d-fine

defining d-fine

XXXIX Heidelberg Physics Graduate Days

Heidelberg, October 9th, 2017

Dr Jörn Rank
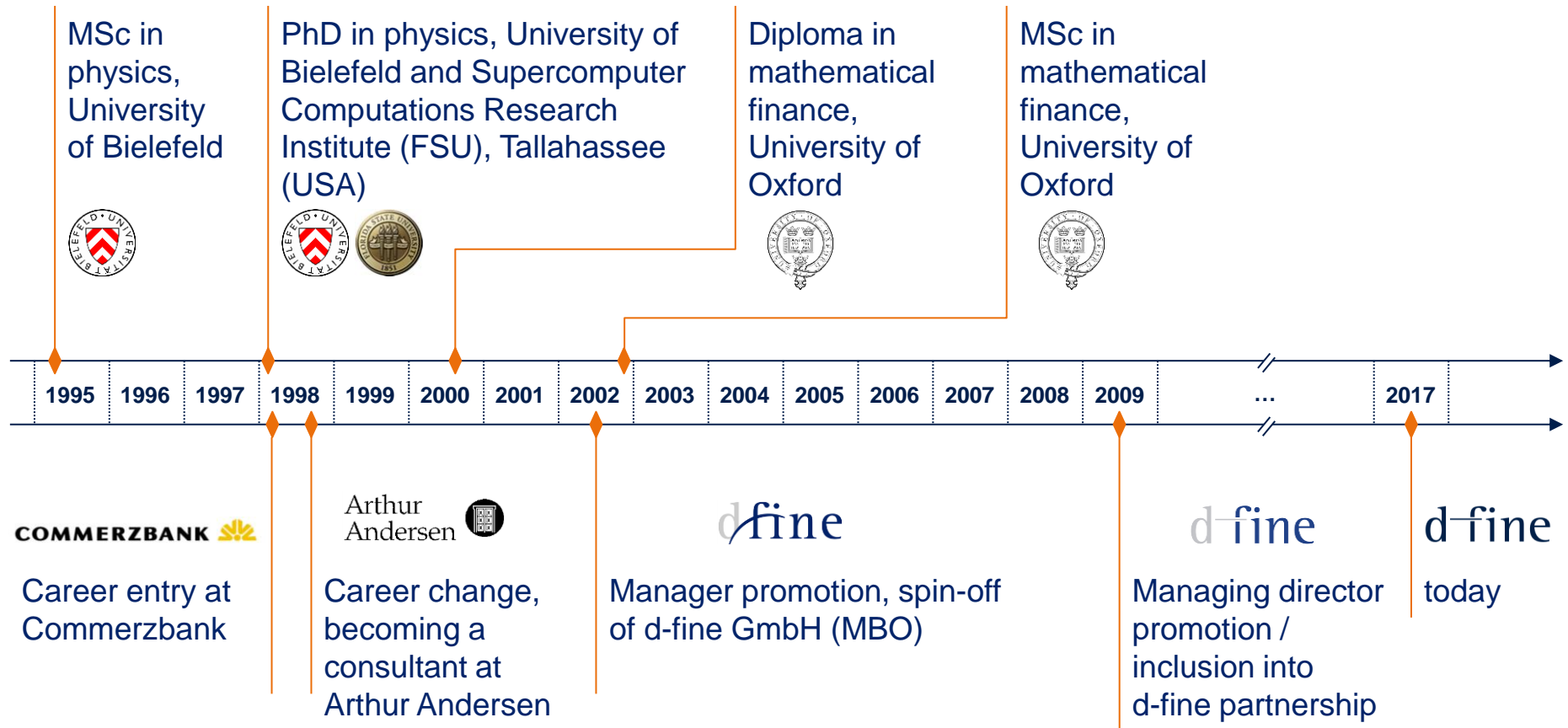
MSc in physics, University of Bielefeld

PhD in physics, University of Bielefeld and Supercomputer Computations Research Institute (FSU), Tallahassee (USA)

Diploma in mathematical finance, University of Oxford

MSc in mathematical finance, University of Oxford

| 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | … | 2017 |

COMMERZBANK

Arthur Andersen

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Career entry at Commerzbank

Career change, becoming a consultant at Arthur Andersen

Manager promotion, spin-off of d-fine GmbH (MBO)

Managing director promotion / inclusion into d-fine partnership

today

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Agenda today

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Why we exist

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Various developments in the financial world lead to a high demand for advice

Trends in finance

Relevant trends

» Regulatory requirements
   › Increasing requirements for measuring and reporting of market, credit, liquidity and operational risks
   › Regulatory reporting (AnaCredit, BCBS 239)
   › Market value-driven accounting (IFRS)

» High competitive pressure
   › Declining profit margins, controlled acquisition of risks

» Increasing functional and mathematical complexity
   › Products (complex derivatives) and models
   › Risk measurements, control procedures

» IT development
   › Prerequisite for increasing complexity of products
   › Big Data: Machine Learning, Text Analytics, …
   › Digitalization and FinTech topics, e.g. Blockchain

Results

» Building business functionalities

» (Further) development of risk / return strategies

» Development and implementation of mathematical models and methods

» Implementation through use of information technology and design of organizational processes

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Who we are

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d-fine in a nutshell (1 / 2)

» With **more than 600 professionals** and offices in Frankfurt, Munich, London, Vienna, and Zurich, d-fine is one of the leading providers for **quantitative** and **technically demanding** projects.

» In Germany, d-fine belongs to the **Top 10 Management Consulting Firms** [1] since 2005.

