Managing Model Risk

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Book

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MANAGING MODEL RISK
LESSONS AND EXPERIENCES FROM INDUSTRY AND RESEARCH ON THE CHALLENGES AND DANGERS OF ANALYTICAL MODELS

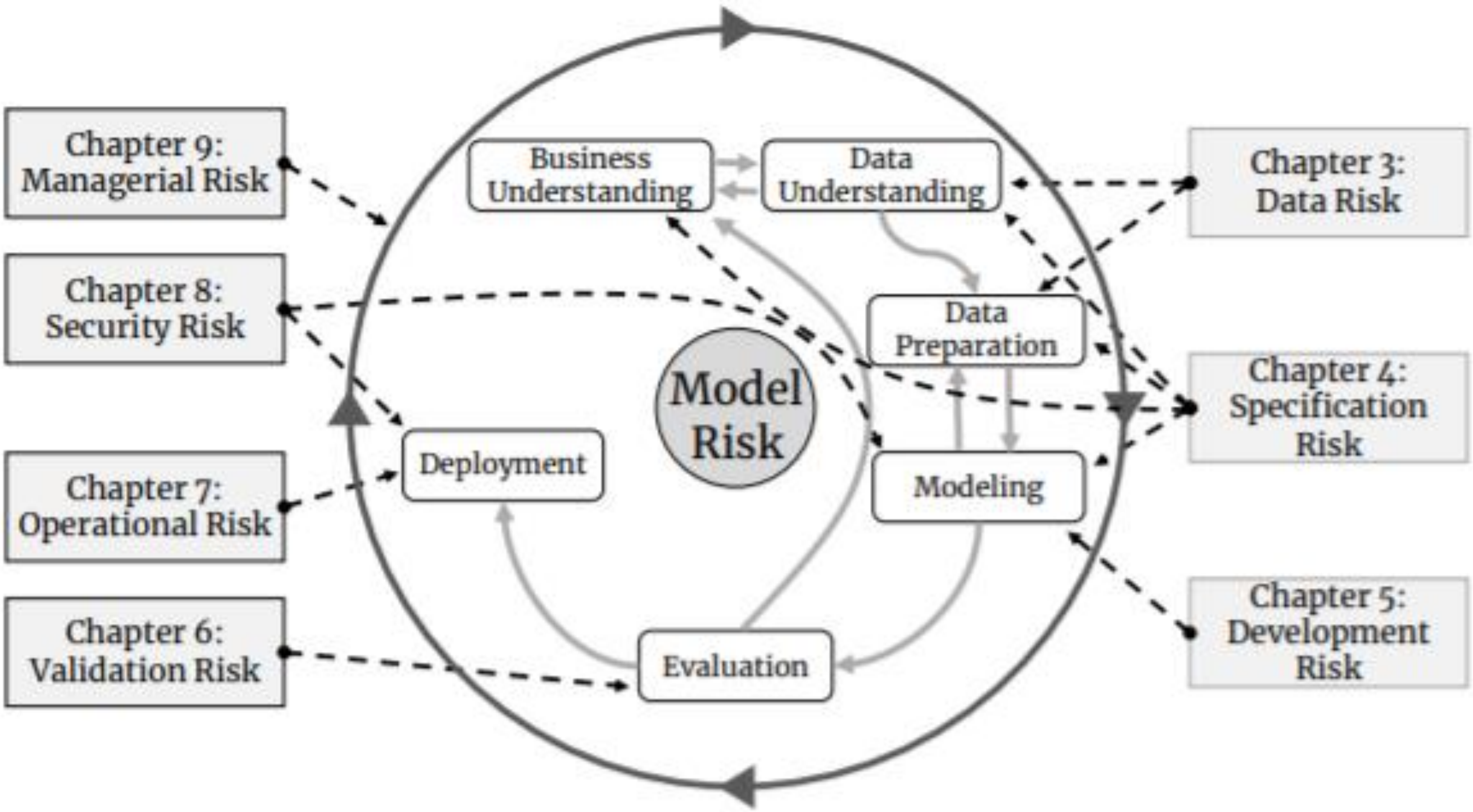
Setting the Stage

- FICO (2021)
  - 65% of companies cannot explain how specific AI model decisions or predictions are made
  - 73% have struggled to get executive support for prioritizing AI ethics
  - Only 20% actively monitor their models in production
  - 30% of organizations report an increase in adversarial and other attacks against their model

