DecL Cheat Sheet for Compound Distributions

The DecL specification of an `Aggregate` compound distribution object has eight clauses:
`agg <NAME> <EXPOSURE> <LIMIT*> <SEVERITY> <OCC_RE*> <FREQUENCY> <AGG_RE*> <NOTE*>`
Key: `<INPUT>` user input(s); `lower_case` is a DecL keyword; `CLAUSE_TYPE` is a valid clause; options: `a|b|c`; `inf` for infinity; clauses marked with an asterisk are optional.

1. Name Clause

`agg <NAME>` `agg <NAME> sev <NAME> <SEVERITY>`

Name of the compound or severity.
Names match regex
`r'[a-zA-Z][\._: a-zA-Z0-9\-]*'`.
Created objects can be referenced
`agg.<NAME>` `agg <NEW_NAME> agg.<OLD_NAME>`

2. Exposure Clause

`<EXP_LOSS> loss`
`<PREMIUM> premium at <LR> lr`
`<EXPOSURE> exposure at <RATE> rate`
`<CLAIMS> claims`
`dfreq <OUTCOMES> <PROBABILITIES*>`

Outcomes entered `[1 2 3 4]` or `[2:10:2]` and probabilities `[.5 .25 1/8 1/9]` or omitted for equally likely.

3. Limit Clause (optional)

`<LIMIT> xs <ATTACHMENT>`

Occurrence limits applied to ground-up severity, unlimited reinstatements, losses conditional on attaching layer by default.

4. Severity Clause

`sev <DIST_NAME> <MEAN> cv <CV>`
`sev <DIST_NAME> <SHAPE1> <SHAPE2>`
`sev sev.<NAME>`
`dsev <OUTCOMES> <PROBABILITIES>`

`<SCALE> * SEV + <LOC>.`

`SEV splice [<LB> <UB>]` *conditional in layer*

`SEV !` *unconditional, when* `ATTACHMENT` *> 0*

5. Occurrence Reinsurance Clause

`occurrence ceded to LAYERS`
`occurrence net of LAYERS`
`LAYER=«SHARE> so> <LAYER> xs <ATTACH>`
`LAYERS=LAYER1 and LAYER2 and ...`

$0 \le$ SHARE ≤ 1 *share of (so)*

`LAYERS=tower[250 500 1000]`

Specify layer breaks, expands to `250 xs 0`, `250 xs 250`, and `500 xs 500`; ground-up layer automatically added.

6. Frequency Clause

`poisson`, `bernoulli`, `fixed`, `geometric`, `logarithmic`, `binomial <P>`, `negbin <VAR_MULT>`, `neymana <CLAIMS-PER-OCC>`, `pascal <CV> <CLAIMS-PER-OCC>`
`mixed <MIXING DIST> <SHAPE1> <SHAPE2>`
`MIXING DIST=gamma|delaporte|ig|sig|sichel|beta <CV> <VARIES>`
`FREQ zt`
`FREQ zm <P0>`

zero truncated, zero modified with $\Pr(N = 0) = p0$

7. Aggregate Reinsurance Clause

`aggregate ceded to LAYERS`
`aggregate net of LAYERS`
`aggregate (net of|ceded to) tower [<BREAKS>]`

8. Note

`note{prems op A curve, effective 1/1/2024;}`
`note{bs=100; log2=17; normalize=False}`

Add hints for updating; split on semicolon then split on equals.

9. Vectorization

Exposure clause
`[1 2 3] claims`
`[100 200 300] loss`
`[100 200 300] premium at [.8 .7 .65] lr`
Layers clause
`[250 250 500] xs [0 250 500]` *zip layers*
Severity clause
`[1 3] * expon 1 wts [.6 .4]`
`[1 3] * [gamma lognorm] [4 1.25] wts [.6 .4]`
`100 * lognorm [.75 1.5] wts [.6 .4] slice [0 200 inf] 100 * lognorm [.5 .75 1.5] wts [.4 .4 .2] slice [0 0 200] [200 200 inf]`
Vectors are broadcast; layers, exposure etc. are zipped.

