Every program in the book

The DecL declarations behind the reproductions, collected

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This appendix collects every DecL program the book builds, chapter by chapter, in the order the chapters appear, each chapter's programs headed by the paper they reproduce and a link back to the chapter. It is not transcribed. Each chapter writes the programs it parses into a store as it runs, and this page reads the store back, so the appendix cannot drift from the chapters the way a hand-maintained list would. What is printed is the canonical form: the declaration re-parsed and written back from the resulting specification, which is what the library understood rather than what was typed. A line wider than the page is folded at its spaces onto indented continuation lines, which parse exactly as the unfolded line does. One declaration, 28,000 characters of exact rational probabilities, is cut short where marked.

Three things follow from generating it this way. A chapter that builds nothing does not appear. Programs are collected by declaration rather than by object, so a chapter that rebuilds one model at ten bucket sizes contributes one entry and not ten, and where it swept the grid the `hints{}` clause is dropped, since no one setting is the model's. And the numerical arguments some chapters pass to `build` as keyword arguments are not here at all: those are instructions to the solver, not part of the declaration, and the chapters that depend on them say so where they use them.

Declarations that share a shape are sampled rather than listed in full. A chapter that values the same severity at thirty limits writes thirty distinct declarations, and printing all thirty teaches a reader nothing the first two do not. Two of each shape are shown, followed by a count of the rest, where a shape is the declaration with its numbers taken out. Nothing is hidden by this that is not an arithmetic variant of something on the page beside it.

Every program below except the one cut short runs as it stands, in the aggregate Loss Lab (aLL) with no installation, or through `build` in a Python session.

The same declarations are also available as one loadable file, `reproductions.agg` in the project root, written from the same store by `make_agg.py`. Each one there carries a `note{}` naming the paper it comes from and saying in a line what it is, and each is renamed by citation key so that nothing in the file shadows anything else: `build.load('reproductions.agg')` puts all of them in the recipe base, after which `build('Bear1990.BN.TreatyVI')` rebuilds that treaty by name. Two things differ from the listing below. The shipped severity curves appear in full rather than sampled, each being a curve in its own right rather than an arithmetic variant of the one above it, and a model that more than one chapter builds appears once.

Five papers, five programs

From Venter (1983), Bear and Nemlick (1990), Homer and Clark (2003), Bruno et al. (2006) and Denuit, Dhaene, et al. (2025), reproduced in Five papers, five programs.

```
agg Venter
  13.7376 claims
  250000 xs 0
  sev chistogram xps [0 1000 5000 6000 7000 8000 9000 10000 12500 15000 17500 20000
    25000 35000 50000 75000 100000 125000 150000 175000 200000 225000 250000 300000]
    [0.38935 0.38935 0.00568 0.00543 0.00517 0.00495 0.00473 0.01098 0.00989 0.00896
    0.00815 0.01426 0.02237 0.02353 0.02459 0.01517 0.01021 0.00732 0.00547 0.00423
    0.00337 0.00274 0.0241]
  poisson
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  poisson
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  poisson
  aggregate net of
    360 xs 0
```

```
agg HC
  5 claims
  dsev [200000 400000 600000 800000 1000000] [0.378 0.235 0.146 0.091 0.15]
  occurrence net of
    400000 xs 600000
  mixed gamma 0.2
```

```
agg B7
  91000 claims
  dsev [14 15 16 17 18 19 20 24 26 28 30 31 55 60] [0.0103301 0.030799 0.0293511
    0.0103301 0.0730414 0.0111568 0.0264554 0.1002133 0.0815418 0.0252146 0.0212857
    0.0254214 0.0991756 0.4556837]
  poisson
```

```
port Denuit.Pool
  agg Agent1
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg Agent2
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg Agent3
    1 claim
    sev 2 * gamma [1 8] wts [0.504541349633 0.495458650367] splice [0 0] [30 30]
    fixed
```

Mack and Fackler's test of Riebesell's rule

From Mack and Fackler (2003), reproduced in Mack and Fackler's test of Riebesell's rule.

```
agg S
  1 claim
  0.01 xs 0
  sev expon
  fixed
```

```
agg S
  1 claim
  0.1 xs 0
  sev expon
  fixed
```

and 5 more of this shape, differing only in their numbers.

```
agg S
  1 claim
  sev expon
  fixed
```

```
agg S
  1 claim
  0.01 xs 0
  sev 10 * gamma 0.1
  fixed
```

```
agg S
  1 claim
  0.1 xs 0
  sev 10 * gamma 0.1
  fixed
```

and 5 more of this shape, differing only in their numbers.

```
agg S
  1 claim
  sev 10 * gamma 0.1
  fixed
```

```
agg S
  1 claim
  0.01 xs 0
  sev lognorm 1 cv 4.95315270785704
  fixed
```

```
agg S
  1 claim
  0.1 xs 0
  sev lognorm 1 cv 4.95315270785704
  fixed
```

and 5 more of this shape, differing only in their numbers.

```
agg S
  1 claim
  sev lognorm 1 cv 4.95315270785704
  fixed
```

```
agg S
  1 claim
  0.01 xs 0
  sev 0.5 * lomax 1.5
  fixed
```

```
agg S
  1 claim
  0.1 xs 0
  sev 0.5 * lomax 1.5
  fixed
```

and 5 more of this shape, differing only in their numbers.

```
agg S
  1 claim
  sev 0.5 * lomax 1.5
  fixed
```

```
agg Riebesell
  1 claim
  5000000 xs 0
  sev [9894.934954 259286.6924] * [lognorm pareto] [1.8 0.7369655942] wts
    [0.965191548087 0.034808451913] splice [0 259286.6924 inf]
  fixed
```

```
agg Riebesell
  1 claim
  50000 xs 0
  sev [9894.934954 259286.6924] * [lognorm pareto] [1.8 0.7369655942] wts
    [0.965191548087 0.034808451913] splice [0 259286.6924 inf]
  fixed
```

and 11 more of this shape, differing only in their numbers.

