# The “ChainLadder” package - Insurance claims reserving in R

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# Agenda

- Motivation / Background
- Current status of the "ChainLadder" package
- Example - The Mack chain ladder method
- Next steps

## Insurer’s product is a promise of unknown costs

- Insurers sell the promise to pay for future claims occurring over an agreed period for an upfront received premium
- Unlike other industries insurers don’t know the production cost of their product
- The estimated future claims have to be held in the reserves, one of the biggest liability items on an insurer’s balance sheet

## Reserving in insurance

- Reserves cover IBNR (Incurred But Not Reported) claims
- Reserves are usually estimated based on historical claims payment/reporting patterns
- The most popular method is called "chain ladder"
- In the past a point estimator for the reserves was sufficient
- New regulatory requirements ($\rightarrow$ Solvency II) foster stochastic methods



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## Current situation

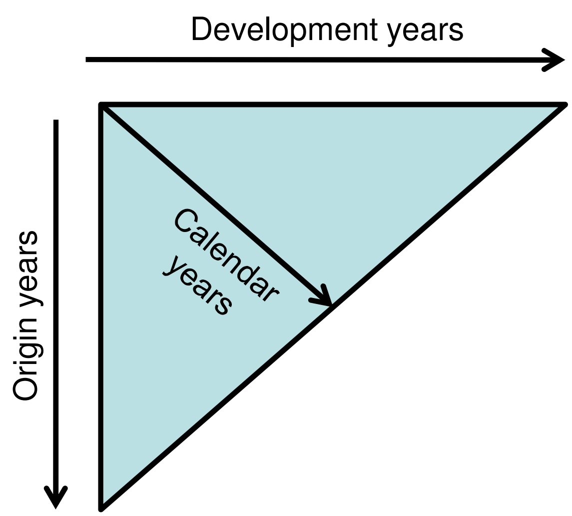
- Over recent years stochastic methods have been developed and published, but have been rarely used in practise
- Excel is still the standard tool in the industry, but is not an ideal environment for implementing those stochastic methods
- The number of R users in the insurance market has grown over recent years
- **Idea**: Use R to implement stochastic reserving methods, and CRAN to distribute them
- Use the RExcel Add-in as a front end for Excel

# The ChainLadder package for R

- Started out of presentations given at the Institute of Actuaries on stochastic reserving
- Mack-, Munich-chain ladder implemented, Bootstrap and Log-normal model in experimental stage
- Spreadsheet shows how to use the functions within Excel using the RExcel Add-in
- Available from CRAN
- Home page: http://code.google.com/p/chainladder/
- Contributions most welcome!

## Example

- Usually an insurance portfolio is split into 'homogeneous" classes of business, e.g. motor, marine, property, etc.
- Policies are aggregated by class and looked at in a triangle view of cumulative or incremental paid and reported claims



