A Portfolio Model for Natural Catastrophe Reinsurance

Experience using Ada and the GNAT programming environment

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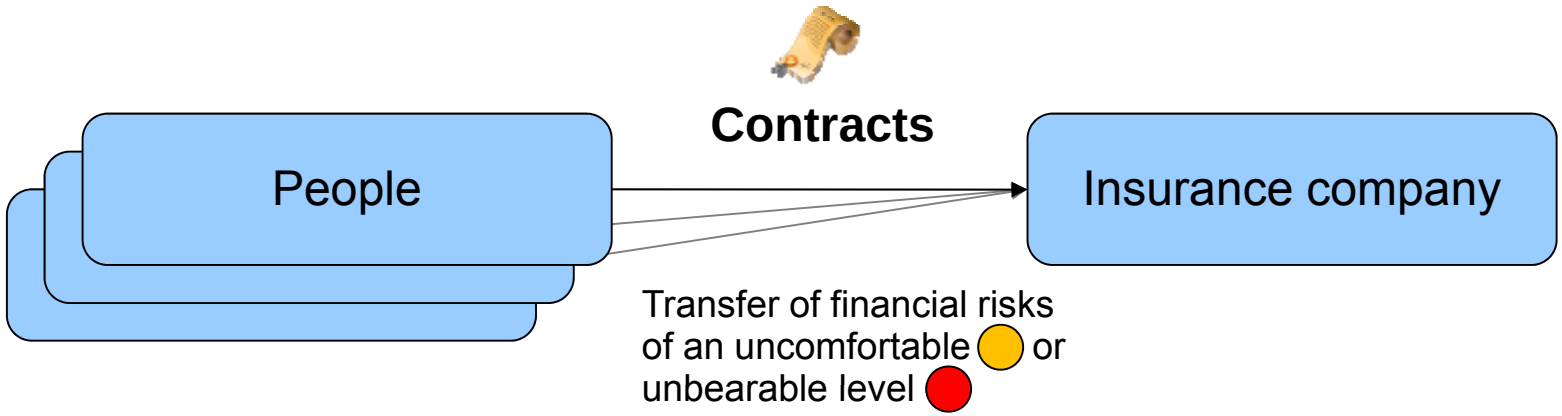
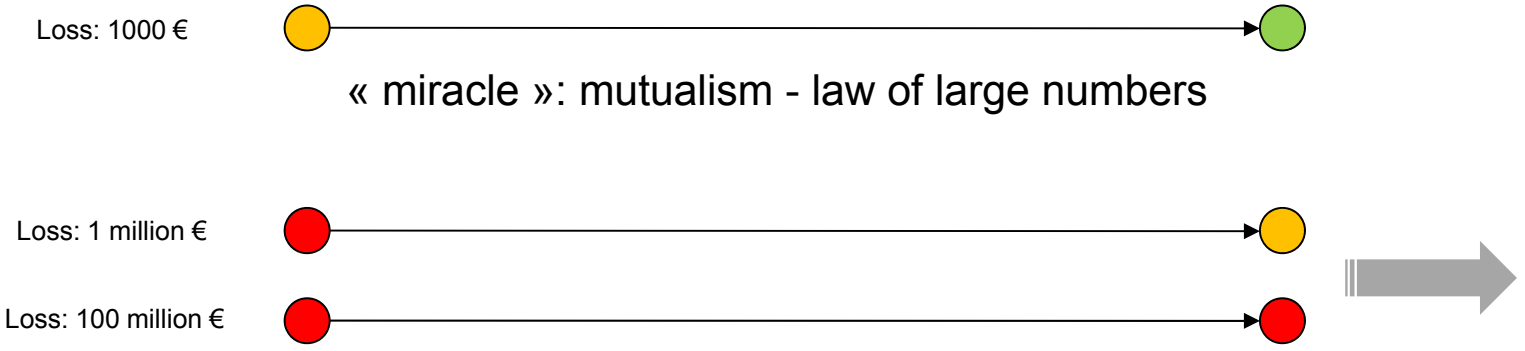
What is reinsurance ?