Mata and Verheyen on trend by layer

From Mata and Verheyen (2005), reproduced in Mata and Verheyen on trend by layer.

```
agg M
  1 claim
  250000 xs 0
  sev lognorm 152062.97146657703 cv 13.727535749987513
  fixed
```

```
agg M
  1 claim
  500000 xs 0
  sev lognorm 152062.97146657703 cv 13.727535749987513
  fixed
```

and 8 more of this shape, differing only in their numbers.

```
agg M
  1 claim
  sev lognorm 152062.97146657703 cv 13.727535749987513
  fixed
```

```
agg M
  1 claim
  sev lognorm 103491.50327117534 cv 13.727535749987513
  fixed
```

Bodoff and excess of policy limits losses

From Bodoff (2017), reproduced in Bodoff and excess of policy limits losses.

```
agg B
  1 claim
  50000 xs 0
  sev 50000 * lomax 1.5
  fixed
```

```
agg B
  1 claim
  100000 xs 0
  sev 50000 * lomax 1.5
  fixed
```

and 8 more of this shape, differing only in their numbers.

Homer and Clark's bivariate FFT

From Homer and Clark (2003), reproduced in Homer and Clark's bivariate FFT.

```
bivariate A
  dfreq [2]
  dbvsev [0 1 2] [0 1 2] [[0.4 0 0] [0.3 0.3 0] [0 0 0]]
```

```
agg HC
  5 claims
  dsev [200000 400000 600000 800000 1000000] [0.378 0.235 0.146 0.091 0.15]
  occurrence net of
    400000 xs 600000
  mixed gamma 0.2
```

```
bivariate HC3
  4 claims
  dbvsev [0 200000 400000 600000 800000 1000000] [0 200000 400000 600000 800000 1000000
    1200000] [[0.08389999999999327 0.014699999999998822 0.0012999999999998956
    9.9999999999992e-05 0 0 0] [0.27979999999997757 0.13289999999998933
    0.03159999999999747 0.004999999999999599 0.0005999999999999518 9.9999999999992e-05
    0] [0.04149999999999668 0.03209999999999742 0.012499999999998998
    0.003199999999999744 0.0005999999999999518 9.9999999999992e-05 0]
    [0.030699999999997542 0.03299999999999736 0.01769999999999858 0.006399999999999488
    0.0016999999999998637 0.000399999999999968 9.9999999999992e-05]
    [0.022799999999998172 0.03129999999999749 0.021499999999998274 0.009899999999999208
    0.003999999999997275 0.0008999999999999279 0.000199999999999984]
    [0.033756260434097296 0.05659432387309546 0.047378964941596206 0.02644407345579788
    0.011118530884799109 0.003706176961599703 0.0010016694490799197]]
  mixed gamma 0.5
```

```
bivariate HC4
  10 claims
  dbvsev [0 200000 400000 600000 800000] [0 1 2 3 4 5] [[0 0.10000000000000002 0 0 0 0]
    [0.43800000000000006 0 0 0 0 0] [0.24600000000000002 0 0 0 0 0] [0.13800000000000004
    0 0 0 0 0] [0.07800000000000001 0 0 0 0 0]]
  mixed gamma 0.31622776601683794
```

```
bivariate HC4b
  10 claims
  dbvsev [0 200000 400000 600000 800000] [0 1 2 3 4 5] [[0 0.10000000000000002 0 0 0 0]
    [0.43800000000000006 0 0 0 0 0] [0.24600000000000002 0 0 0 0 0] [0.13800000000000004
    0 0 0 0 0] [0.07800000000000001 0 0 0 0 0]]
  mixed gamma 0.31622776601683794
```

Bear and Nemlick on adjustable treaty features

From Bear and Nemlick (1990), reproduced in Bear and Nemlick on adjustable treaty features.

```
port BearNemlick.One
  agg Class1
    9000 premium at 0.04 lr
    160 xs 0
    sev 40 * pareto 0.9 + -40
    mixed gamma 0.07879574790219362
  agg Class2
    3000 premium at 0.03 lr
    160 xs 0
    sev 40 * pareto 0.95 + -40
    mixed gamma 0.22335691114062584
```

```
port BearNemlick.Two
  agg Class1
    2000 premium at 0.1 lr
    700 xs 0
    sev 300 * pareto 1.5 + -300
    mixed gamma 0.09022811434760547
  agg Class2
    2000 premium at 0.14 lr
    700 xs 0
    sev 300 * pareto 1.3 + -300
    mixed gamma 0.09869275424396479
  agg Class3
    2000 premium at 0.21 lr
    700 xs 0
    sev 300 * pareto 1.1 + -300
    mixed gamma 0.12408498159738195
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  poisson
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  poisson
  aggregate net of
    360 xs 0
```

```
xpnl BN.TreatyII
  1172 premium
  less
    agg BN.Two
      [2000 2000 2000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      occurrence net of
        700 xs 0 deposit 1172 reinstatements [0 0 0] as Layer
      poisson
```

```
agg BN.TwoAlt
  [2000 2000 2000] premium at [0.1 0.14 0.21] lr
  700 xs 0
  sev 300 * pareto [1.5 1.3 1.1] + -300
  poisson
  aggregate ceded to
    2800 xs 0
```

```
xpnl BN.TreatyIII
  10000 premium
  less
    agg BN.Three
      [4500 4500 1000] premium at [0.032 0.038 0.035] lr
      400 xs 0
      sev 100 * pareto 1.1 + -100
      poisson
      aggregate net of
        10000 xs 0 deposit 350 corridor 1 po 1 xs 1 as Corridor
```

```
xpnl BN.TreatyIIIb
  10000 premium
  less
    agg BN.Three
      [4500 4500 1000] premium at [0.032 0.038 0.035] lr
      400 xs 0
      sev 100 * pareto 1.1 + -100
      poisson
      aggregate net of
        10000 xs 0 deposit 366.9658642415209 corridor 1 po 0.9537671868292504 xs
          0.9537671868292504 as Corridor
```

```
pnl BN.TreatyIV
  retro basic 0 lcm 1.3333333333 min 360 max 1200 premium
  less
    agg BN.Four
      [9000 3000] premium at [0.04 0.03] lr
      160 xs 0
      sev 40 * pareto [0.9 0.95] + -40
      poisson
```

```
xpnl BN.TreatyV
  18000 premium
  less
    agg BN.Five
      [6000 6000 6000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      poisson
      aggregate net of
        80% po 100000 xs 0 deposit 5625 pc 0.25 after 0.2 as "PC layer"
```

```
xpnl BN.TreatyVI
  25000 premium
  less
```

```
    agg BN.Six
      25000 premium at 0.1 lr
      900 xs 0
      sev 100 * pareto 0.98 + -100
      poisson
      aggregate net of
        100000 xs 0 deposit 5000 slide 0.4 at 0.35 and 0.25 at 0.55 and 0.2 at 0.65 as
          Slide
```

```
xpnl BN.TreatyVI
  25000 premium
  less
    agg BN.Six
      25000 premium at 0.1 lr
      900 xs 0
      sev 100 * pareto 0.95 + -100
      poisson
      aggregate net of
        100000 xs 0 deposit 5000 slide 0.4 at 0.35 and 0.25 at 0.55 and 0.2 at 0.65 as
          Slide
```