» d-fine is listed by kununu.com as **Top Company** und **Open Company** [2].

| Top 10 der deutschen Managementberatungen				
Unternehmen, die ihren Hauptsitz sowie die Mehrheit des Grund- und Stammkapitals in Deutschland haben.	Gesamtumsatz in Mio. Euro		Mitarbeiterzahl insgesamt	
	2016	2015	2016	2015
1 Roland Berger Holding GmbH, München *) 1)	>500,0	>500,0	2.400	2.300
2 Simon-Kucher & Partners Strategy Consultants GmbH, Bonn	240,0	208,0	935	820
3 zeb.rolfes.schierenbeck.associates GmbH, Münster	190,0	180,0	860	841
4 Horváth (Horváth & Partners-Gruppe), Stuttgart	152,0	132,0	634	570
5 KPS Unterföhring	144,9	122,9	417	354
erior AG, München	131,0	104,0	459	438
7 d ine GmbH, Frankfurt am Main	125,7	115,2	669	610
sche Consulting Gruppe, Bietigheim-Bissingen	116,5	103,6	407	385
9 Kienbaum Consultants International GmbH, Köln	108,0	110,0	630	650
10 goetzpartners Group, München	100,7	90,0	309	280

(1) see Lünendonk ® list as of May 24th, 2017   (2) see kununu.com as of May 30th, 2017

d-fine in a nutshell (2 / 2)

» We help **banks, asset managers, insurance companies, industrial corporations, hedge funds** and **supervisory organizations** with all **trading, risk management, asset/liability, loan management** and **back office projects**

  › From A to Z, from first strategic ideas to industry-strength solutions

  › From mathematical modelling to business process implementations

  › From retail and corporate loans to exotic credit and equity derivatives

  › From internal market risk models to IFRS

  › From capital allocation to risk-adjusted portfolio management

  › From internal rating systems to fully fledged Basel III and Solvency II implementations
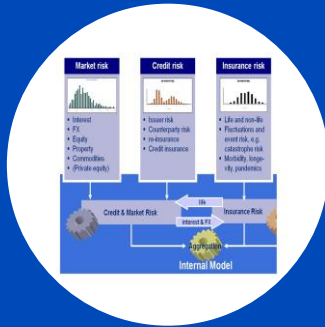
  › From business analysis to project management

d-fine is actually the leader within some of these specialized areas

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Our services
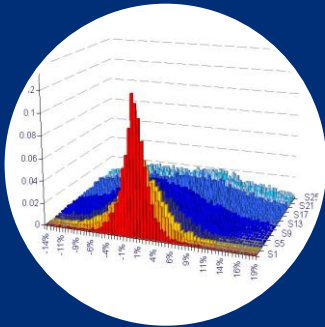
Valuation / Models
- Development and validation of models for valuation and hedging of derivatives
- Rating methodologies
- Calculation and profit testing of insurance rates

Risk Management
- Development of risk models and control procedures
- Realization of regulatory requirements, e.g.
- Solvency II, Basel III or EMIR and REMIT
- Audits with focus on mathematical and regulatory aspects
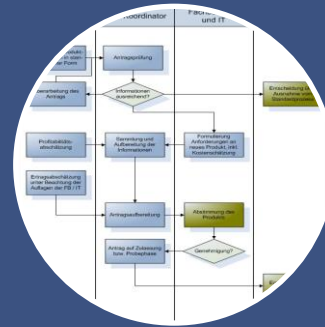
Professional Design
- Advice on processes and organizational issues
- IFRS realization
- Procedures for the value-based management of enterprises
- Valuation in the context of corporate finance
- Post merger integration
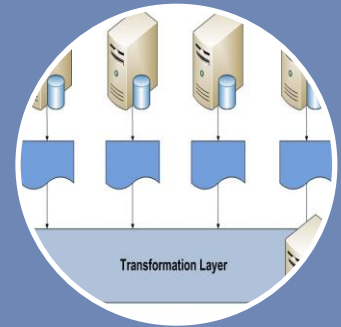
System Integration
- Selection and implementation of standard software
- Development of individual software
- Design of system architectures
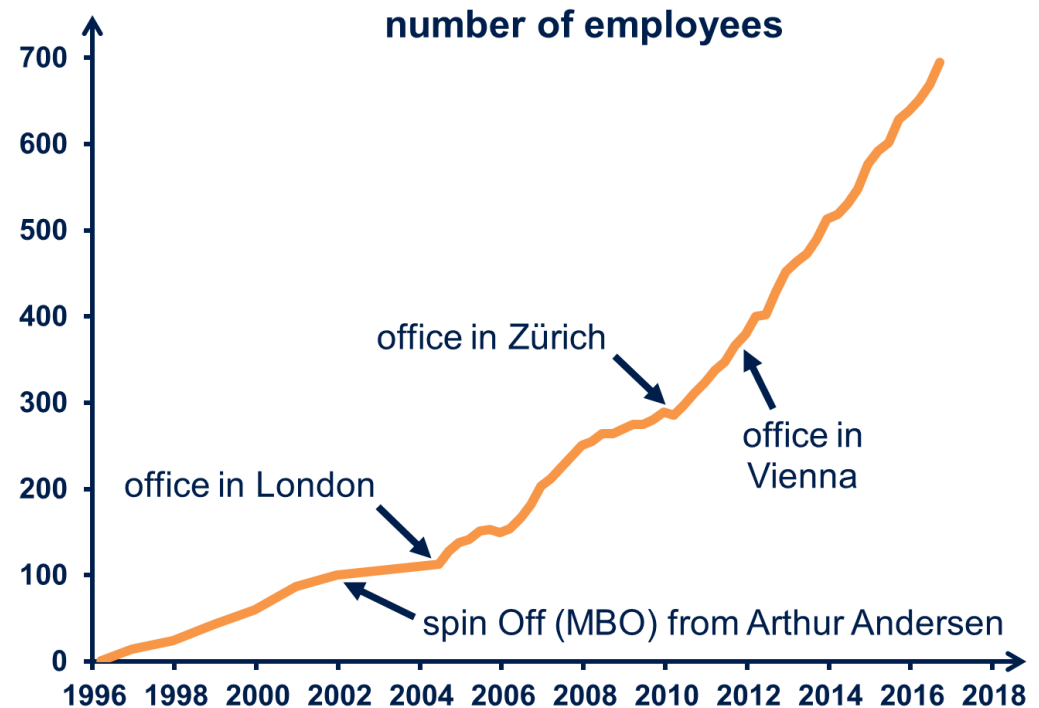- Audit of existing systems