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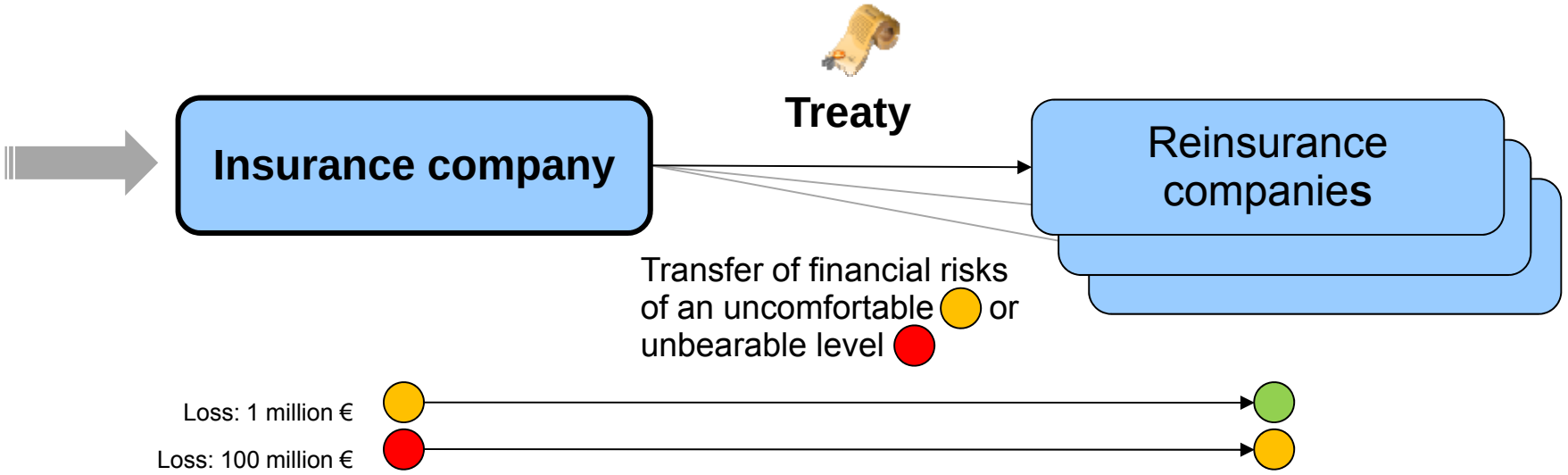
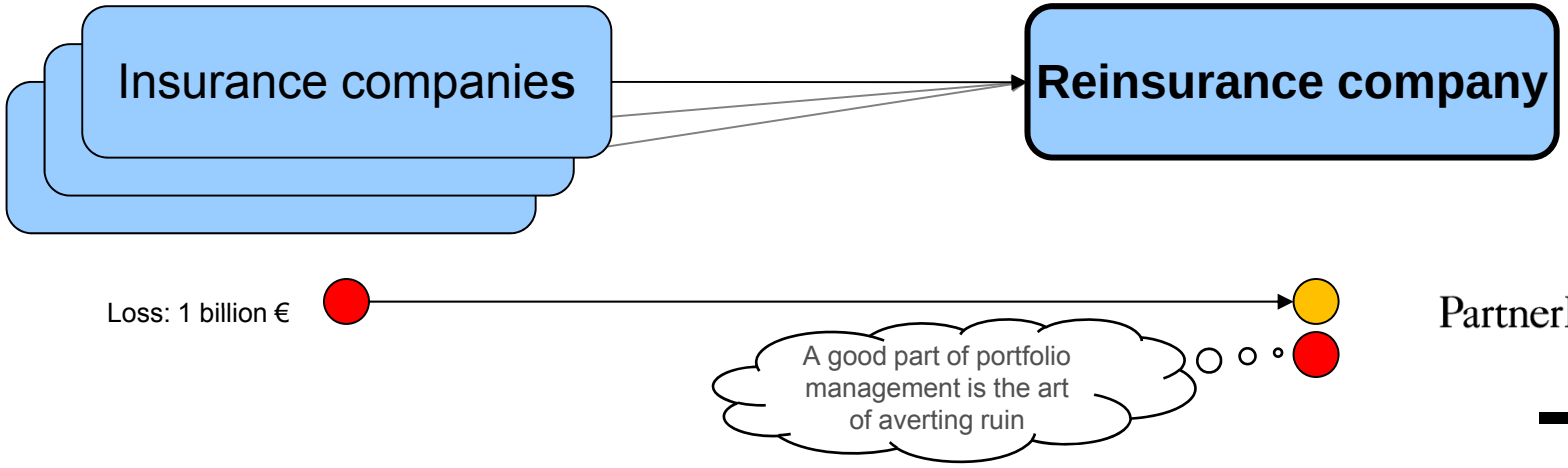
What is reinsurance ? (continued)