and 4 more of this shape, differing only in their numbers.

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  mixed gamma 0.22360679774997896
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  mixed gamma 0.31622776601683794
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  mixed gamma 0.22360679774997896
  aggregate net of
    360 xs 0
```

```
agg BN.One
  [9000 3000] premium at [0.04 0.03] lr
  160 xs 0
  sev 40 * pareto [0.9 0.95] + -40
  mixed gamma 0.31622776601683794
  aggregate net of
    360 xs 0
```

```
xpnl BN.TreatyII
  1172 premium
  less
    agg BN.Two
      [2000 2000 2000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      occurrence net of
        700 xs 0 deposit 1172 reinstatements [0 0 0] as Layer
      mixed gamma 0.22360679774997896
```

```
xpnl BN.TreatyII
  1172 premium
  less
    agg BN.Two
      [2000 2000 2000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      occurrence net of
        700 xs 0 deposit 1172 reinstatements [0 0 0] as Layer
      mixed gamma 0.31622776601683794
```

```
xpnl BN.TreatyIII
  10000 premium
  less
    agg BN.Three
      [4500 4500 1000] premium at [0.032 0.038 0.035] lr
      400 xs 0
      sev 100 * pareto 1.1 + -100
      mixed gamma 0.22360679774997896
      aggregate net of
        10000 xs 0 deposit 350 corridor 1 po 1 xs 1 as Corridor
```

```
xpnl BN.TreatyIII
  10000 premium
  less
    agg BN.Three
      [4500 4500 1000] premium at [0.032 0.038 0.035] lr
      400 xs 0
      sev 100 * pareto 1.1 + -100
      mixed gamma 0.31622776601683794
      aggregate net of
        10000 xs 0 deposit 350 corridor 1 po 1 xs 1 as Corridor
```

```
pnl BN.TreatyIV
  retro basic 0 lcm 1.3333333333 min 360 max 1200 premium
  less
    agg BN.Four
      [9000 3000] premium at [0.04 0.03] lr
      160 xs 0
      sev 40 * pareto [0.9 0.95] + -40
      mixed gamma 0.22360679774997896
```

```
pnl BN.TreatyIV
  retro basic 0 lcm 1.3333333333 min 360 max 1200 premium
  less
    agg BN.Four
      [9000 3000] premium at [0.04 0.03] lr
      160 xs 0
      sev 40 * pareto [0.9 0.95] + -40
      mixed gamma 0.31622776601683794
```

```
xpnl BN.TreatyV
  18000 premium
  less
    agg BN.Five
      [6000 6000 6000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      mixed gamma 0.22360679774997896
      aggregate net of
        80% po 100000 xs 0 deposit 5625 pc 0.25 after 0.2 as "PC layer"
```

```
xpnl BN.TreatyV
  18000 premium
  less
    agg BN.Five
      [6000 6000 6000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      mixed gamma 0.31622776601683794
      aggregate net of
        80% po 100000 xs 0 deposit 5625 pc 0.25 after 0.2 as "PC layer"
```

```
xpnl BN.TreatyVI
  25000 premium
  less
    agg BN.Six
      25000 premium at 0.1 lr
      900 xs 0
      sev 100 * pareto 0.98 + -100
      mixed gamma 0.22360679774997896
      aggregate net of
        100000 xs 0 deposit 5000 slide 0.4 at 0.35 and 0.25 at 0.55 and 0.2 at 0.65 as
          Slide
```

```
xpnl BN.TreatyVI
  25000 premium
  less
    agg BN.Six
      25000 premium at 0.1 lr
      900 xs 0
      sev 100 * pareto 0.98 + -100
      mixed gamma 0.31622776601683794
      aggregate net of
        100000 xs 0 deposit 5000 slide 0.4 at 0.35 and 0.25 at 0.55 and 0.2 at 0.65 as
          Slide
```

```
xpnl BN.TreatyIIp
  1172 premium
  less
    agg BN.Two
      [2000 2000 2000] premium at [0.1 0.14 0.21] lr
      700 xs 0
      sev 300 * pareto [1.5 1.3 1.1] + -300
      occurrence net of
        700 xs 0 deposit 1172 reinstatements [1 1 1] as Layer
      poisson
```

Wang and risk loads by layer

From Wang (2000), reproduced in Wang and risk loads by layer.