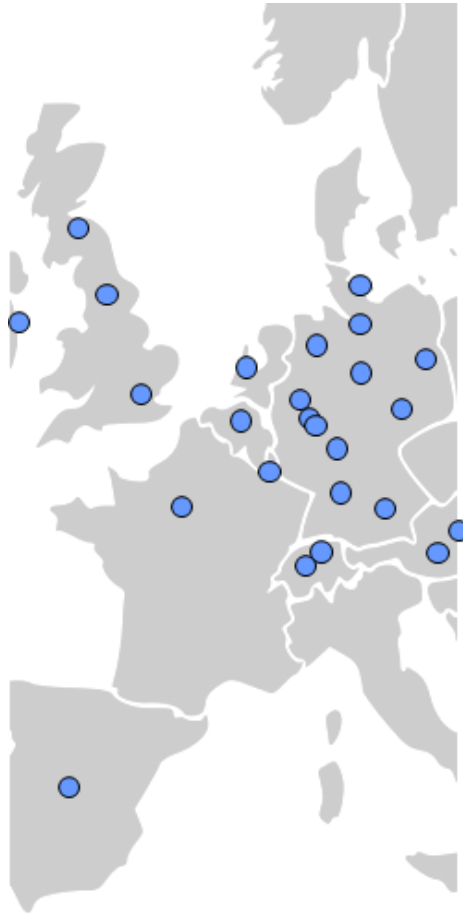**From strategy to design to integration into processes and IT**

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Our history

» Successful in business since 1996

» Founded as a specialty consulting service of Arthur Andersen Germany

» Continuous and constant **organic growth**

» Hundreds of **successful** projects on all scales

» Developed a very high level of **cooperation** with universities and software providers

» d-fine milestones

› Since 07 / 2002: **d-fine GmbH**

› Since 11 / 2004: **d-fine Ltd, London**

› Since 07 / 2010: **d-fine AG, Zurich**

› Since 03 / 2012: **d-fine Austria GmbH, Vienna**

number of employees

office in Zürich

office in Vienna

office in London
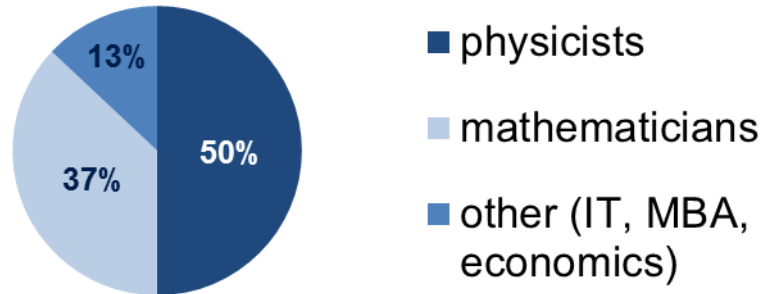
spin Off (MBO) from Arthur Andersen

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Our clients

» Large, medium sized, and specialized banks
» Insurances, asset managers, hedge funds
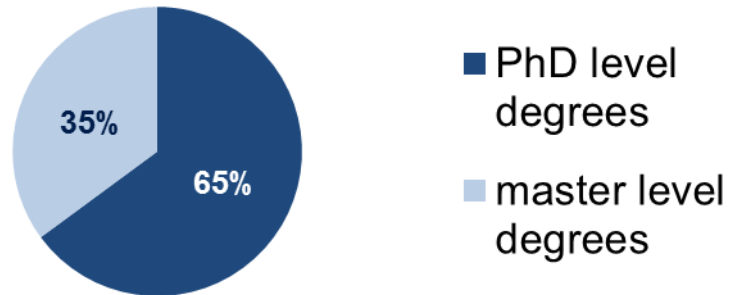» International industry corporations and energy traders

Our client list (abridged):

» Aareal Bank	» DekaBank	» KfW
» ABN Amro	» Deutsche Bank	» Landesbank Berlin
» apoBank	» Deutsche Bundesbank	» LBBW
» ampegaGerling	» Deutsche Hyp	» MEAG
» ARAG	» Deutsche Schiffsbank	» Münchener Hypothekenbank
» AXA	» DG Hyp	» NRW.BANK
» Barclays Capital	» DVB	» Nord/LB
» BayernLB	» DWS	» R+V
» Berlin Hyp	» DZ BANK	» RZB, RBI
» BMW	» EIB	» Raiffeisen-LB Steiermark
» Bundesrepublik Deutschland Finanzagentur	» European Commodity Clearing	» RWE
» Central Bank of Ireland	» E.ON	» Sparkasse KölnBonn
» Commerzbank	» Erste Bank	» Talanx
» CQS Management	» Hannover Rück	» Toyota Kreditbank
» CLS	» Helaba	» UBS
» Daimler	» HSH Nordbank	» Union Investment
» DBS Singapore	» HSBC Trinkaus	» WestLB/Portigon
		» Zürcher Kantonalbank