Portfolio of treaty shares



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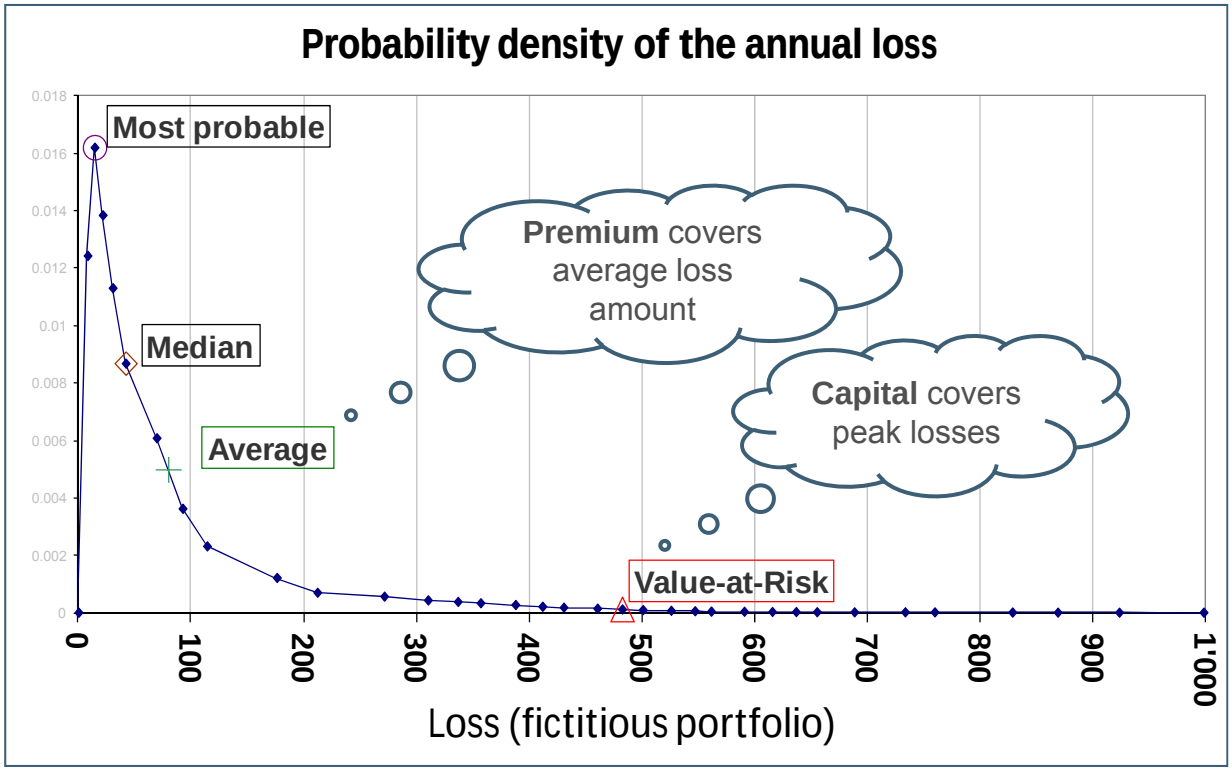
Use of Portfolio Modelling

