Underwriting Decisions: Evaluating Model Risk
Introduction to Model Risk

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Agenda

- John Major: Introduction to Model Risk (this talk)
  - What is model risk, where does it come from, why is it important
  - Examples
  - What to do about it (intro)

- Alietia Caughron: Model Risk Management

- Erin Kang: Implementing and Using Models

What is a model?

- A model is a constructed representation of something else
    - focus on essential aspects; for a particular purpose
    - simplifying; aiding understanding

- Examples
    - model airplane $\rightarrow$ appearance
    - model rocket $\rightarrow$ function

- Models in business: usually mathematical/computational
    - formulas relate or predict quantities
    - catastrophe model: characteristics of exposed properties $\rightarrow$ damage amounts at various levels of probability
    - credit scoring model: characteristics of a creditor $\rightarrow$ likelihood of default

What is model risk?

- One definition (Wikipedia):
  - "In finance, model risk is the risk of loss resulting from using models to make decisions, initially and frequently referring to valuing financial securities."
  - There are several. Alietia will go into more depth.

- Why does it exist?
  - human error
  - statistical error
  - simplification implies missing detail
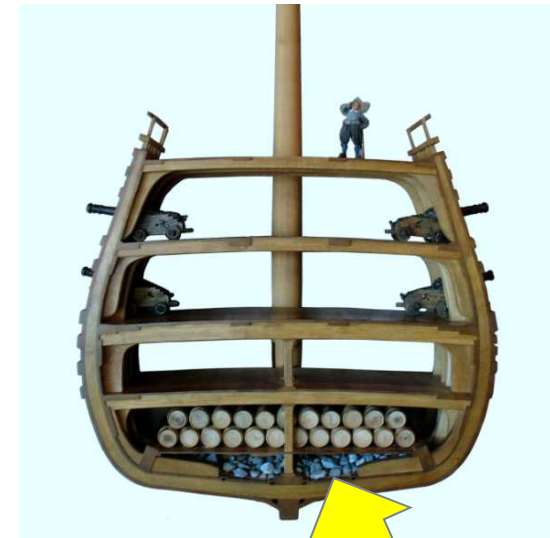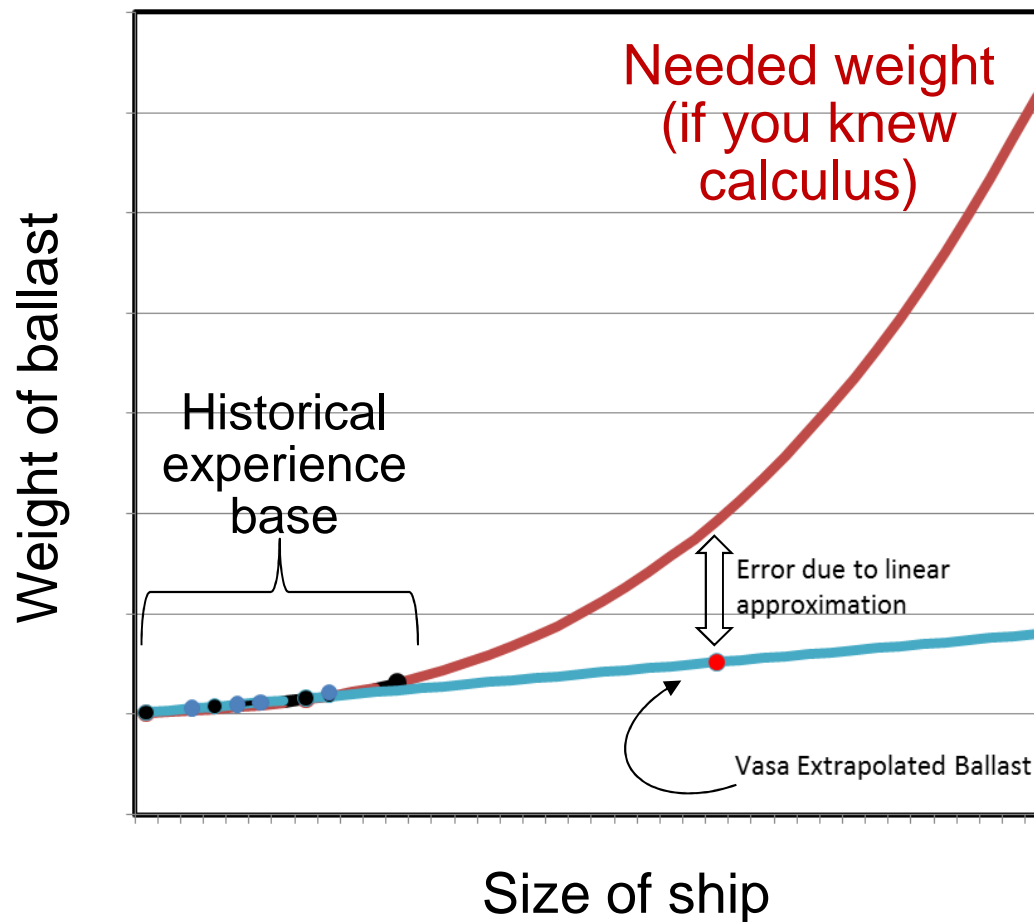   - something important gets overlooked