```
agg Wang.Layers
  1 claim
  10000000 xs 0
  sev 2000 * lomax 1.2
  occurrence ceded to
    50000 xs 0 and
    50000 xs 50000 and
    100000 xs 100000 and
    100000 xs 200000 and
    100000 xs 300000 and
    100000 xs 400000 and
    500000 xs 500000 and
    1000000 xs 1000000 and
    3000000 xs 2000000 and
    5000000 xs 5000000
  fixed
```

```
distortion wang_a wang 0.1
```

```
distortion ph_r ph 0.9245
```

```
distortion tmp ph 0.9
```

```
distortion tmp ph 0.95
```

and 4 more of this shape, differing only in their numbers.

Wang and the pricing of weather options

From Wang (2002), reproduced in Wang and the pricing of weather options.

```
agg HDD
  1 claim
  dsev [972.5 1147 1244 901 1573 1055 1488 1065.5 1018.5 1155 1474.5 1129.5 1077.5
    1129.5 1090.5 938.5 1199.5 1156 1040 940.5 1090.5 1517.5]
  fixed
```

```
distortion wang25 wang 0.25
```

Denuit and conditional mean risk sharing

From Denuit (2019), reproduced in Denuit and conditional mean risk sharing.

```
port D61a
  agg P1
    0.08 claims
    dsev [1 2 3 4] [0.1 0.2 0.4 0.3]
    poisson
  agg P2
    0.08 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
  agg P3
    0.1 claims
    dsev [1 2 3 4] [0.1 0.2 0.4 0.3]
    poisson
  agg P4
    0.1 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
```

```
port D61b
  agg P1
    0.08 claims
    dsev [1 2 3 4] [0.1 0.2 0.4 0.3]
    poisson
  agg P2
    0.08 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
  agg P3
    0.1 claims
    dsev [1 2 3 4] [0.1 0.2 0.3 0.4]
    poisson
  agg P4
    0.1 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
```

```
port Denuit61
  agg P1
    0.08 claims
    dsev [1 2 3 4] [0.1 0.2 0.4 0.3]
    poisson
```

```
  agg P2
    0.08 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
  agg P3
    0.1 claims
    dsev [1 2 3 4] [0.1 0.2 0.4 0.3]
    poisson
  agg P4
    0.1 claims
    dsev [1 2 3 4] [0.15 0.25 0.3 0.3]
    poisson
```

Denuit, Hieber and Robert on mortality credits

From Denuit et al. (2022), reproduced in Denuit, Hieber and Robert on mortality credits.

```
port Fund100
  agg Low
    6 claims
    dsev [1]
    binomial 0.1
  agg High
    8 claims
    dsev [3]
    binomial 0.2
```

```
port Fund500
  agg Low
    30 claims
    dsev [1]
    binomial 0.1
  agg High
    40 claims
    dsev [3]
    binomial 0.2
```

and 1 more of this shape, differing only in their numbers.

Denuit et al. on comonotonic allocations

From Denuit, Dhaene, et al. (2025), reproduced in Denuit et al. on comonotonic allocations.

```
port Denuit.Pool
  hints{log2=16; bs=0.002; normalize=False; padding=1}
  agg Agent1
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg Agent2
    1 claim
    sev 2 * expon splice [0 10]
```

```
    fixed
  agg Agent3
    1 claim
    sev 2 * gamma [1 8] wts [0.504541349633 0.495458650367] splice [0 0] [30 30]
    fixed
```

```
port Denuit.PoolAlt
  hints{log2=16; bs=0.002; normalize=False; padding=1}
  agg A1
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg A2
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg A3
    1 claim
    sev 2 * gamma [1 8] wts=2
    fixed
```

```
port Denuit.PoolB
  hints{log2=16; bs=0.002; normalize=False; padding=1}
  agg B1
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg B2
    1 claim
    sev 2 * expon splice [0 10]
    fixed
  agg B3
    1 claim
    sev 2 * gamma [1 8] wts=2 splice [0 0] [30 30]
    fixed
```

Denuit, Ortega-Jiménez and Robert on conditional expectations given the sum

From Denuit, Ortega-Jiménez, et al. (2025), reproduced in Denuit, Ortega-Jiménez and Robert on conditional expectations given the sum.

```
port K
  hints{log2=20; bs=0.01; normalize=False; padding=1}
  agg X
    1 claim
    sev pareto 3.5
    fixed
  agg Y
    1 claim
    sev pareto 2.5
    fixed
```

```
port K
  hints{log2=20; bs=0.01; normalize=False; padding=1}
  agg X
    1 claim
    sev pareto 2.5
    fixed
  agg Y
    1 claim
    sev pareto 1.5
    fixed
```

and 1 more of this shape, differing only in their numbers.

```
port K
  hints{log2=18; bs=0.002; normalize=False; padding=1}
  agg X
    1 claim
    sev lomax 3.5
    fixed
  agg Y
    1 claim
    sev lomax 3
    fixed
```

Gerber and compound Poisson stop loss premiums

From Gerber (1982), reproduced in Gerber and compound Poisson stop loss premiums.

```
agg Gerber
  1 claim
  sev 2 * uniform + 1
  poisson
  hints{log2=18; bs=0.0009765625}
```

```
agg Gerber
  10 claims
  sev 2 * uniform + 1
  poisson
  hints{log2=18; bs=0.0078125}
```

```
agg Gerber
  100 claims
  sev 2 * uniform + 1
  poisson
```

Robertson and the sum of uniform claims

From Robertson (1992), reproduced in Robertson and the sum of uniform claims.

```
agg Robertson
  5 claims
  sev chistogram xps [0 0.2 0.4 0.6 0.8 1] [0.2 0.2 0.2 0.2 0.2]
  fixed
```

```
agg Robertson2
  5 claims
  sev uniform
  fixed
```

Embrechts, Grübel and Pitts on discretization error

From Embrechts et al. (1993), reproduced in Embrechts, Grübel and Pitts on discretization error.

```
agg EGP
  20 claims
  sev expon 1
  poisson
```

Grübel and Hermesmeier on aliasing and exponential tilting

From Grübel and Hermesmeier (1999), reproduced in Grübel and Hermesmeier on aliasing and exponential tilting.

```
agg Levy
  20 claims
  sev levy
  poisson
```

Pittarello, Luini and Marchione's GEMAct package

From Pittarello et al. (2024), reproduced in Pittarello, Luini and Marchione's GEMAct package.