1. Compute how much **risk-based capital** is needed.



Worldwide Catastrophe loss distribution

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Use of Portfolio Modelling (continued)

2. Quantify **diversification** and **profitability** over regions and types of perils (~400 peril zones)
3. Consider dependencies

→ **Large probabilistic model**

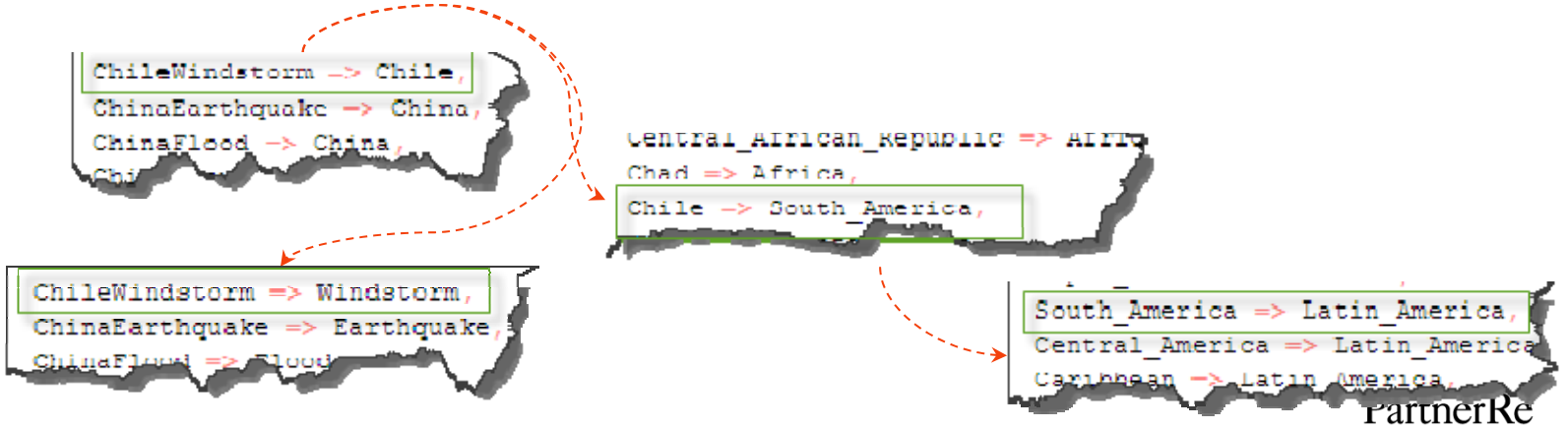
Active use, beyond reporting: **portfolio planning and optimization.** Goal: reduce the capital at risk while keeping a certain volume of business and profitability

How did portfolio optimization cross Lady Ada's way ?

- Portfolio optimization initiative started 2007
- **Idea: genetic algorithm** with random mutations (recent addition: selection) of a portfolio
- **Problem:** the software available in 2007 could not be used for that: 1/2 hour to load a portfolio, > 1/2 hour to compute a single portfolio
- Fall-back, at that time, was to consider over-simplified portfolios, or script an external software (slow *and* over-simplified) 
- **Solution**…

Portfolio optimization & Lady Ada (continued)