A (fairly) early example of model risk
The Vasa disaster

- 1626: Sweden's King Gustavus Adolphus commissions construction of the Vasa, a warship *twice as big as any that had ever existed*. Cost equivalent to several hundred million current dollars.

- 1628: Launched to great fanfare, unfurled her sails, heeled over and sank to the bottom of the harbor. Had only about half the ballast it needed.

- This illustrates (at least) two types of model risk
    - Inappropriate use of mathematical approximation
    - Failure to communicate validation results

A (fairly) early example of model risk
Vasa: Calculation of needed ballast in a ship that big

Weight of ballast

Needed weight
(if you knew
calculus)

Historical
experience
base

Error due to linear
approximation

Linear
extrapolation

Vasa Extrapolated Ballast

Size of ship

Source: Jon Hill, Morgan Stanley

A (fairly) early example of model risk
Vasa part 2: Failure to communicate validation results

- Before the Vasa first set to sea, Vice Admiral of the Swedish Navy, Klas Fleming directed a test:
  - 30 sailors start at one side of the top deck, rush to the other side, repeat; get the Vasa rocking in the harbor.
  - See how quickly the ship could right itself in heaving seas.

- Results:
  - so slow, so troubling, he cancelled the test after only 3 cycles
  - …***but told no one***.
  - Perhaps because the king, away in northern Europe, kept insisting that the ship put to sea as soon as possible.

Where does model risk come from?
Not an exhaustive list

*Contains errors,
Out of date,
Does not apply,
Random variability,
Not enough*
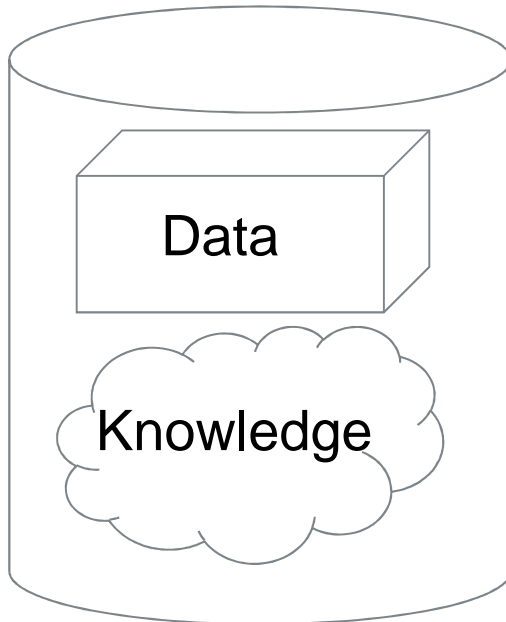
*Lack of skill,
Human error*