10. Mathematical Expressions

Only division, exponentiation, and exponential allowed
`123`, `12.34e2`, `-12.4e-5`, `-12.0`, `12.4%`
`1/2`, `3**4`, `exp(2)`
Scale factor for lognormal μ, σ entered as `exp(mu)/exp(sigma**2/2)`.
Warning: *minus binds to the number:* $-4^2 = (-4)^2 = 16$*; there is no unary minus.*

`aggregate v.0.20.0`
Confidence and precision meets ease of use in actuarial analysis

`Aggregate` Class Cheat Sheet

Ⓜ `Aggregate(name, exp_el=0, exp_premium=0, exp_lr=0, exp_en=0, exp_attachment=None, exp_limit=np.inf, sev_name='', sev_a=np.nan, sev_b=0, sev_mean=0, sev_cv=0, sev_loc=0, sev_scale=0, sev_xs=None, sev_ps=None, sev_lb=0, sev_ub=np.inf, sev_wt=1, sev_conditional=True, occ_reins=None, occ_kind='', freq_name='', freq_a=0, freq_b=0, freq_zm=False, freq_p0=np.nan, agg_reins=None, agg_kind='', note='')`[0]

The `Aggregate` call signature follows the corresponding DecL clauses, using prefixes for exposure (including limit sub-clause), severity, occurrence reinsurance, frequency, aggregate reinsurance, and note. `sev_xs`, `sev_ps` equal `dsev` outcomes and probabilities, and `(occ|agg)_reins` clauses are lists of (share, limit, attachment) triples. The following tables show all Ⓜ `methods`, and fields or properties (used interchangeably). Comments elucidate the meaning of more obscure entries.

1. Specification & creation

`name`, `limit`, `attachment`, `freq_name`, `freq_a`, `freq_b`, `freq_p0`, `freq_zm`, `note`, `sev_pick_attachments`, `sev_pick_losses`, `program` (DecL program), `pprogram` (pretty printed), `spec` (constructor kwarg dictionary; `Aggregate(**spec)` re-creates the object), `spec_ex` (adds meta elements)

2. Update

`log2`, `bs`, `sev_calc` (discrete=round, forward, backwards), `discretization_calc` (distribution, survival, both), `normalize`, `padding`, `tilt_vector`, `approximation` (exact, slognorm, sgamma), `fzapprox` (frozen approximation rv), Ⓜ `picks`, Ⓜ `discretize`, Ⓜ `easy_update`, Ⓜ `recommend_bucket`, Ⓜ `rescale` (homogeneous severity or inhomogeneous frequency rescaling), Ⓜ `update`, Ⓜ `update_work`

3. Moments

`est` prefix=estimated from FFT approximation

`agg_m`, `agg_cv`, `agg_sd`, `agg_var`, `agg_skew`, `est_m`, `est_cv`, `est_sd`, `est_var`, `est_skew`, `sev_m`, `sev_cv`, `sev_sd`, `sev_var`, `sev_skew`, `est_sev_m`, `est_sev_cv`, `est_sev_sd`, `est_sev_var`, `est_sev_skew`, Ⓜ `freq_moms`, Ⓜ `freq_pmf`, Ⓜ `freq_pgf`, `panjer_ab` (Panjer parameters), Ⓜ `prn_eq_0` (Pr($N = 0$) unmodified), `n` (frequency), `en` (vector), `unmodified_mean` (when ZT or ZM)

4. Statistical functions

`sevs` (list of `Severity`s), Ⓜ `cdf`, Ⓜ `sf` (survival), Ⓜ `pdf`, Ⓜ `pmf`, Ⓜ `q` (lower quantile=VaR), Ⓜ `tvar`, Ⓜ `sev` (exact severity cdf, sf, pdf), Ⓜ `q_sev`, Ⓜ `tvar_sev`, Ⓜ `var_dict`[1], Ⓜ `sample`

5. Validation

`describe` (validation statistics), `valid` (true="not unreasonable" or false), `validation_eps` (validation epsilon threshold 1e-04), Ⓜ `qt` ("quick test" validation details), Ⓜ `aggregate_error_analysis` (agg errors over range of bs), Ⓜ `severity_error_analysis` (truncation and discretization errors by severity component)