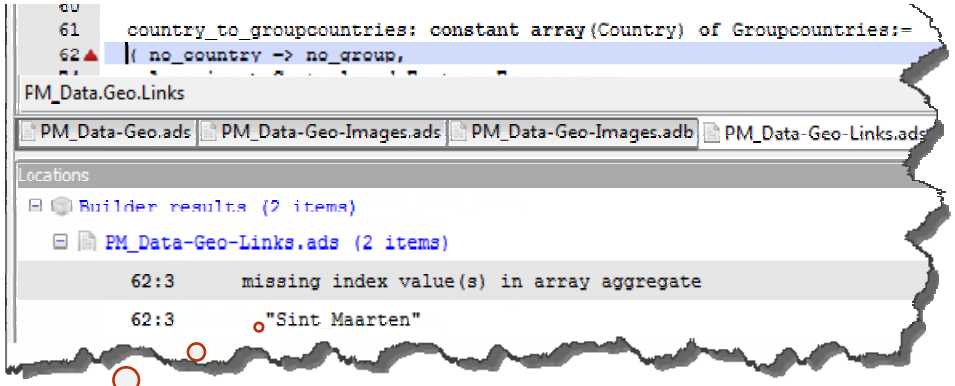
- **Solution:** write a new model from scratch with run-time performance *and* easy maintenance in mind
- **Precomputation**. Furthermore: move **run-time** effort to **compile-time** effort. Embed **constant data** (esp. geography).
- From database to source code: enumerated types (type PerilZone: more than 4000 items!) and arrays with initialized data in an arbitrary, human-readable order:



Data embedded in source code

- Maintenance of data as source **without** Ada: would be more difficult than in a database, or would need to be at least backed by a database (SQL scripts to regenerate sources)
- Maintenance **with** Ada: easier than in a database. Source code generation had to be done only once, in 2007.

Real example of maintenance change:



New country, from the ex-NL Antilles

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Data embedded in source code (continued)

Gain:

- performance: thousands-fold *), portfolio is loaded within a second
- code safety (language rules on arrays and case statements)
- data safety: any error in data is caught – would pass through, in SQL

The number-crunching side…

- Monte-Carlo simulation to compute each portfolio
- Matrix computations for getting correlations into random vectors
- Choice of platform: native; and compiler: GNAT, with optimized machine code generation

Gain in performance: 20x*) : a whole portfolio is computed in < 2 minutes

- Possibility of not using access types (pointers, reference types) !

→ faster **and** safer – unusual with IT!

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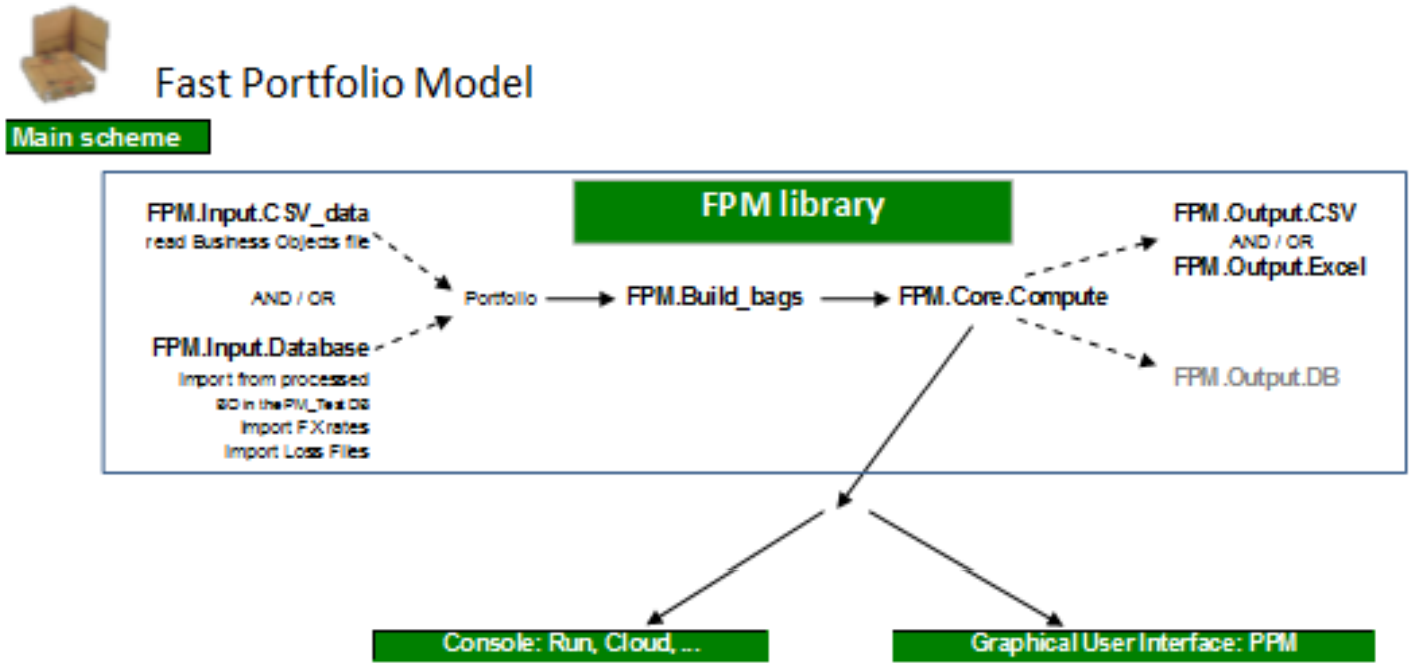
*) Compared to the previous generation of the Portfolio Model