*Implementation
bugs,
Inadequate
process*

*Used incorrectly,
Used in inappropriate
context*

Data

Knowledge

Model
Development

Model

Model
Usage

Model risk in the insurance industry
Catastrophe models
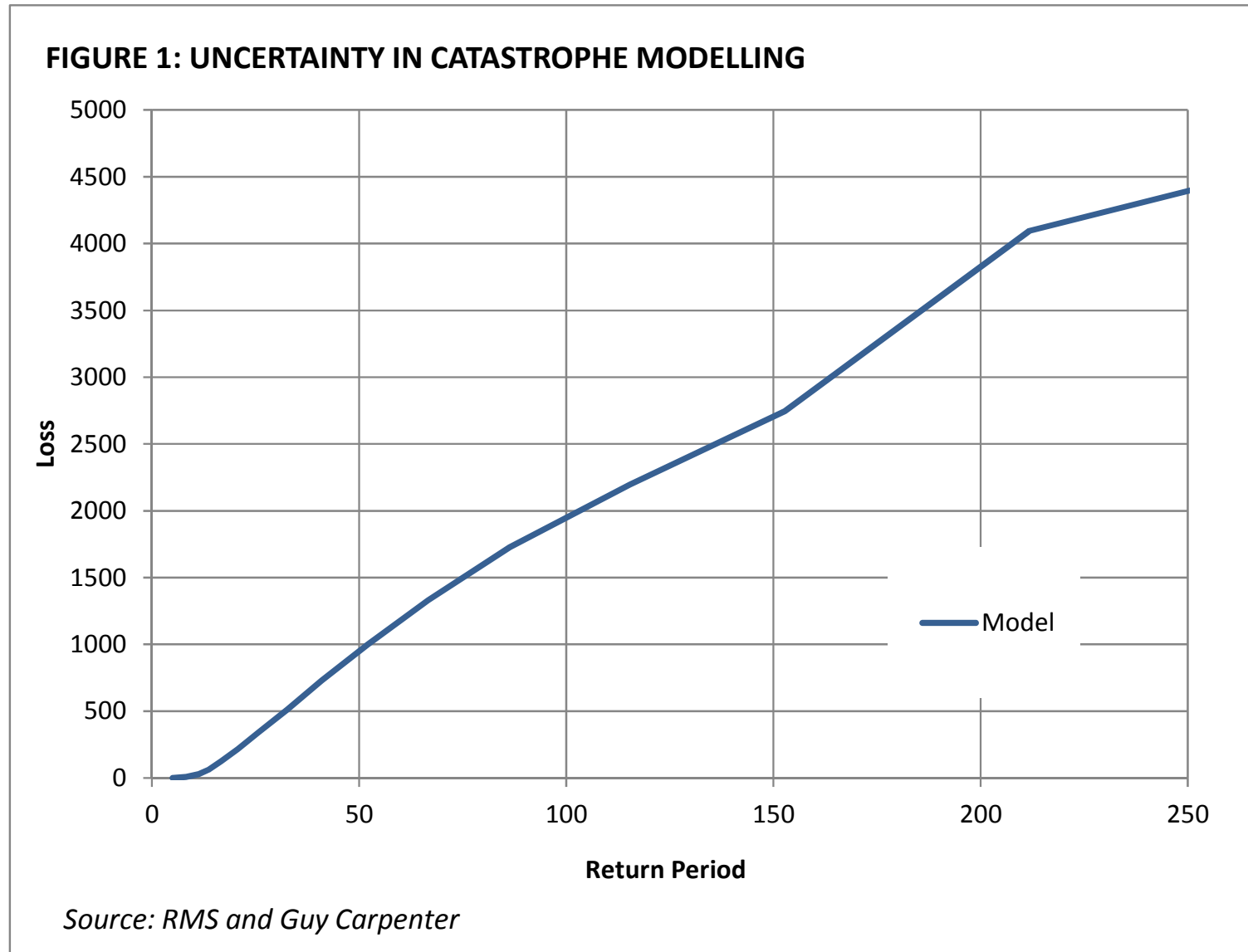
FIGURE 1: UNCERTAINTY IN CATASTROPHE MODELLING