6. Output dataframes

`density_df`[1] (main output), `report_df` (component, mixture & empirical stats), `agg_density`, `agg_density_ceded`, `agg_density_gross`, `agg_density_net`, `sev_density`, `sev_density_ceded`, `sev_density_gross`, `sev_density_net`, `ftagg_density`, `xs`, `statistics_df` (row, by component), `statistics_total_df` (row, indep. vs. mixed), `statistics` (cols, combined, better index), `audit_df` (deprecated), `report_ser` (internal, series), *see also Reinsurance.*

7. Reinsurance

`agg_kind` (net of or ceded to), `agg_reins` (list), `agg_reins_df` (gcn loss and dists), `occ_kind`, `occ_reins`, `occ_reins_df`, Ⓜ `agg_ceder`, Ⓜ `agg_netter`, Ⓜ `apply_agg_reins`, Ⓜ `occ_ceder`, Ⓜ `occ_netter`, Ⓜ `apply_occ_reins`, Ⓜ `reinsurance_description` (text rendering of re), `reinsurance_kinds` (None, occ, agg, or both), `reinsurance_audit_df` (stats by gcn, split severity for occ), `reinsurance_occ_layer_df` (aggregate gcn stats for occ layers), `reinsurance_df` (all combinations of gcn occ and agg densities), `reinsurance_report_df` (m, cv, sd, skew for `reinsurance_df`)

8. Visualization

Ⓜ `plot`, Ⓜ `reinsurance_occ_plot figure` (return last figure), Ⓜ `limits` (suggest axis limits for plotting),

9. Risk and pricing

Ⓜ `apply_distortion`, Ⓜ `price(p, dist)` Ⓜ `cramer_lundberg aka pollaczeck_khinchine` (probability of eventual ruin vs. initial capital and margin)

10. Approximations

Method of moments (shifted gamma or lognormal), or minimum entropy approximations.

Ⓜ `approximate`, Ⓜ `entropy_fit`

11. Meta

`aggregate_keys` (internal), Ⓜ `more(regex)` (print all methods and fields matching `regex`), `info` (text meta info), Ⓜ `html_info_blob` (internal), Ⓜ `json` (persist to json), Ⓜ `snap`[1] (snap argument to index)

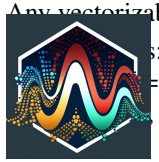
Notes:

[0]: Arguments `sev_pick_attachments=None, sev_pick_losses=None,` omitted; see help.

[1]: matches `Portfolio`

Any vectorizable input accepts numeric or iterable datatypes.

s: gcn=gross (subject), ceded, and net; stats: =coefficient of variation, sd=standard deviation, skew(ness); VaR=value-at-risk



Portfolio Class Cheat Sheet

m Portfolio(self, name, spec_list, uw=None)

The Portfolio call signature requires a name and spec_list a DecL program, a list of Aggregate objects or kwargs, or names known to the Underwriter, or a multivariate loss sample in a pandas DataFrame. The following tables show all m methods, s static methods, and fields or properties (used interchangeably). Comments elucidate the meaning of more obscure entries. Internal methods and fields are not shown.

1. Specification & creation

name *more*
spec_list *more*
uw *more*
n_units, agg_list (list of Aggregate objects), line_names, line_names_ex, unit_names (unit ← line), unit_names_ex, line_name_pipe, program (DecL program), pprogram (pretty printed), spec (constructor kwarg dictionary; Aggregate(**spec) re-creates the object), spec_ex (adds meta information), m nice_program, s from_DataFrame, s from_dict_of_aggs, s from_Excel, s create_from_sample

2. Update

log2, bs, sev_calc (discrete=round, forward, backwards), discretization_calc (distribution, survival, both), normalize, padding, tilt_amount, approx_freq_ge, approx_type (exact, slognorm, sgamma), m best_bucket, m recommend_bucket, m update, m add_exa, m add_exa_details, m add_exa_sample, m trim_df, m ft & m ift (FFT and inverse FFT), m remove_fuzz, m set_a_p

3. Moments

est prefix=estimated from FFT approximation
agg_m, agg_cv, agg_sd, agg_var, agg_skew, est_m, est_cv, est_sd, est_var, est_skew, ex

4. Statistical functions

m cdf, m sf (survival), m pdf, m pmf, m q (lower quantile=VaR), m tvar, m tvar_threshold, m var, m var_dict, m density_sample, m percentiles, m sample, m sample(_density)_compare,