Fast Portfolio Model architecture



type Portfolio_data → type Portfolio

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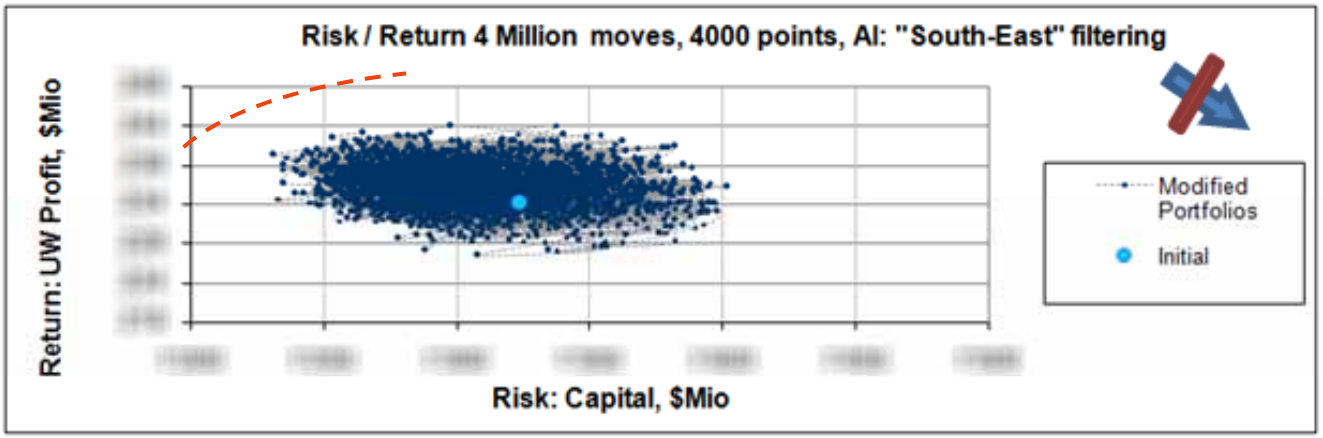
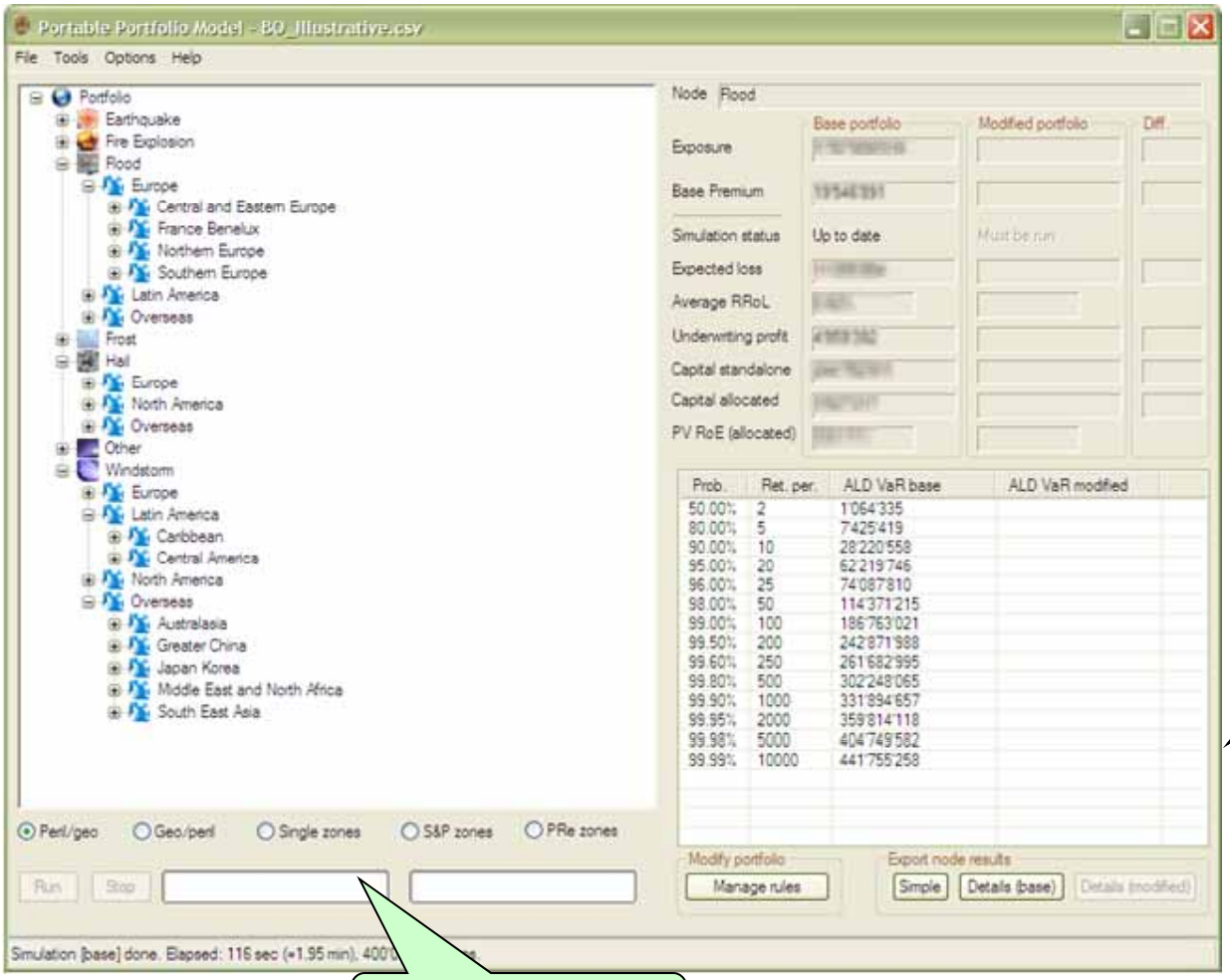
Out of the factory: Portfolio Optimizer



- **Mutation** of a portfolio by moving exposure from a peril zone to another one, all by rescaling treaty shares (must stay realistic)
- **Selection** rule: reject variants with more risk and less profit

Out of the factory: the Portable Portfolio Model



100% made with free, open-source components: GNAT GPL, GWindows, Excel Writer, database lib, math libs…

Multicore

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Portable Portfolio Model (continued)

```
package PPM_Main.Daemons is

  task Status_display is
    entry Start;
    entry Display(pw: in out PPM_Main.Main_window_type);
    entry Stop;
  end;

  task type Simulation_type is
    entry Start;
    entry Run(pw: in out PPM_Main.Main_window_type; vers: PF_Version);
    entry Stop;
  end;

  Simulation: array(PPM_Main.PF_version) of Simulation_type;

end PPM_Main.Daemons;
```