Source: RMS and Guy Carpenter

Model risk in the insurance industry
Catastrophe models

FIGURE 1: UNCERTAINTY IN CATASTROPHE MODELLING

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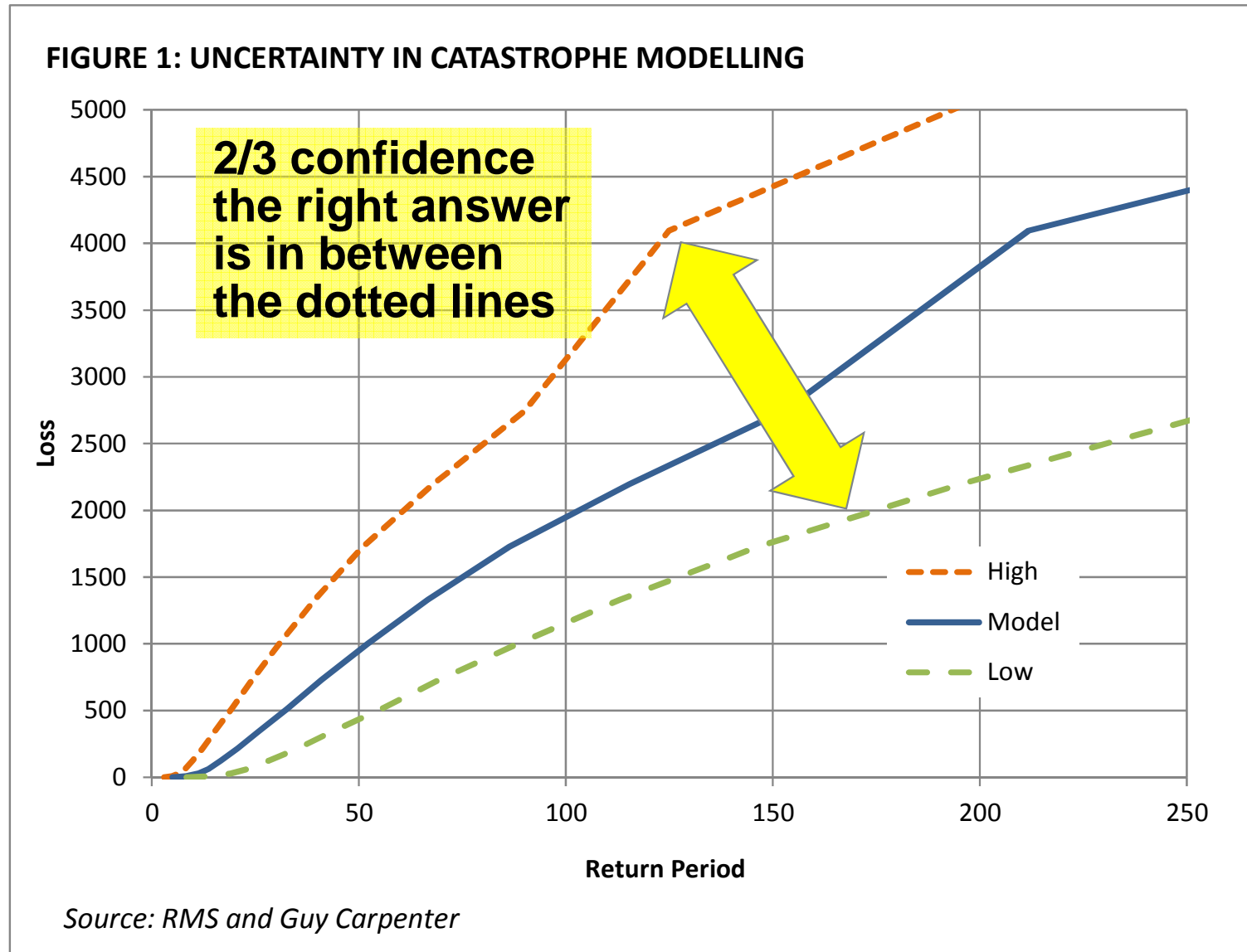
Model risk in the insurance industry
Risk attribution and technical pricing

	Risk-free rate	0		
ACCOUNT	**Premium**	**Tech. Premium**	**Margin**	**%**
Pellentesque Valley School District	850	661	189	29%
Sapien Cursus Foods	1,100	880	220	25%
Suscipit Oil and Gas	500	344	156	46%
Aliquet Florist Supplies	1,150	988	162	16%
Vitae Vitae Dry Cleaning	900	846	54	6%
Nulla Tempor Convenience Stores	650	530	120	23%
Orci, Inc.	600	436	164	38%
Felis Pet Stores	350	169	181	107%
Integer Consultants	500	434	66	15%
Semper Blandit Septic Services	1,150	997	153	15%

Danger Zone: below 20% margin

"Critical Event Cost" (CEC) method uses a generalized risk measure that reflects cost of risk capital.

It prescribes a minimum premium necessary to keep investors happy.

Actual or proposed account premiums need to be sufficiently above the technical premium.

Model risk in the insurance industry
What's your confidence interval?