5. Validation

describe (validation statistics),
valid (true=all components and total "not unreasonable" or false),
validation_eps (validation epsilon threshold 1e-04),
m audits, m uat, m uat_differential, m uat_interpolation_functions

6. Output dataframes

density_df[1] (main output),
report_df (component, mixture & empirical stats), statistics, statistics_df, audit_df, augmented_df, independent_audit_df, independent_density_df, priority_analysis_df, m make_audit_df, m make_all, m report

7. Reinsurance

None – applies at the component level

8. Visualization & exhibits

m plot, m scatter, m twelve_plot, m biv_contour_plot, m analyze_distortion_plots, m natural_profit_segment_plot, m profit_segment_plot, figure (return last figure), m limits, line_renamer, premium_capital_renamer, renamer, m short_renamer, stat_renamer, tm_renamer, m show_enhanced_exhibits, EX_accounting_economic_balance_sheet, EX_multi_premium_capital, EX_premium_capital

9. Risk and pricing

m accounting_economic_balance_sheet, m analysis_collateral, m analysis_priority, m analyze_distortion(s|_add_comps), m apply_distortion(s), assets_2_epd, m bodoff, m calibrate_blends, m calibrate_distortion(s), m cotvar, dist_ans, distortion, distortion_df, dists, epd_2_assets, m equal_risk_epd, m equal_risk_var_tvar, m gamma, m gradient, m merton_perold, m multi_premium_capital, m premium_capital, m price, m price_ccoc, m pricing_bounds, priority_capital_df, m stand_alone_pricing,

10. Approximations

m approximate, m as_severity, m collapse

11. Meta

audit_percentiles, hash_rep_at_last_update, info (text meta info), m json (persist to json), last_update, m more(regex) (print all methods and fields matching regex), m save, m snap[1] (snap argument to index)

Notes:

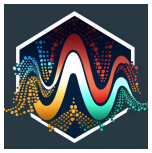
[1]: matches Aggregate

Any vectorizable input accepts numeric or iterable datatypes.

Abbreviations: gcn=gross (subject), ceded, and net; stats: m=mean, cv=coefficient of variation, sd=standard deviation, var=variance, skew(ness); VaR=value-at-risk

aggregate v.0.20.0
Confidence and precision meets ease of use in actuarial analysis

2023-07-22 18:13:56+01:00



`Severity` Class Cheat Sheet

m `Severity(name, sev_name="", sev_a=np.nan, sev_b=0, sev_mean=0, sev_cv=0, sev_loc=0, sev_scale=0, sev_xs=None, sev_ps=None, sev_wt=1, sev_lb, sev_ub, sev_conditional=True)`

The following tables show all m `methods`, and fields or properties (used interchangeably). Comments elucidate the meaning of more obscure entries.

1. Specification & creation

`name` *name for object*
`sev_name` *scipy distribution name, or* `(c|d)histogram`
`exp_attachment` *gross loss attachment or* `None`
`exp_limit` *gross loss limit* `sev_a` *shape parameter 1*
`sev_b` *shape parameter 2*
`sev_mean` *ground-up loss mean*
`sev_cv` *ground-up loss CV*
`sev_loc` *location (shift)*
`sev_scale` *scale factor*
`sev_xs` *vector of outcomes*
`sev_ps` *vector of probabilities; missing for equal likelihood*
`sev_wt` *ignored, mixing handled by* `Aggregate`
`sev_lb` *lower bound for conditional range*
`sev_ub` *upper bound*
`sev_conditional` *gross losses conditional on attaching layer (default) or unconditional*
Specify the ground-up loss, optionally converted to gross loss by the limit clause.

2. Update

m `cv_to_shape`, m `mean_to_scale`, `pattach`, `pdetach`,

3. Moments

m `generic_moment`, m `mean`, m `median`, m `moment`, m `moment_type`, m `moms`, `sev1`, `sev2`, `sev3`, m `stats`, m `std`, m `support`, m `var`,

4. Statistical functions

m `cdf`, m `entropy`, m `expect`, m `interval`, m `isf`, m `logcdf`, m `logpdf`, m `logsf`, m `nnlf`, m `pdf`, m `ppf`, m `rvs`, m `sf`, m `vecentropy`,

5. Validation

None

6. Output dataframes

None

7. Reinsurance

None

8. Visualization

m `plot`,

9. Risk and pricing

None

10. Approximations

m `fit`, m `fit_loc_scale`, m `freeze`,

11. Meta

`fz`, `random_state`, `xtol`,

Notes:

[0]: Arguments `sev_pick_attachments=None`, `sev_pick_losses=None`, omitted; see help.