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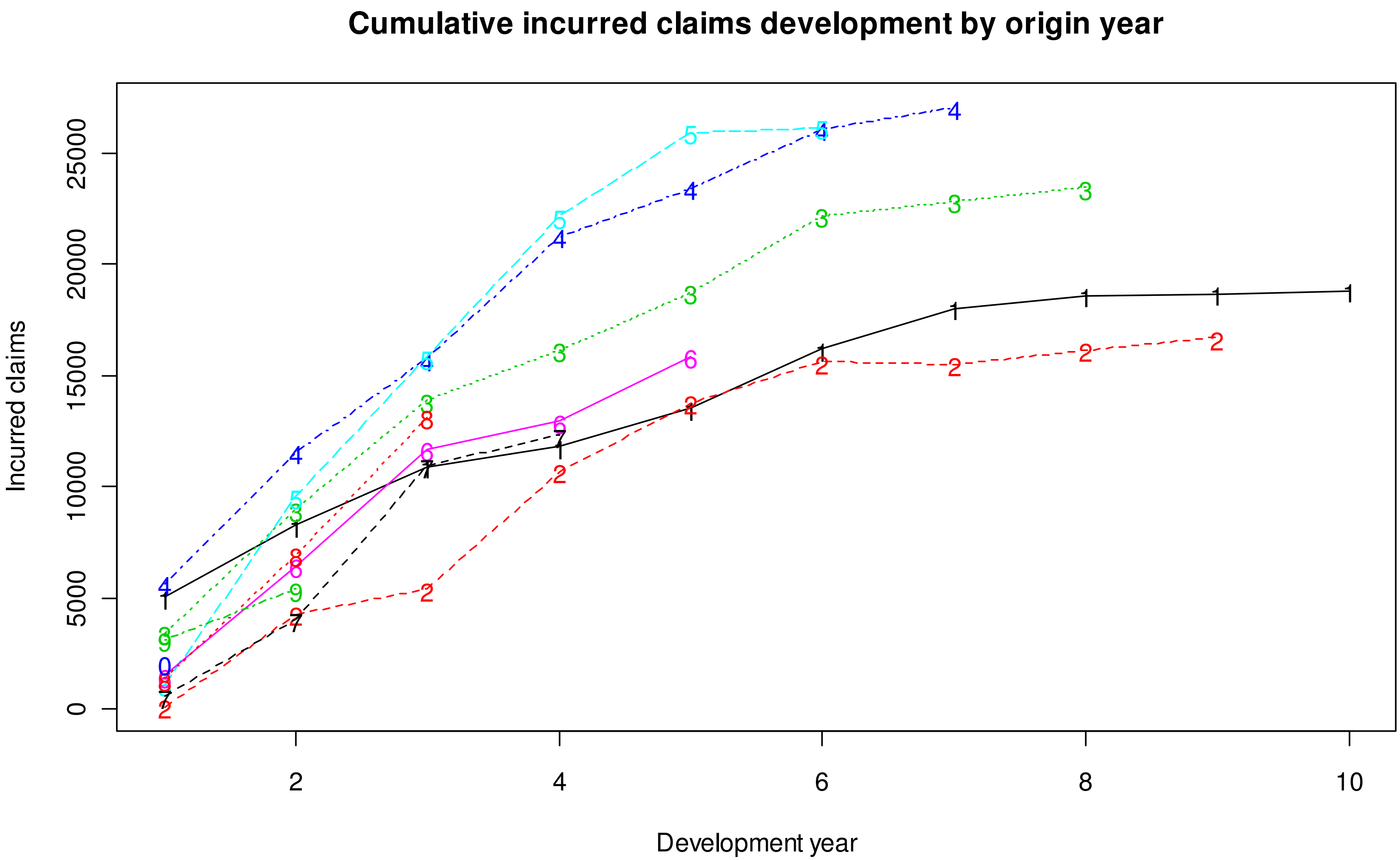
# Example of a development triangle

- Start with an aggregate cumulative reported claims development triangle $C_{ik}$

```
> library(ChainLadder)
> RAA
      dev
origin    1     2     3     4     5     6     7     8     9    10
  1981 5012  8269 10907 11805 13539 16181 18009 18608 18662 18834
  1982  106  4285  5396 10666 13782 15599 15496 16169 16704    NA
  1983 3410  8992 13873 16141 18735 22214 22863 23466    NA    NA
  1984 5655 11555 15766 21266 23425 26083 27067    NA    NA    NA
  1985 1092  9565 15836 22169 25955 26180    NA    NA    NA    NA
  1986 1513  6445 11702 12935 15852    NA    NA    NA    NA    NA
  1987  557  4020 10946 12314    NA    NA    NA    NA    NA    NA
  1988 1351  6947 13112    NA    NA    NA    NA    NA    NA    NA
  1989 3133  5395    NA    NA    NA    NA    NA    NA    NA    NA
  1990 2063    NA    NA    NA    NA    NA    NA    NA    NA    NA
```

# Example of a development triangle



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# The chain ladder algorithm

- $C_{ik}$ : cumulative loss amount of origin year 1,...,n
- Losses are know for $k \leq n+1-i$
- Forecast $\hat{C}_{ik}$ for $k > n+1$ with

