental and behavioural disorders	-0.31	###	###	###	###	###					
7	Diseases of the nervous system and the sense organs	-0.05	###	###	###	###	###					
8	Heart disease	0.52	###	###	###	###	###					
9	Cerebrovascular disease	0.33	###	###	###	###	###					
10	Other and unspecified disorders of the circulatory system	0.08	###	###	###	###	###					
11	Respiratory diseases	0.15	###	###	###	###	###					
12	Diseases of the digestive system	0.06	###	###	###	###	###					
13	Diseases of the skin and subcutaneous tissue	0.01										
14	Diseases of the musculoskeletal system/connective tissue	0.01										
15	Diseases of the genitourinary system	0.04	###	###	###	###	###					
16	Complications of pregnancy, childbirth and puerperium	0.00										
17	Certain conditions originating in the perinatal period	0.00										
18	Congenital malformations/anomalies	0.00										
19	Ill-defined or unknown	0.04				###	###					
20	External causes (MVA, Accident, Poisoning, Suicide, Homicide)	0.01				###	###					
21	All Causes	1.06	###	###	###	###	###					

US Population Mortality Analysis 2016

- Decrease in Life Expectancy
- 0.6% Decrease in Age-Adjusted Population Mortality
- Wide variety of mortality changes across ages
- Comparison of mortality by county average incomes
- <https://www.soa.org/research-reports/2017/population-mortality-observations/>



U.S. Population Mortality Observations
Updated with 2016 Experience



US Population Mortality Analysis 2016

All Ages	Annual Improvement		
	1999-2016	2011-2016	2015-2016
Both	1.1%	0.3%	0.6%
Female	1.0%	0.4%	1.1%
Male	1.2%	0.3%	0.3%
Age Group*			
< 1	1.4%	0.6%	1.1%
1 - 4	1.7%	0.7%	-1.8%
5 - 14	1.9%	-0.4%	-1.9%
15 - 24	0.3%	-2.0%	-7.7%
25 - 34	-1.4%	-4.3%	-10.5%
35 - 44	0.2%	-2.2%	-6.8%
45 - 54	0.2%	0.2%	-0.4%
55 - 64	0.8%	-0.8%	-1.0%
65 - 74	1.9%	0.6%	0.5%
75 - 84	1.4%	1.2%	2.3%
85+	0.9%	0.6%	2.1%

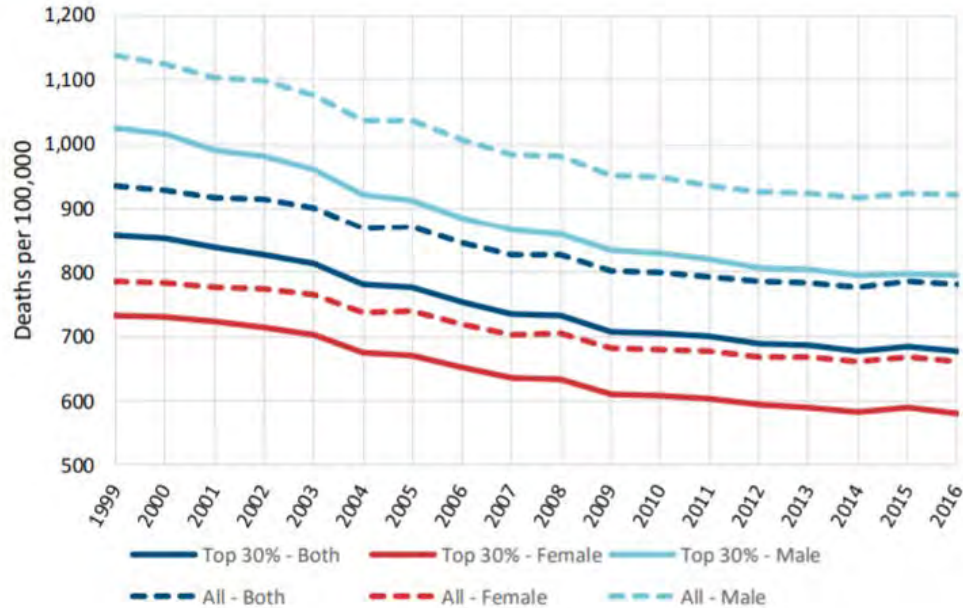
*includes both genders

US Population Mortality Analysis 2016

Age Group	Annual Improvement								
	Both Genders			Female			Male		
	1999-2016	2011-2016	2015-2016	1999-2016	2011-2016	2015-2016	1999-2016	2011-2016	2015-2016
< 1	1.4%	0.6%	1.1%	1.3%	0.6%	1.3%	1.4%	0.6%	0.9%
1 - 4	1.7%	0.7%	-1.8%	1.6%	0.3%	-6.0%	1.8%	1.0%	1.3%
5 - 14	1.9%	-0.4%	-1.9%	1.6%	-1.2%	-4.8%	2.1%	0.2%	0.2%
15 - 24	0.3%	-2.0%	-7.7%	0.5%	-2.2%	-5.9%	0.3%	-2.0%	-8.3%
25 - 34	-1.4%	-4.3%	-10.5%	-1.2%	-3.6%	-9.1%	-1.4%	-4.5%	-11.0%
35 - 44	0.2%	-2.2%	-6.8%	0.0%	-1.5%	-4.6%	0.3%	-2.7%	-8.0%
45 - 54	0.2%	0.2%	-0.4%	-0.2%	0.0%	-0.2%	0.4%	0.4%	-0.5%
55 - 64	0.8%	-0.8%	-1.0%	0.9%	-0.9%	-1.3%	0.7%	-0.8%	-0.7%
65 - 74	1.9%	0.6%	0.5%	1.8%	0.9%	0.8%	2.0%	0.5%	0.2%
75 - 84	1.4%	1.2%	2.3%	1.3%	1.2%	2.5%	1.7%	1.3%	2.2%
85+	0.9%	0.6%	2.1%	0.8%	0.6%	2.3%	1.1%	0.7%	1.8%

US Population Mortality Analysis 2016

TOP 30% VS. ALL COUNTIES BY INCOME AGE ADJUSTED MORTALITY 1999-2016



All Ages	1999-2016 Deaths per 100,000		
	Top 30%	All	Ratio
Both	741.6	836.0	88.7%
Female	639.9	710.6	90.0%
Male	871.7	993.3	87.8%
Age Group*			
< 1	528.4	661.4	79.9%
1 - 4	21.4	28.7	74.5%
5 - 14	11.5	15.0	76.6%
15 - 24	61.1	74.4	82.1%
25 - 34	82.4	107.4	76.8%
35 - 44	137.9	187.6	73.5%
45 - 54	314.2	417.6	75.3%
55 - 64	704.7	891.1	79.1%
65 - 74	1,714.7	2,001.0	85.7%
75 - 84	4,688.7	5,034.3	93.1%
85+	13,840.2	14,301.3	96.8%

*includes both genders

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May 10, 2018





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