	Risk-free rate	0		
	Assumed science yrs	100		
ACCOUNT	**Premium**	**Tech. Premium**	**±error**	
Pellentesque Valley School District	850	661	62.2%	
Sapien Cursus Foods	1,100	880	29.7%	
Suscipit Oil and Gas	500	344	25.6%	
Aliquet Florist Supplies	1,150	988	72.6%	
Vitae Vitae Dry Cleaning	900	846	22.7%	
Nulla Tempor Convenience Stores	650	530	20.6%	
Orci, Inc.	600	436	82.5%	
Felis Pet Stores	350	169	61.7%	
Integer Consultants	500	434	14.4%	
Semper Blandit Septic Services	1,150	997	31.9%	

Error bands based on assumptions about quantity of data underlying the risk model

Model risk in the insurance industry
Drawing robust conclusions

Risk-free rate	0			
Assumed science yrs	100			

ACCOUNT	Premium	Tech. Premium	Margin	%
Pellentesque Valley School District	850	200-1100	($200)-$600	29%
Sapien Cursus Foods	1100	600-1100	$0-$500	25%
Suscipit Oil and Gas	500	300-400	$100-$200	46%
Aliquet Florist Supplies	1150	300-1700	($600)-$900	16%
Vitae Vitae Dry Cleaning	900	700-1000	($100)-$200	6%
Nulla Tempor Convenience Stores	650	400-600	$0-$200	23%
Orci, Inc.	600	100-800	($200)-$500	38%
Felis Pet Stores	350	100-300	$100-$300	107%
Integer Consultants	500	400-500	$0-$100	15%
Semper Blandit Septic Services	1150	700-1300	($200)-$500	15%

Danger Zone: possibly not enough premium

Reflecting uncertainty, we can see that a comparison of actual to technical premiums is probably going to be *indicative*, not *definitive*.

Chances are, no one is going to show you this.

But you should be aware that it lurks behind the scenes, nonetheless.

The 2-Digit Law
If you remember nothing else from this session…

The mass of an electron is 9.10938356 × 10^{-28} grams.

If you are actually counting things (like money)
or you are working in the physical sciences,
you may be justified in reporting this many significant digits.

For social sciences (including economics and actuarial science),
*any estimates worth knowing are **at best** good to 2 digits; usually less.*

"AAL = $77,791,312.19" ?   ***No!***

"AAL = $78,000,000"   *Maybe.*

"AAL = $80,000,000"   More likely.

"AAL = $50-100 million"
Probably best answer in this case.

The regulatory landscape

- Banking
  - U.S. Office of the Comptroller of the Currency, Federal Reserve
  - Mandating positive steps to control model risk

- Insurance
  - A few SIFIs subject to same regime
  - Otherwise, behind the curve, but moving in that direction
  - Actuarial Standards Board
    - Modeling Task Force and Catastrophe Modeling Task Force
    - Several existing ASOPs deal with models
  - NAIC: "The ORSA Summary Report should provide a general description of the insurer's process for model validation…."

Defending against model risk
Best practices

- "Three lines of defense" mandated by OCC
  - developers themselves test the model
  - independent validation and testing
  - internal audit determines the first two are actually doing their jobs

- Senior management oversees, sets "model risk appetite", directs short-term remediation

- User vigilance
  - results must pass the "smell test"

- Robust decision making
  - recognize the existence of uncertainty
    - *"What's your confidence interval?"*
  - allow for a buffer in the most adverse direction

Summary

- A model is a simplification, cannot be perfect
  - Human and statistical error will make it less so

- Statistical error needs to be recognized, quantified, and reported
  - At least, remember the 2-digit rule

- Users are the last line of defense against model risk
  - If you see something, say something

To Learn More…

- Jon Hill: Regulatory Guidelines and Model Validation Best Practices
  http://imrmcon.org/wp-content/uploads/2015/05/03-Regulatory-Guidelines.pdf
  - Includes more references on page 23

- OCC: Supervisory Guidance on Model Risk Management
  http://www.occ.gov/news-issuances/bulletins/2011/bulletin-2011-12a.pdf

- North American CRO Council: Model Validation Principles
  http://crocouncil.org/images/CRO_Council_-_Model_Validation_Principles.pdf

- KPMG: Survey on Model Risk Management Practices
  https://www.kpmg.com/US/en/services/Advisory/risk-and-compliance/financial-risk-management/Documents/kpmg-model-risk-management-practices-survey.pdf

- Major: Managing Catastrophe Model Uncertainty – Issues and Challenges
  http://gcportal.guycarp.com/portal/extranet/getDoc?vid=1&docId=10068

- Major et al.: The Most Dangerous Model – A Natural Benchmark for Assessing Model Risk
  http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2611806

- Major & Thomas: Portfolio Management with the Critical Event Cost Method
  https://www.soa.org/Library/Proceedings/Arch/2014/arch-2014-iss1-major-thomas-paper.pdf

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