```
agg PLM.XL
  4 claims
  20 xs 5
  sev gamma 5 !
  poisson
```

```
agg PLM.Layer1
  0.5 claims
  100 xs 100
  sev 83.34 * genpareto 0.834 !
  poisson
```

```
agg PLM.Layer3
  0.5 claims
  100 xs 100
  sev 83.34 * genpareto 0.834 !
  poisson
  aggregate ceded to
    200 xs 0
```

```
xpnl PLM.Layer2
  1 premium
  less
    agg PLM.Layer2Gross
      0.5 claims
      sev 83.34 * genpareto 0.834
      occurrence net of
        200 xs 100 deposit 1 reinstatements [0.6 0.6] as Layer
      poisson
```

```
agg PLM.RS
  0.5 claims
  100 xs 0
  sev 100 * pareto 1.2 + -100 !
  poisson
```

```
agg PLM.Layer2Net
  0.5 claims
  200 xs 100
  sev 83.34 * genpareto 0.834 !
  poisson
```

```
agg PLM.Table1
  3 claims
  inf xs 10000
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
```

```
agg PLM.Gross
  3 claims
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
```

```
agg PLM.XL1M
  3 claims
  1000000 xs 10000
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
```

```
agg PLM.SL
  3 claims
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
  aggregate ceded to
    1000000 xs 50000
```

```
agg PLM.XLAgg
  3 claims
  1000000 xs 10000
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
  aggregate ceded to
    1000000 xs 50000
```

```
agg PLM.Cut
  3 claims
  819150 xs 10000
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
```

```
agg PLM.Cut
  3 claims
  1638300 xs 10000
  sev lognorm 84541.68 cv 2.1022565437545127
  poisson
```

and 10 more of this shape, differing only in their numbers.

Embrechts and Frei's three discretization designs

From Embrechts and Frei (2009), reproduced in Embrechts and Frei's three discretization designs.

```
agg EF
  50 claims
  sev expon
  poisson
```

```
agg EF1
  20 claims
  sev 3 * pareto 4 + -3
  poisson
```

Schaller and Temnov on a severity with no mean

From Schaller and Temnov (2008), reproduced in Schaller and Temnov on a severity with no mean.

```
agg SchallerTemnov
  18 claims
  sev 12000 * genpareto 1 + 7000
  poisson
  hints{log2=20; bs=4.76837158203125; padding=2; normalize=False}
```

Bruno et al. on thresholded direct convolution

From Bruno et al. (2006), reproduced in Bruno et al. on thresholded direct convolution.

```
agg B
  504.814259 claims
  dsev [14 15 16 17 18 19 20 24 26 28 30 31 55 60] [0.0103301 0.030799 0.0293511
    0.0103301 0.0730414 0.0111568 0.0264554 0.1002133 0.0815418 0.0252146 0.0212857
    0.0254214 0.0991756 0.4556837]
  poisson
```

```
agg B8
  dfreq [0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17] [0.79870839980732
    0.168928395537711 0.0275621536510322 0.00411140723243176 0.000591554176846273
    8.41033531369783e-05 1.19716064327213e-05 1.71994460232325e-06 2.50751602571129e-07
    3.72405307143863e-08 5.65056685224704e-09 8.77932283380845e-10 1.39934149169577e-10
    2.29163277016947e-11 3.86088331748775e-12 6.69927670844654e-13 1.19834141403275e-13
    2.211580538677e-14]
  dsev [14 15 16 17 18 19 20 24 26 28 30 31 55 60] [0.0103301 0.030799 0.0293511
    0.0103301 0.0730414 0.0111568 0.0264554 0.1002133 0.0815418 0.0252146 0.0212857
    0.0254214 0.0991756 0.4556837]
```

```
agg B7
  91000 claims
  dsev [14 15 16 17 18 19 20 24 26 28 30 31 55 60] [0.0103301 0.030799 0.0293511
    0.0103301 0.0730414 0.0111568 0.0264554 0.1002133 0.0815418 0.0252146 0.0212857
    0.0254214 0.0991756 0.4556837]
  poisson
```

Gollini and Rougier on a catastrophe model event loss table

From Gollini and Rougier (2016), reproduced in Gollini and Rougier on a catastrophe model event loss table.

```
agg Hurricane
  2.974183 claims
  dsev [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 24] [0.58889746 0.21928748
    0.0672295 0.05374453 0.01379374 0.01411 0.00846236 0.0061182 0.00446063 0.00941256
    0.00198404 0.00452247 7.436e-05 0.00025122 0.00253892 0.00435067 0.0007371 1.486e-05
    4.95e-06 4.95e-06]
  poisson
```

```
agg Hurricane.Capped
  2.974183 claims
  5 xs 0
  dsev [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 24] [0.58889746 0.21928748
    0.0672295 0.05374453 0.01379374 0.01411 0.00846236 0.0061182 0.00446063 0.00941256
    0.00198404 0.00452247 7.436e-05 0.00025122 0.00253892 0.00435067 0.0007371 1.486e-05
    4.95e-06 4.95e-06]
  poisson
```

```
agg Hurricane.Gamma
  2.974183 claims
  sev gamma [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 24] cv 0.5 wts [0.58889746
    0.21928748 0.0672295 0.05374453 0.01379374 0.01411 0.00846236 0.0061182 0.00446063
    0.00941256 0.00198404 0.00452247 7.436e-05 0.00025122 0.00253892 0.00435067
    0.0007371 1.486e-05 4.95e-06 4.95e-06]
  poisson
```

Wilson and Keich on accurate FFT convolution

From Wilson and Keich (2016), reproduced in Wilson and Keich on accurate FFT convolution.

```
agg Toy
  dfreq [2]
  dsev [1 2 3] [0.99999 1e-05 1e-20]
```

```
nttagg Wilson
  dfreq [2]
  dsev [1 2 3] [9999899999999999999/10000000000000000000 1/100000
    1/10000000000000000000]
```

Wilson and Keich's sisFFT for small tail probabilities

From Wilson and Keich (2017), reproduced in Wilson and Keich's sisFFT for small tail probabilities.