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Our people

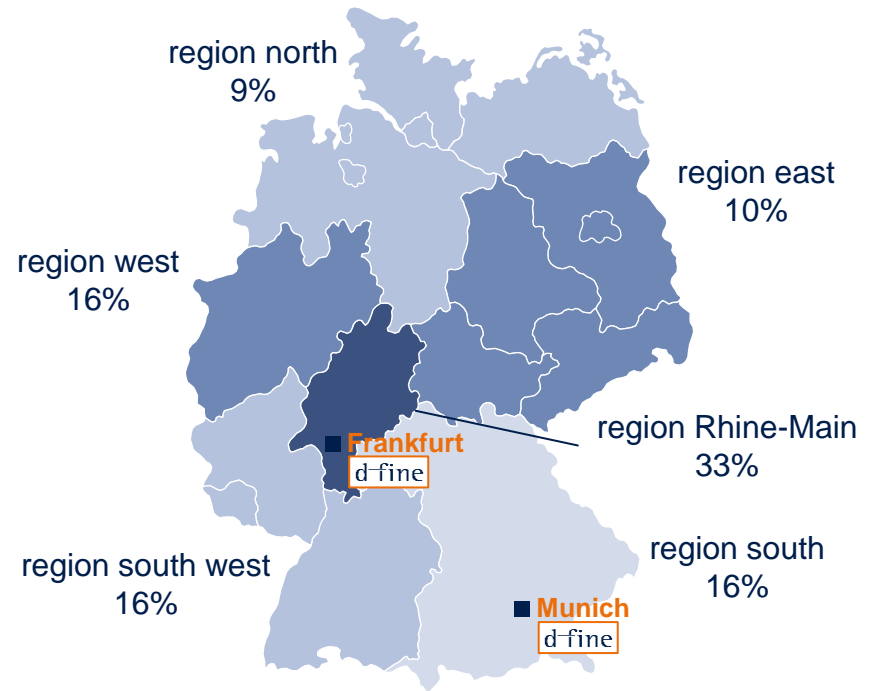» Deep **technical** and **mathematical** skills

- physicists 50%
- mathematicians 37%
- other (IT, MBA, economics) 13%

» **Highly qualified**

- PhD level degrees 65%
- master level degrees 35%

» Typically in **top percentile** of their class at university

Residences of employees in German regions

region north 9%

region east 10%

region west 16%

Frankfurt d-fine

region Rhine-Main 33%

region south west 16%

Munich d-fine

region south 16%

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What we offer

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On every step of the career: interesting tasks

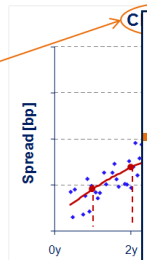## Risk Factors – Spread Curves (2/3)

(Credit) Spread

Spread Curve Construction (Bonds)

In **practice** one often **lacks** the **data** to generate individual spread curves for each address. Instead general spread curves (per sector/rating) with a residual spread are used.

Spread

- Residual spread $s_{residual}$
- General spread $s_{general}$ } Total spread
- Base curve r_{base}
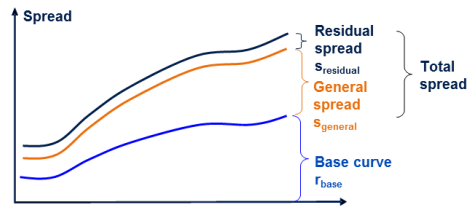
$$r_{total} = r_{base} + s_{general} + s_{residual}$$

systematic   idiosyncratic

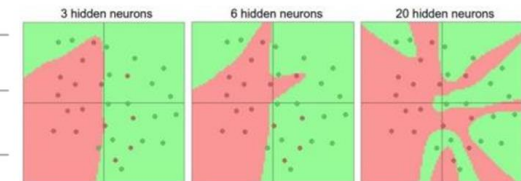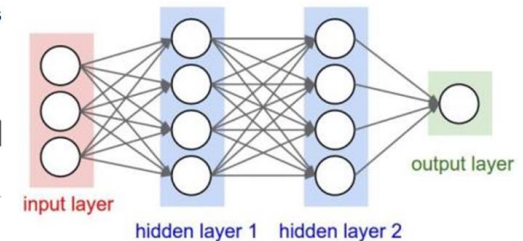Spread [bp]

0y   2y

Spread Curve

- » Similar to i... individual te... general (se...
- » The residua... single risk f...
- » For CDS, is...

▶ Spread curves can be separated into systematic and idiosyncratic p...

General overview of neural networks

- » Typical[1] neural networks models come with various so-called layers.
- » There are various activation functions used in the literature and in practice.