[1]: matches `Portfolio`

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Abbreviations: gcn=gross (subject), ceded, and net; stats: m=mean, cv=coefficient of variation, sd=standard deviation, var=variance, skew(ness); VaR=value-at-risk

`aggregate v.0.20.0`
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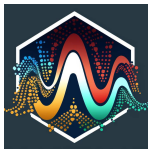

`Underwriter` Class Cheat Sheet

m `Underwriter(name='Rory', databases=None, update=False, log2=10, debug=False)`

The `Underwriter` call signature lists DecL program databases to pre-load (e.g. test_suite or site specific severity curves and aggregate distributions). The following tables show all m `methods`, and fields or properties (used interchangeably). Comments elucidate the meaning of more obscure entries.

1. Specification & creation

`name` *asdf*
`databases` *name or list of names of severity curves and aggregate DecL files to pre-load*
`update` *update (calculate probabilities) created objects with default settings*
`log2` *default number of buckets for discretization*
`debug` *asdf*

2. Update

`knowledge`, `lexer`, `log2`, `parser`, m `read_database`, m `read_databases`, m `safe_lookup`, `update`, m `write`, m `write_from_file`,

3. Moments

None

4. Statistical functions

None

5. Validation

m `interpret_program`, m `interpreter_file`, m `interpreter_line`, m `interpreter_list`, m `interpreter_test_suite`, m `test_suite`,

6. Output dataframes

None

7. Reinsurance

None

8. Visualization

None

9. Risk and pricing

None

10. Approximations

None

11. Meta

m `build`, `case_dir`, `databases`, `debug`, `default_dir`, m `dir`, m `factory`, m `logger_level`, m `more`, `name`, m `qlist`, m `qshow`, m `show`, `site_dir`, `template_dir`, `test_suite_file`, `version`,

Notes:

[0]: Arguments `sev_pick_attachments=None`, `sev_pick_losses=None`, omitted; see help.

[1]: matches `Portfolio`

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Abbreviations: gcn=gross (subject), ceded, and net; stats: m=mean, cv=coefficient of variation, sd=standard deviation, var=variance, skew(ness); VaR=value-at-risk

`aggregate v.0.20.0`
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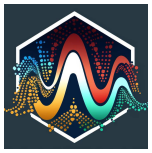

`Distortion` Class Cheat Sheet

m `Distortion(name, shape, r0=0.0, df=None, col_x='', col_y='', display_name='')`

The following tables show all m `methods`, and fields or properties (used interchangeably). Comments elucidate the meaning of more obscure entries.

1. Specification & creation

`name` it name
`shape` it name
`r0` it name
`df` it name
`col_x` it name
`col_y` it name
`display_name` it name
Create using DecL
`distortion <NAME> <DIST_NAME> <SHAPE>`
`DIST_NAME=ccoc|ph|wang|dual|tvar`
m `average_distortion`, `col_x`, `col_y`, `df`, `display_name`, m `distortions_from_params`, `has_mass`, `mass`, `name`, `premium_target`, `r0`, m `s_gs_distortion`, `shape`,

2. Update

m `bagged_distortion`, `error`,

3. Moments

None

4. Statistical functions

m `g`, m `g_dual`, m `g_inv`, m `g_prime`, m `wtd_tvar`,

5. Validation

m `test`,

6. Output dataframes

None

7. Reinsurance

None

8. Visualization

m `plot`,

9. Risk and pricing

m `price`, m `price2`,

10. Approximations

None

11. Meta

m `available_distortions`, m `convex_example`, `renamer`,

Notes:

[0]: Arguments `sev_pick_attachments=None`, `sev_pick_losses=None`, omitted; see help.

[1]: matches `Portfolio`

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Abbreviations: gcn=gross (subject), ceded, and net; stats: m=mean, cv=coefficient of variation, sd=standard deviation, var=variance, skew(ness); VaR=value-at-risk