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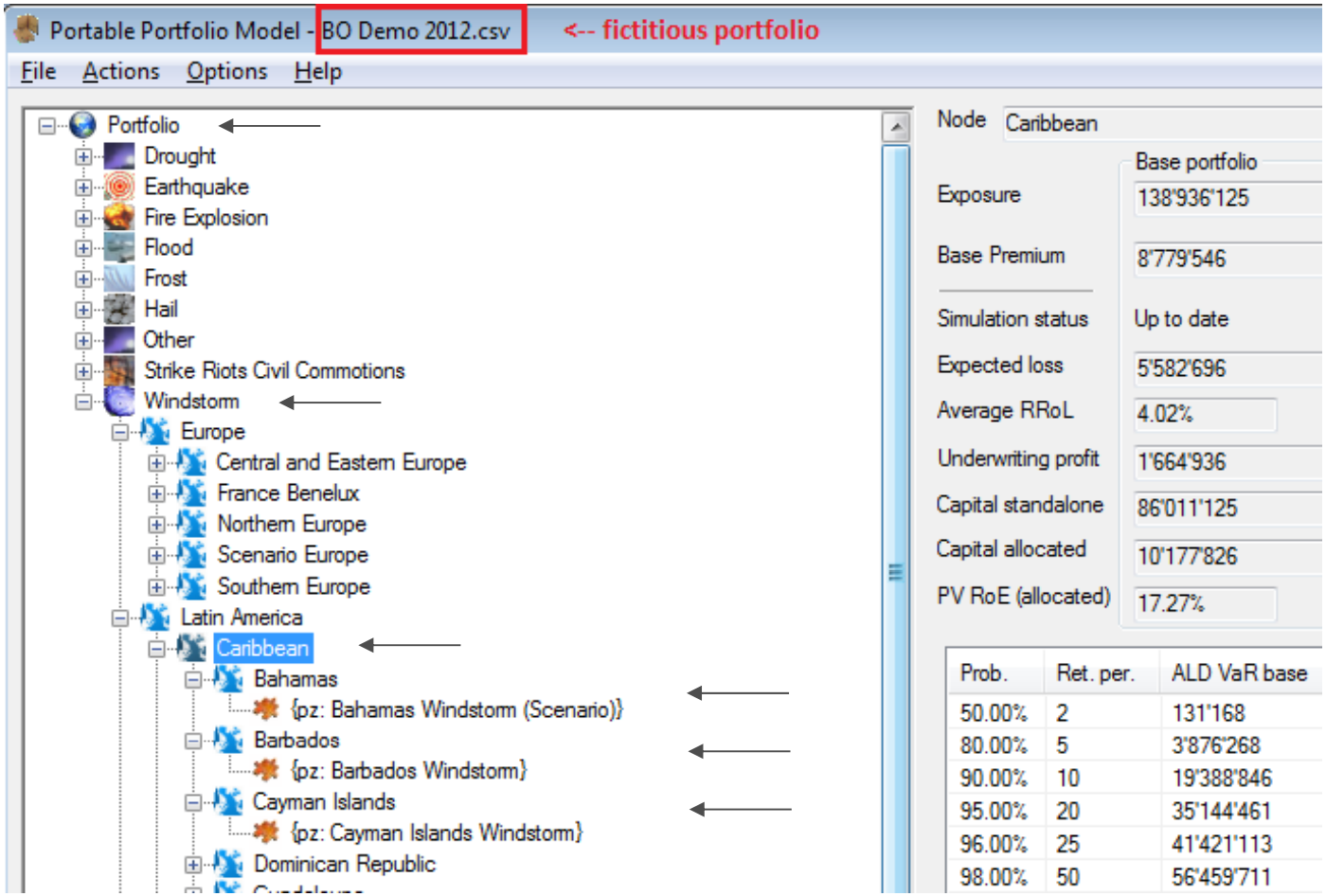
Portable Portfolio Model (continued)



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