Activation function	Equation	Example	1D Graph
Unit step (Heaviside)	$\phi(z) = \begin{cases} 0, & z < 0, \\ 0.5, & z = 0, \\ 1, & z > 0, \end{cases}$	Perceptron variant	
Sign (Signum)	$\phi(z) = \begin{cases} -1, & z < 0, \\ 0, & z = 0, \\ 1, & z > 0, \end{cases}$	Perceptron variant	
Linear	$\phi(z) = z$	Adaline, linear regression	
Piece-wise linear	$\phi(z) = \begin{cases} 1, & z \geq \frac{1}{2}, \\ z + \frac{1}{2}, & -\frac{1}{2} < z < \frac{1}{2}, \\ 0, & z \leq -\frac{1}{2}, \end{cases}$	Support vector machine	
Logistic (sigmoid)	$\phi(z) = \frac{1}{1 + e^{-z}}$	Logistic regression, Multi-layer NN	
Hyperbolic tangent	$\phi(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}}$	Multi-layer NN	

input layer   hidden layer 1   hidden layer 2   output layer

3 hidden neurons   6 hidden neurons   20 hidden neurons

▶ Nowadays neural networks are build with 100s of layers leading to a high capacity[2].

[1]There are also other types like Hopfian networks or (Deep) Boltzmann Machines which are not discussed here
[2]http://playground.tensorflow.org

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Flexible career perspectives – one starting point…two paths

d-fine offers two exciting perspectives to career starters with a background in natural science:

d-fine BLUE	**Classical career path of a consultant**	**Career as an expert, focused on business work**	d-fine ORANGE
	» Flexible projects for many different customers	» Implementation of complex and possibly longer ongoing projects	
	» International projects with a focus on Germany, Austria, Switzerland and UK	» Work in the vicinity of the office location (currently in the Rhine-Main region)	
	» Possibility of a typical career history with a consultancy, but without up-or-out mechanism	» Waiver of a rigid layered approach, instead possibility of flexible taking different project roles	
		» Professional high quality work without any career pressure, but with many development opportunities	

Blue or **Orange**: to all employees, we apply the **same, very high quality standard**.
All employees work in the d-fine typical topics in joint teams.

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Many challenging roles, many exciting tasks, lots of possibilities

Partnership

d-fine BLUE			d-fine ORANGE		

(Senior) Manager `3`
- » Project acquisition
- » Project responsibility
- » Support of the development of employees
- » Specialist activities

Senior Consultant `2`
- » Subproject lead
- » Working independently on comprehensive project tasks
- » Onsite project work

Consultant `1`
- » Working independently on project tasks
- » Onsite project work
- » Intensive training on- / off-the-job

A **(Junior) Analyst**
- » Working independently on project tasks
- » Onsite project work
- » Intensive training on- / off-the-job

B **Senior Analyst**
- » Expert on projects with the client
- » Working independently on comprehensive project tasks
- » Onsite project work

C **Lead Analyst Special roles**
- » Support of the project acquisition
- » Project lead and leadership of employees
- » Support of recruiting events
- » Expert on projects with the client

Entry at d-fine

Blue or **Orange**: in mixed teams, all employees are working together on the implementation of demanding projects of our customers

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For young professionals: Intensive training and supervision

» Ca. **4 weeks of internal initial skill adaption training** in the beginning, covering

  › My role as a professional (soft skill training)

  › Advanced IT curriculum

  › Basics of banking

  › Practical trainings on typical trading or risk management systems, e.g. Front Arena, IBM Algorithmics, …

  › Business trainings, covering various topics, e.g. credit risk, market risk, basics of valuation, capital markets business, accounting, regulation, …

  › Further trainings: essential SQL, essential PowerPoint

  › Internal processes (travelling expenses, time reports, HR tool, …)

  › Other stuff (notebook, internal Wiki, data protection, …)

» **Mentoring program** during the first two to three years

  › Supervision by a manager or senior manager

  › Contact person for personal development and potential problems

> The career entry is also facilitated by an extremely collegial corporate culture: open handling of hierarchies, from intern to partner

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d-fine offers „high end training" [1]

» **University of Oxford**
  › M.Sc. or Diploma in Mathematical Finance
  › Duration approx. 2,5 years, modules take place in Oxford

registration, e.g. at New College (founded 1379)

» **Mannheim Business School**
  › Part-Time MBA
  › Duration approx. 2 years, modules take place in Mannheim and abroad (e.g. Singapore)

courses at Mannheim Baroque Palace

» **European Business School**
  › Executive MBA
  › Duration approx. 2 years, modules take place near Wiesbaden and in Durham (UK)

courses at Castle Reichartshausen

» **HHL Leipzig Graduate School of Management**
  › Part-Time MBA
  › Duration approx. 2 years, modules take place in Leipzig or Cologne

courses at Campus Leipzig (re-established 1992)

(1) These trainings will be offered for the d-fine BLUE career track only. The d-fine ORANGE career track contains different training offerings.

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Additional trainings – career accompanying and intensive

» **CFA** (Chartered Financial Analyst)

» **Actuary**[1]

» **Corporate Finance**: University of Warwick

» Further additional internal and external trainings, e.g. on finance, soft skills, software, project management, …

» **Cooperation with leading universities**, e.g.

  › Frankfurt School of Finance & Management

  › Ruprecht-Karls-University Heidelberg

  › Johann Wolfgang Goethe-University Frankfurt am Main

  › Humboldt-University Berlin

» Participation / presentations at **international conferences** and seminars

  › European Credit Risk Conference (Wien)

  › Annual Capital Allocation and Management Conference (London)

  › RiskMinds Conference (Amsterdam)

  › Testing & Finance Conference (Frankfurt)

(1) This training will be offered for the d-fine BLUE career track only.