```
agg WK
  dfreq [2]
  dsev [0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
    30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57
    58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
    86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109
    110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127]
    [0.05698071412216734 0.06620214484224507 0.07439431506585613 0.0808594823064372
    0.08500523661668595 0.08643386270782825 0.08500523661668595 0.0808594823064372
    0.07439431506585613 0.06620214484224507 0.05698071412216734 0.0474359096066097
    0.03819531491351482 0.02974654116430425 0.022407137097008607 0.016325247924520128
    0.011504207774114473 0.007841103119752254 0.005169173762132145 0.003296010711360087
    0.0020327296165158883 0.0012125345785902368 0.0006995715951974206
    0.0003903855371025767 5 0.00021070691529164931 0.00010999865526234663
    5.554173985207159e-05 2.7125334425354087e-05 1.2813100714451682e-05
    5.854056311225143e-06 2.586920418962627e-06 1.105688414827683e-06
    4.570944696450248e-07 1.827690656905043e-07 7.068429552096851e-08
    2.644031917226084e-08 9.566079154710707e-09 3.347532207218618e-09
    1.1330239115747578e-09 3.709171412794566e-10 1.1744600532204117e-10
    3.59685651045085e-11 1.0654461224833036e-11 3.0525542488755614e-12
    8.458995729331485e-13 2.2672412675735592e-13 5.8776021715289e-14
    1.473757926702887e-14 3.574173561367906e-15 8.38394921987302e-16
    1.902151734895072e-16 4.174122530025176e-17 8.859490495024046e-18
    1.818761770055943e-18 3.611323587025658e-19 6.935543648882527e-20
    1.2883033361832961e-20 2.3146177051578186e-21 4.0222024620549385e-22
    6.760395460348606e-23 1.0990154370000577e-23 1.7280607304882195e-24
```

```
    2.628074830109522e-25 3.865805235535093e-26 5.500038508200373e-27
    7.568590490625302e-28 1.0073671919033027e-28 1.2968331832718913e-29
    1.6147449836629747e-30 1.9446761623098232e-31 2.2652396490885474e-32
    2.5521402435349255e-33 2.781111713376742e-34 2.931270180098265e-35
    2.9882490005560692e-36 2.9464646373490424e-37 2.81001863961723e-38
    2.5920339497460392e-39 2.3125742607080913e-40 1.9956032700263374e-41
    1.6656212138890558e-42 1.3446269064639106e-43 1.0499070900667768e-44
    7.929092000468263e-46 5.791880098166922e-47 4.092033548360507e-48
    2.796290748421717e-49 1.8482000741056655e-50 1.1815147781965363e-51
    7.305548867286579e-53 4.3690806287813747e-54 2.5272650181927225e-55
    1.4139531828455055e-56 7.651433198651694e-58 4.004737637015077e-59
    2.0273506236978068e-60 9.92675213472881e-62 4.701203037982131e-63
    2.1534478334709612e-64 9.540765472727624e-66 4.088420924459984e-67
    1.6945387385131509e-68 6.79314552283295e-70 2.6339883633345665e-71
    9.878256594055475e-73 3.583193580753452e-74 1.2571403239902966e-75
    4.2659991042454884e-77 1.4001716502139405e-78 4.4449340074571594e-80
    1.364812125339333e-81 4.0532551594801475e-83 1.1642829388275267e-84
    3.234719599335948e-86 8.692371190637349e-88 2.2592453900859697e-89
    5.679525621992663e-91 1.3809699827592993e-92 3.247730108931048e-94
    7.387528029916211e-96 1.6253311884427783e-97 3.4586619315136957e-99
    7.118653852801502e-101 1.4171347738069365e-102 2.7286507445183277e-104
    5.081691135606408e-106 9.153603493842637e-108 1.5947750937110134e-109]
```

```
nttagg WKExact
  dfreq [2]
  dsev [0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
    30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57
    58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
    86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109
    110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127] [1205358117
    64446499302627767141300693656836408314036477899945172967332002636542964039960919606
    86262214058546805318733319372 8/21153791001287953841412697047875387498293910313973251
    56479702597911102712337040158720475206605482703083788986571601650839700 3 14004263358
    29845571578239240903718494240992908282963197796760858189765888474030421110930534260 9
    94701597220333948174021427200/21153791001287953841412697047875387498293910313973251 5
    64797025979111027123370401587204752066054827030837889865716016508397003 157372179258
    70883236071749785133813154663534520204378281828859226984346822449726357173903251053 1
    63235598066422342555522826 24/21153791001287953841412697047875387498293910313973251 56
    47970259791110271233704015872047520660548270308378898657160165083970 03 1710484589182
    71398473385047278500960604216834855898300044105363232283467012828959445278442826109 2
    75294416681751591619710156 8/21153791001287953841412697047875387498293910313973251564
    79702597911102712337040158720475206605482703083788986571601650839700 3 17981830094044
    04637114502989356361510338483795743649982320353691105560694753443765327880796704603 2
    60059644846490769095131136/21153791001287953841412697047875387498293910313973251564 7
    97025979111027123370401587204752066054827030837889865716016508397003 182840386715541
    59003520233158334254305025384189384888087133797473601071364849438392445578265847175 8
    95788387215054494907760 64/21153791001287953841412697047875387498293910313973251564 79
    70259791110271233704015872047520660548270308378898657160165083970 03 ...
```

The declaration runs to 28,081 characters and is cut short here; `reproductions.agg` contains it in full.

```
nttagg DiceOfDice
  dfreq [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
    30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57
    58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
    86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109
    110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130
    131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151
```

```
    152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172
    173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193
    194 195 196 197 198 199 200]
  dsev [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
    31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
    59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
    87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110
    111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131
    132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152
    153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173
    174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194
    195 196 197 198 199 200]
```

Asmussen, Jensen and Rojas-Nandayapa on the lognormal left tail

From Asmussen et al. (2016), reproduced in Asmussen, Jensen and Rojas-Nandayapa on the lognormal left tail.