$$\hat{C}_{i,k+1} = \hat{C}_{ik}\hat{f}_k \text{ and}$$

$$\hat{f}_k = \frac{\sum_{j=1}^{n-k} C_{j,k+1}}{\sum_{j=1}^{n-k} C_{jk}}$$

Chain ladder ratios – volume weighted average

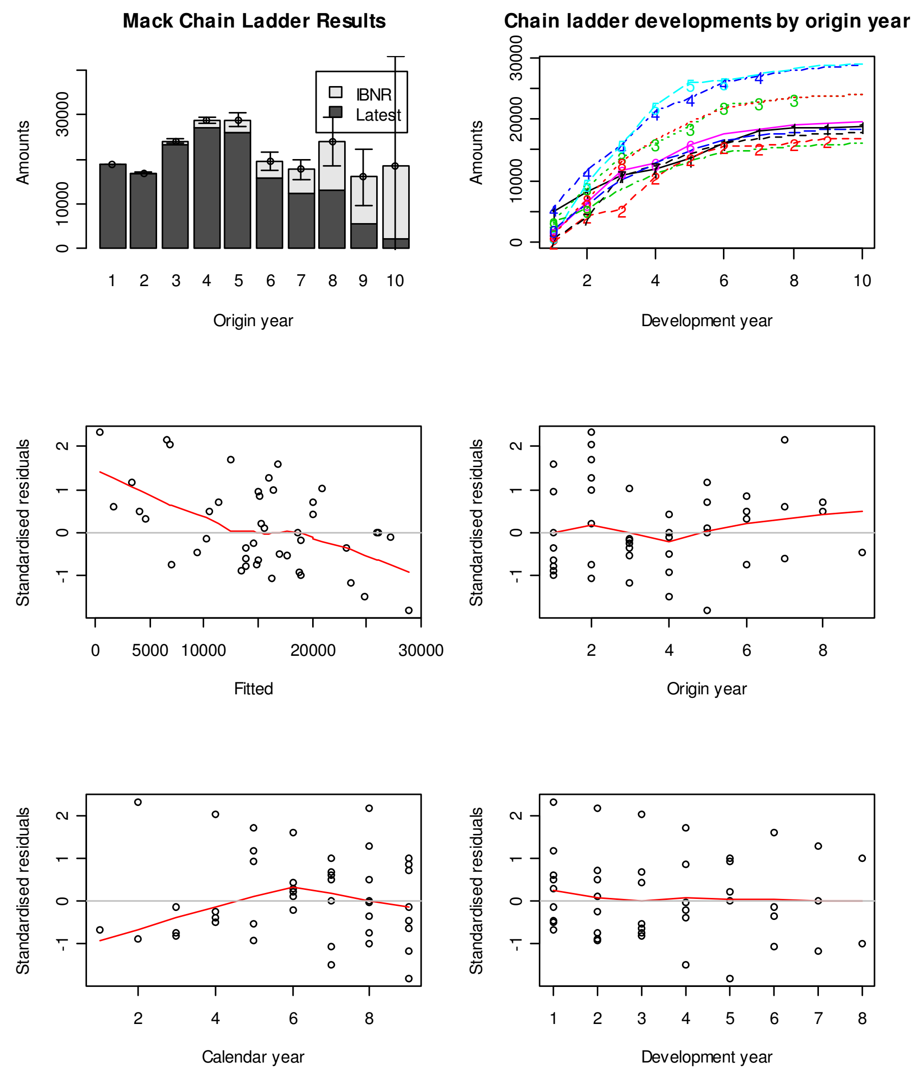
# The Mack chain ladder method

- The Mack chain ladder method [1,2] allows under certain assumptions to estimate the ultimate loss and the standard error around it
- It is straightforward in R to implement it, as the chain ladder method can be regarded as a linear regression through the origin [3]

```
# Chain ladder ratio for development step 1
x <- Triangle[1:(n-1),1]; y <- Triangle[1:(n-1),2]
chainladder.model <- lm(y~x+0, weights=1/x)
coef(chainladder.model )
2.999359
```

# MackChainLadder - Example

```
> library(ChainLadder)
> MCL <- MackChainLadder(RAA)
> plot(MCL)
```




```
> MCL
   Latest Dev.To.Date Ultimate   IBNR Mack.S.E   CoV
1981 18,834       1.000   18,834      0        0   NaN
1982 16,704       0.991   16,858    154      143 0.928
1983 23,466       0.974   24,083    617      592 0.959
1984 27,067       0.943   28,703  1,636      713 0.436
1985 26,180       0.905   28,927  2,747    1,452 0.529
1986 15,852       0.813   19,501  3,649    1,995 0.547
1987 12,314       0.694   17,749  5,435    2,204 0.405
1988 13,112       0.546   24,019 10,907    5,354 0.491
1989  5,395       0.336   16,045 10,650    6,332 0.595
1990  2,063       0.112   18,402 16,339   24,566 1.503

                 Totals:
Sum of Latest:   160,987
Sum of Ultimate: 213,122
Sum of IBNR:      52,135
Total Mack S.E.:  26,881
Total CoV:            52
```

# Next steps

- Implement further stochastic reserving methods, see for example [4]
  - The bootstrap and log-normal methods are in an experimental stage
- Provide more diagnostic tools to verify the model assumptions
- Advertise R as the ideal language for knowledge transfer for stochastic reserving methods

# Refernces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4. P.D.England and R.J.Verrall, Stochastic Claims Reserving in General Insurance, British Actuarial Journal, Vol. 8, pp.443-544, 2002.

5. Gerhard Quarg and Thomas Mack. Munich Chain Ladder. Blätter DGVFM 26, Munich, 2004.

6. Nigel De Silva. An Introduction to R: Examples for Actuaries. Actuarial Toolkit Working Party, version 0.1 edition, 2006. http://toolkit.pbwiki.com/RToolkit.

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- Steady state.
- Accelerated growth.
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