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d-fine publications – MSc theses, articles, books, …

Improving Value at Risk
Calculations by Using Copulas
and Non-Gaussian Margins

Dr Jörn Rank

New College

University of Oxford

A thesis submitted in partial fulfillment for the MSc in
Mathematical Finance

September 6, 2002

2 Applications of Copulas for the Calculation of Value-at-Risk
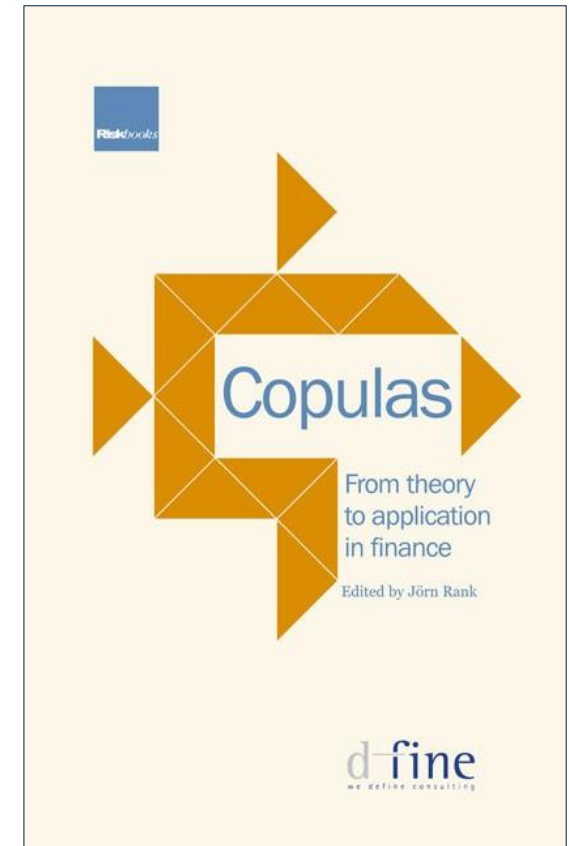
Jörn Rank and Thomas Siegl

We will focus on the computation of the Value-at-Risk (VaR) from the perspective of the dependency structure between the risk factors. Apart from historical simulation, most VaR methods assume a multivariate normal distribution of the risk factors. Therefore, the dependence structure between different risk factors is defined by the correlation between those factors. It is shown in Embrechts, McNeil and Straumann (1999) that the concept of correlation entails several pitfalls. The authors therefore propose the use of *copulas* to quantify dependence.

For a good overview of copula techniques we refer to Nelsen (1999). Copulas can be used to describe the dependence between two or more random variables with arbitrary marginal distributions. In rough terms, a copula is a function $C : [0,1]^n \to [0,1]$ with certain special properties. The joint multidimensional cumulative distribution can be written as

$$P(X_1 \leq x_1, \ldots, X_n \leq x_n) = C\left(P(X_1 \leq x_1), \ldots, P(X_n \leq x_n)\right)$$
$$= C(F_1(x_1), \ldots, F_n(x_n)),$$

where $F_1, \ldots, F_n$ denote the cumulative distribution functions of the n random variables $X_1, \ldots, X_n$. In general, a copula C depends on one or more copula parameters $p_1, \ldots, p_k$ that determine the dependence between the random variables $X_1, \ldots, X_n$. In this sense, the correlation $\rho(X_i, X_j)$ can be seen as a parameter of the so-called Gaussian copula.

Here we demonstrate the process of deriving the VaR of a portfolio using the copula method with XploRe, beginning with the estimation of the selection of the copula itself, estimation of the copula parameters and the computation of the VaR. Backtesting of the results is performed to show the validity and relative quality of the results. We will focus on the case of a portfolio containing

Riskbooks

Copulas

From theory
to application
in finance

Edited by Jörn Rank

d-fine
we define consulting

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d-fine is a „Fair Company"

Fair Companies…

» … they do offer internships mainly for **professional orientation** during the time of education,

» … they do give **well defined tasks and goals** and name a **dedicated contact person** within the company,

» … they do hire interns for a **meaningful duration** only,

» … they **do not put off** a university graduate who applied for permanent position **with an internship**,

» … they do pay **adequate expense refunds** to interns,

» … they do **inform** interns **about the tasks, contact persons, and objective** of the internship and do inform on the **Fair Company regulations**[1].

d-fine obeys the above mentioned rules. That's why we are allowed to use the Fair Company seal of quality, issued by karriere.de.

(1) http://www.faircompany.de

d-fine supports science – …

» …by scholarships

Wir fördern das

Deutschland STIPENDIUM

» …by sponsorships
(selection only)

Deutsches Jungforscher Netzwerk juFORUM e.V.

dts 2015 BERLIN

STUNT
Studentische Unternehmensberatung Bielefeld

LATTICE 13
JULY 29 – AUGUST 03 2013
MAINZ, GERMANY

» …by long-running sponsorships

Φ DPG

FIT FOR TUMORROW

HGSFP

BERLINER BÖRSENKREIS

» …by cooperations

MARIE CURIE ACTIONS

ITN ★STRIK€

ITN STRONG net

Frankfurt School of Finance & Management
German Excellence. Global Relevance.

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d-fine offers attractive compensation and work-life balance

Attractive compensation

» Competitive fixed **salary** plus **bonus**

» **Accident insurance** and pension fund

» **Company car program**

Work-life balance

» **Free choice of place of residence** all over Germany (d-fine BLUE)

› You may live wherever you like, we take care of your business travel and accommodation

» Projects **close to home possible**

› d-fine BLUE: "Local Contract", i.e. working in Rhine-Main area or in Munich area, possible from level "Senior Consultant" onward

› d-fine ORANGE: Working in Rhine-Main area[1], possible from the first day at d-fine

» Extra program "**Childcare**"

› Support when looking for suited child care or in cases of emergency care in almost all big German cities

(1) Restriction to Rhine-Main area at the moment. Additional areas possible in the future.