```
agg S
  dfreq [4]
  sev lognorm 0.25
```

```
agg S
  dfreq [64]
  sev lognorm 0.25
```

and 3 more of this shape, differing only in their numbers.

Ben Amar et al. on state-dependent importance sampling

From Ben Amar et al. (2023), reproduced in Ben Amar et al. on state-dependent importance sampling.

```
agg S10
  dfreq [10]
  sev lognorm 0.6907755278982137
```

```
agg S9
  dfreq [9]
  sev lognorm 0.6907755278982137
```

and 4 more of this shape, differing only in their numbers.

Ben Rached, Hoel and Meo on the FFT accuracy floor

From Ben Rached et al. (2024), reproduced in Ben Rached, Hoel and Meo on the FFT accuracy floor.

```
agg S
  dfreq [16]
  sev lognorm 0.125
```

```
agg L
  dfreq [16]
  sev 0.1 * levy
```

Liu, Wu and Yao on k-moment tilting

From Liu et al. (2026), reproduced in Liu, Wu and Yao on k-moment tilting.

```
agg T
  dfreq [1]
  sev pareto 2.5
```

```
agg T
  dfreq [5]
  sev pareto 2.5
```

```
agg T
  dfreq [1]
  sev 1.1 * pareto 2.6
```

```
agg T
  dfreq [1]
  sev 1.2 * pareto 2.7
```

```
port Paretos
  hints{log2=22;bs=1/8;padding=1;normalize=False}
  agg P0
    dfreq [1]
    sev pareto 2.5
  agg P1
    dfreq [1]
    sev 1.1 * pareto 2.6
  agg P2
    dfreq [1]
    sev 1.2 * pareto 2.7
  agg P3
    dfreq [1]
    sev 0.9 * pareto 2.8
  agg P4
    dfreq [1]
    sev 0.8 * pareto 2.9
```

```
port P
  agg P0
    dfreq [1]
    sev pareto 2.5
  agg P1
    dfreq [1]
    sev 1.1 * pareto 2.6
  agg P2
    dfreq [1]
    sev 1.2 * pareto 2.7
  agg P3
    dfreq [1]
    sev 0.9 * pareto 2.8
  agg P4
    dfreq [1]
    sev 0.8 * pareto 2.9
```

```
port LT
  hints{log2=18;bs=1/1024;padding=1;normalize=False}
  agg C0
    dfreq [1]
    sev expon + 1
  agg C1
    dfreq [1]
    sev 0.8333333333333334 * expon + 1.1
  agg C2
    dfreq [1]
    sev 0.7142857142857143 * expon + 1.2
  agg C3
    dfreq [1]
    sev 0.6666666666666666 * expon + 0.9
  agg C4
    dfreq [1]
    sev 0.5555555555555556 * expon + 0.8
```

Jin, Provost and Ren's moment-based density approximations

From Jin et al. (2016), reproduced in Jin, Provost and Ren's moment-based density approximations.

```
agg J
  3 claims
  sev 2 * gamma 3
  poisson
```

```
agg J
  15 claims
  sev 2 * invgauss 1.5
  poisson
```

```
agg J
  50 claims
  sev 2 * gamma 3
  mixed gamma 0.3162277660168379
```

```
agg J
  50 claims
  sev 2 * invgauss 1.5
  mixed gamma 0.3162277660168379
```

```
agg J
  3 claims
  sev 100 * lomax 20
  poisson
```

```
agg J
  6 claims
  sev 100 * lomax 20
  mixed gamma 0.5773502691896257
```

```
agg NB
  50 claims
  dsev [1]
  mixed gamma 0.31622776601683794
```

```
agg U
  dfreq [1]
  sev 2 * gamma 2
```

```
agg V
  dfreq [1]
  sev 1.5 * gamma 3
```

```
agg X
  15 claims
  sev 2 * gamma 2
  poisson
```

```
agg Y
  16 claims
  sev 1.5 * gamma 3
  poisson
```

Provenance of the named severity curves

From the papers cited in Provenance of the named severity curves.

```
agg T
  1 claim
  sev lognorm 150000 cv 0.25
  fixed
```

```
agg T
  1 claim
  sev lognorm 10000 cv 4.953
  fixed
```

```
agg T
  1 claim
  sev 50000 * pareto 1.5
  fixed
```

```
agg T
  1 claim
  sev 50000 * lomax 1.5
  fixed
```

```
agg T
  1 claim
  sev 100 * lomax 20
  fixed
```

and 3 more of this shape, differing only in their numbers.

```
agg T
  1 claim
  sev gamma 6 cv 0.5774
  fixed
```

```
agg T
  1 claim
  sev 11048 * lognorm 2.29
  fixed
```

```
agg T
  1 claim
  sev chistogram xps [0 1000 5000 6000 7000 8000 9000 10000 12500 15000 17500 20000
    25000 35000 50000 75000 100000 125000 150000 175000 200000 225000 250000 300000]
    [0.38935 0.38935 0.00568 0.00543 0.00517 0.00495 0.00473 0.01098 0.00989 0.00896
    0.00815 0.01426 0.02237 0.02353 0.02459 0.01517 0.01021 0.00732 0.00547 0.00423
    0.00337 0.00274 0.0241]
  fixed
```