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Networking @ d-fine

» Working together with **excellent people**,

    › having the same academic background (physics, mathematics, etc.),

    › having the same level of qualification (at least an MSc degree, plenty of PhD's) and

    › having reached the same high level in their university degrees

is a **great experience**!

» More than 600 d-fine colleagues – distributed over more than 200 projects...

$\Rightarrow$ Q: How to get in contact with colleagues you typically don't see?

$\Rightarrow$ A: Regular **d-fine conventions**, 3 times a year!

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d-fine conventions (1 / 2)

» **Three 2 day d-fine internal events each year** (spring, summer, before Christmas)

» Everybody resides in a hotel

» Content:

› **Plenary talks** for all consultants, e.g. Management Information

› **Parallel talks** on **each level** – beginners, more experienced colleagues, experts

› **Time for networking**, e.g. meetings between mentor & mentee

» Every 2nd year, Summer Convention **together with spouses**

› Destination: Somewhere in Europa

› Duration: Full weekend (Friday – Sunday)

› Content: No business, **fun** and **recreation** only

› Previous events: ...

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d-fine conventions (2 / 2)

Vienna 2008: Gala-Dinner at Kunsthistorisches Museum

Rome 2012: Gala dinner at Villa Miani

Barcelona 2010: Convention Hotel

Strasbourg / Rust 2014: One of the Convention Hotels

Amsterdam 2016: Trip to Noordwijk beach

Small excursion

Physics vs. mathematical finance

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Physics vs. mathematical finance – examples (1 / 4)

» Thermodynamics: **Heat equation**

$$\frac{\partial T}{\partial t} - \frac{\lambda}{\rho\,c}\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right)T = 0$$

$t:$ time
$T:$ temperature
$\lambda/\rho\,c:$ thermal diffusivity
$x,y,z:$ spatial variables

» Mathematical finance: **Black-Scholes equation**

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$t:$ time
$V:$ price of an option on an underlying (e.g. a stock)
$S:$ price of the underlying
$\sigma:$ measure for the variance of the underlying
$r:$ risk free rate
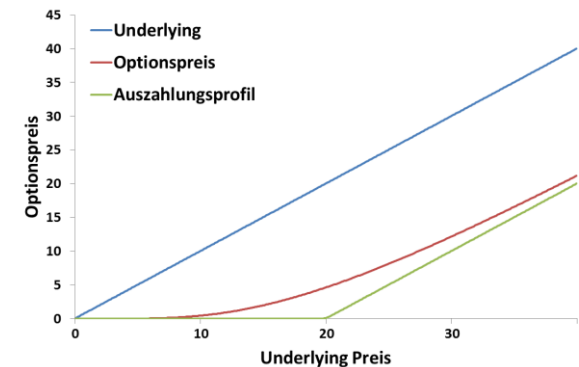
Solve different problems with the same mathematical methods

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Physics vs. mathematical finance – examples (2 / 4)

» Elementary particle physics: solving the path integral of pure **(lattice) gauge theory**

$$\langle \mathcal{O}(U_\mu) \rangle_T \;=\; \frac{1}{Z} \int_{per} \mathcal{D}U \; \mathcal{O}(U_\mu) \exp\left\{ -S_G[U_\mu] \right\}$$

with
$$Z \;=\; \int_{per} \mathcal{D}U \exp\left\{ -S_G[U_\mu] \right\} \;.$$

› so-called thermalization of the configuration by Monte Carlo simulation of the gauge fields (e.g. gluons)

» Mathematical finance: Value at Risk (VaR) computation in the context of **market risk**

$$\text{VaR}_F\left(\vec{S}, P_a, t, \Delta t\right) \cong -a\,\sqrt{\Delta t}\,\sqrt{\sum_{i,j=1}^{n} \Delta_i\, S_i(t)\, \sigma_i\, \rho_{i,j}\, \Delta_j\, S_j(t)\, \sigma_j}$$

with
$$S_i(T) = S_i(t)\, e^{\left(\mu_i - \sigma_i^2/2\right)\Delta t + Y_i} \qquad i = 1, \ldots, n$$

› Monte Carlo simulation of the risk factors (e.g. stock prices)

Solve different problems with the same numerical methods

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Physics vs. mathematical finance – examples (3 / 4)

» **Physics in general, e.g. classical mechanics: model validation**
Testing a theory by experiments

$$t^{\text{Fall}}_{\text{Obj. 1}} = t^{\text{Fall}}_{\text{Obj. 2}}$$
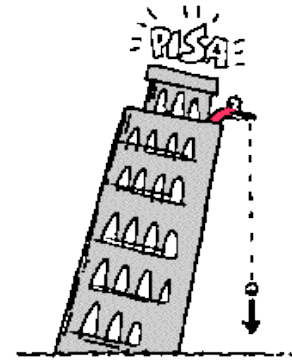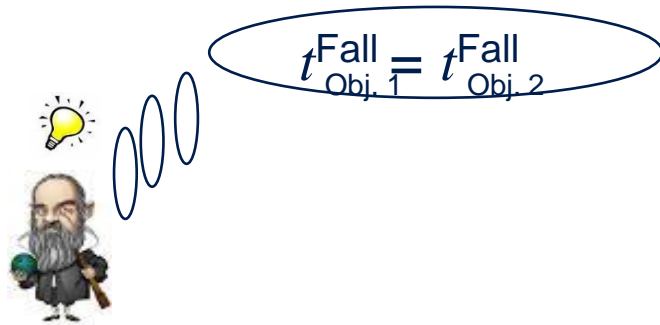
» **Mathematical finance: model validation**
Testing a (marked) risk model by "backtesting"
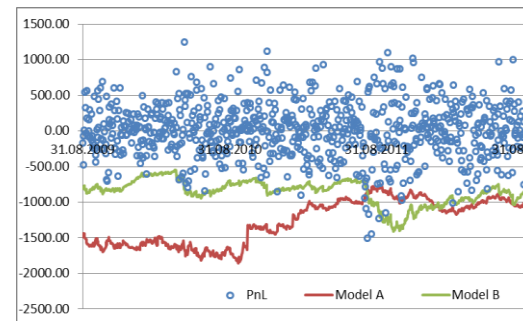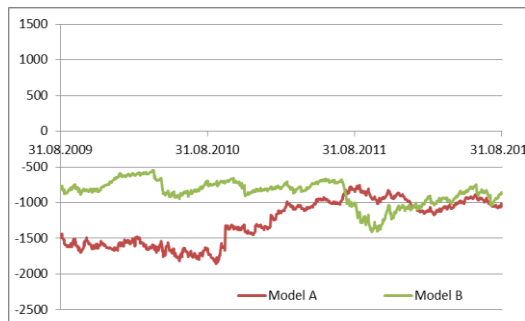
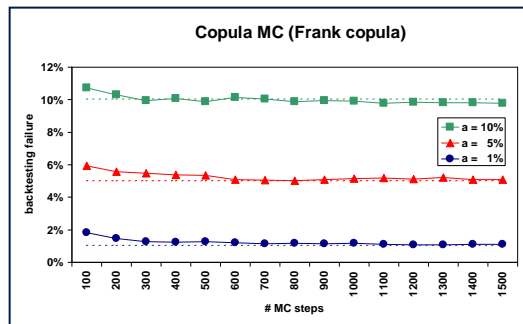Same validation criteria: Check the quality of a model by testing it against "reality"

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Physics vs. mathematical finance – examples (4 / 4)

» **Maximum Likelihood parameter estimation**
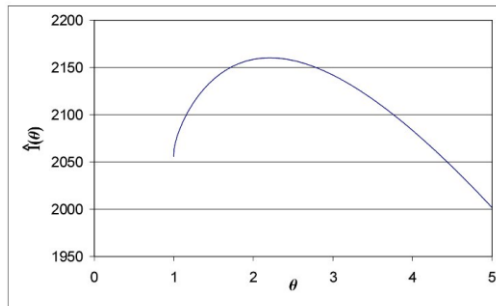
modified likelihood function $\hat{l}(\theta)$ vs. θ

» **Generation of pseudo random numbers (MC simulation)**

» **Evaluation of experimental data**

» **Solving of PDEs**

Computation of option values at these points...

...out of option values at those points.

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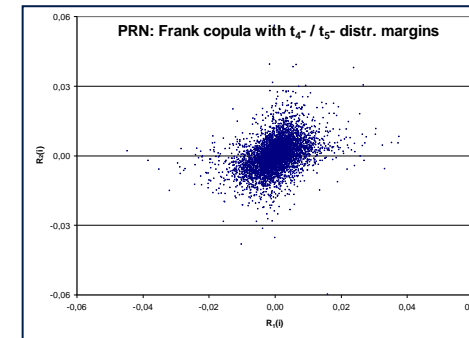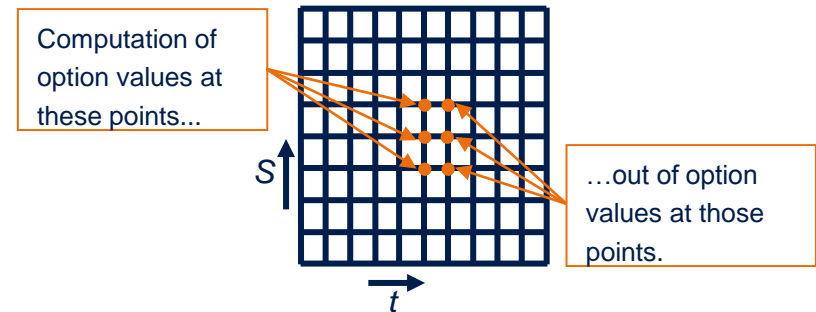
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» Excellent **quantitative** and **analytical** skills

⇒ Very good final degree at university (Diploma, Master) or PhD in **physics, mathematics, business informatics**, etc.

» High grade of **social competence**

» Very good **IT skills**

» Very good **English skills**

» Interest in financial markets

» Work experience abroad, internships, scholarships, etc.

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... and why physicists and mathematicians fulfil most of them

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» Stochastic methods

» Monte Carlo methods

» Differential equations

Strong IT-Know-how

» Programming

» Numerical methods

» Data bases

Good Understanding of Economics and Business Processes

» Developm. of economics

» Financial markets mechanics

» Regulatory requirements
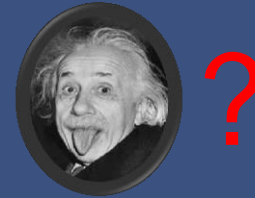
Good Communication Skills

» Presentation skills

» (Simple) representation of complex topics

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