```
agg XPL
  1 claim
  1000000 xs 0
  sev 50000 * lomax 1.5
  fixed
```

```
agg J
  3 claims
  sev gamma 6 cv 0.5774
  poisson
```

29 chapters build 221 distinct programs between them, of which 144 are printed above and 77 are further declarations of a shape already shown.

Asmussen, S., Jensen, J. L., & Rojas-Nandayapa, L. (2016). Exponential Family Techniques for the Lognormal Left Tail. *Scandinavian Journal of Statistics*, *43*(3), 774–787. https://doi.org/10.1111/sjos.12203

Bear, R. A., & Nemlick, K. J. (1990). Pricing the impact of adjustable features and loss sharing provisions of reinsurance treaties. *Proceedings of the Casualty Actuarial Society*, *77*(147), 86–87. https://doi.org/10.1016/0167-6687(93)91078-9

Ben Amar, E., Ben Rached, N., Haji-Ali, A.-L., & Tempone, R. (2023). State-dependent importance sampling for estimating expectations of functionals of sums of independent random variables. *Statistics and Computing*. https://doi.org/10.1007/s11222-022-10202-2

Ben Rached, N., Hoel, H., & Meo, J. V. (2024). A fast and accurate numerical method for the left tail of sums of independent random variables. *Statistics and Computing*. https://doi.org/10.1007/s11222-024-10514-5

Bodoff, N. M. (2017). An Actuarial Model of Excess of Policy Limits Losses. *Variance*, *11*. https://doi.org/10.66573/001c.116059

Bruno, M. G., Camerini, E., Manna, A., & Tomassetti, A. (2006). A new method for evaluating the distribution of aggregate claims. *Applied Mathematics and Computation*. https://doi.org/10.1016/j.amc.2005.09.038

Denuit, M. M. (2019). Size-biased transform and conditional mean risk sharing, with application to p2p insurance and tontines. *ASTIN Bulletin*, *49*(3), 591–617. https://doi.org/10.1017/asb.2019.24

Denuit, M. M., Dhaene, J., Ghossoub, M., & Robert, C. Y. (2025). Comonotonicity and Pareto optimality, with application to collaborative insurance. *Insurance: Mathematics and Economics*, *120*, 1–16. https://doi.org/10.1016/j.insmatheco.2024.11.001

Denuit, M. M., Hieber, P., & Robert, C. Y. (2022). Mortality Credits Within Large Survivor Funds. *ASTIN Bulletin*, *52*(3), 813–834. https://doi.org/10.1017/asb.2022.13

Denuit, M. M., Ortega-Jiménez, P., & Robert, C.-Y. (2025). Conditional expectations given the sum of independent random variables with regularly varying densities. *ASTIN Bulletin*. https://doi.org/10.1017/asb.2025.11

Embrechts, P., & Frei, M. (2009). Panjer recursion versus FFT for compound distributions. *Mathematical Methods of Operations Research*, *69*(3), 497–508. https://doi.org/10.1007/s00186-008-0249-2

Embrechts, P., Grübel, R., & Pitts, S. M. (1993). Some applications of the fast Fourier transform algorithm in insurance mathematics. *Statistica Neerlandica*, *47*(1), 59–75. https://doi.org/10.1111/j.1467-9574.1993.tb01406.x

Gerber, H. U. (1982). On the numerical evaluation of the distribution of aggregate claims and its stop-loss premiums. *Insurance Mathematics and Economics*, *1*(1), 13–18. https://doi.org/10.1016/0167-6687(82)90016-6

Gollini, I., & Rougier, J. (2016). Rapidly bounding the exceedance probabilities of high aggregate losses. *The Journal of Operational Risk*, 1–33. https://doi.org/10.21314/JOP.2016.179

Grübel, R., & Hermesmeier, R. (1999). Computation of Compound Distributions I: Aliasing Errors and Exponential Tilting. *Astin Bulletin*, *29*(2), 197–214. https://doi.org/10.2143/AST.29.2.504611

Homer, D. L., & Clark, D. R. (2003). Insurance Applications of Bivariate Distributions. *Proceedings of the Casualty Actuarial Society*, *90*(iid), 274–307. http://www.casact.org/pubs/proceed/proceed03/03274.pdf

Jin, T., Provost, S. B., & Ren, J. (2016). Moment-based density approximations for aggregate losses. *Scandinavian Actuarial Journal*, *2016*(3), 216–245. https://doi.org/10.1080/03461238.2014.921640

Liu, Z., Wu, J., & Yao, J. (2026). Estimating tail probabilities of heavy-tailed distributions using k-moment tilting. *Operations Research Letters*. https://doi.org/10.1016/j.orl.2026.107509

Mack, T., & Fackler, M. (2003). Exposure-rating in liability reinsurance. *Blätter der DGVFM*, *26*(2), 229–238.

Mata, A. J., & Verheyen, M. A. (2005). An Improved Method for Experience Rating Excess of Loss Treaties using Exposure Rating Techniques. *CAS Forum*.

Pittarello, G., Luini, E., & Marchione, M. M. (2024). GEMAct: a Python package for non-life (re) insurance modeling. *Annals of Actuarial Science*, 1–37. https://doi.org/10.1017/S1748499524000022

Robertson, J. P. (1992). The computation of aggregate loss distributions. *Proceedings of the Casualty Actuarial Society*, *79*(150), 57–133.

Schaller, P., & Temnov, G. (2008). Efficient and Precise Computation of Convolutions: Applying FFTs to Heavy Tailed Distributions. *Computational Methods in Applied Mathematics*, *8*(2), 187–200.

Venter, G. G. (1983). Transformed beta and gamma distributions and aggregate losses. *Proceedings of the Casualty Actuarial Society*, *70*(133), 289–308.

Wang, S. S. (2000). A class of distorion operators for pricing financial and insurance risks. *Journal of Risk and Insurance*, *67*(1), 15–36.

Wang, S. S. (2002). A Universal Framework for Pricing Financial and Insurance Risks. *ASTIN Bulletin*, *32*(2), 213–234. https://doi.org/10.2143/AST.32.2.1027

Wilson, H., & Keich, U. (2016). Accurate pairwise convolutions of non-negative vectors via FFT. *Computational Statistics and Data Analysis*, *101*, 300–315. https://doi.org/10.1016/j.csda.2016.03.010

Wilson, H., & Keich, U. (2017). Accurate small tail probabilities of sums of iid lattice-valued random variables via FFT. *Journal of Computational and Graphical Statistics*, *26*(1), 223–229.