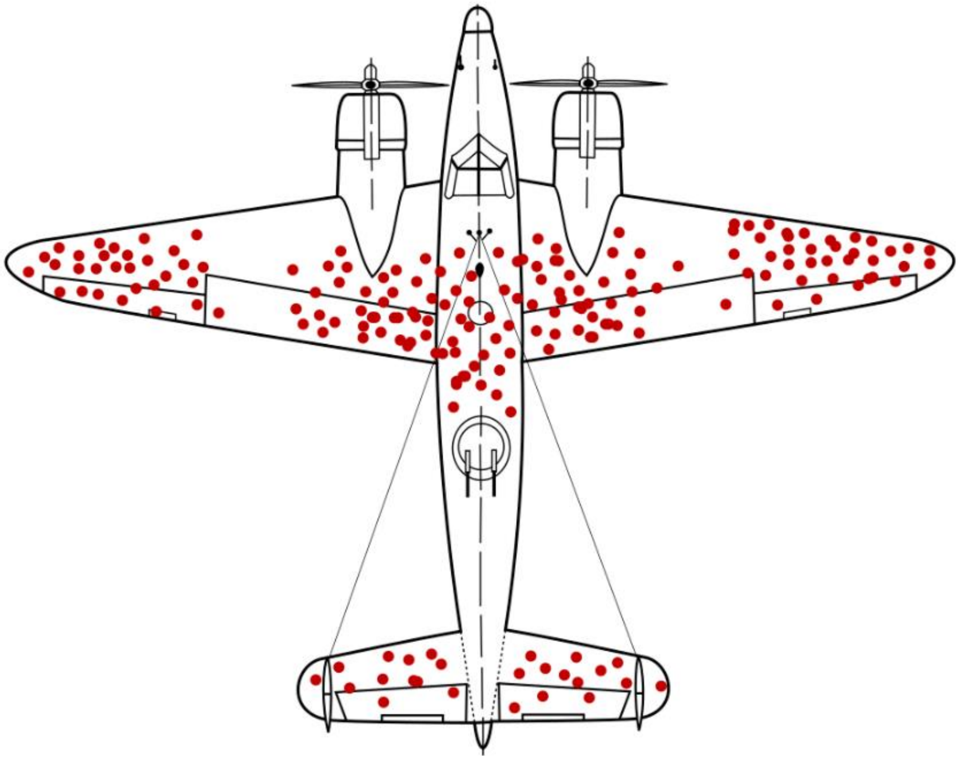
Model Risk

- *“Model risk is the risk of expected or unexpected loss resulting from the inadequate development or usage of analytical models across all business units and activities of the company.”*

Model Risk


Chapter 9: Managerial Risk
Chapter 8: Security Risk
Chapter 7: Operational Risk
Chapter 6: Validation Risk
Business Understanding
Data Understanding
Data Preparation
Model Risk
Deployment
Modeling
Evaluation
Chapter 3: Data Risk
Chapter 4: Specification Risk
Chapter 5: Development Risk

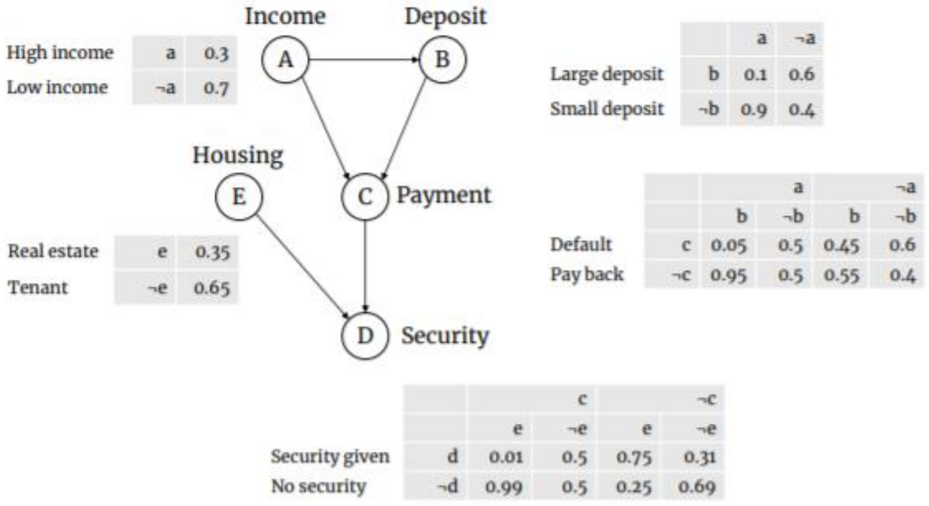
Data Risk: Data Bias



Every sample is biased!

Data Risk: Lack of Predictive Power

- Gather more data
  - external data, unstructured data, …
- Feature engineering
  - Yeo-Johnson
- Domain expertise
  - Bayesian networks



High income	a	0.3
Low income	¬a	0.7

		a	¬a
Large deposit	b	0.1	0.6
Small deposit	¬b	0.9	0.4

Real estate	e	0.35
Tenant	¬e	0.65

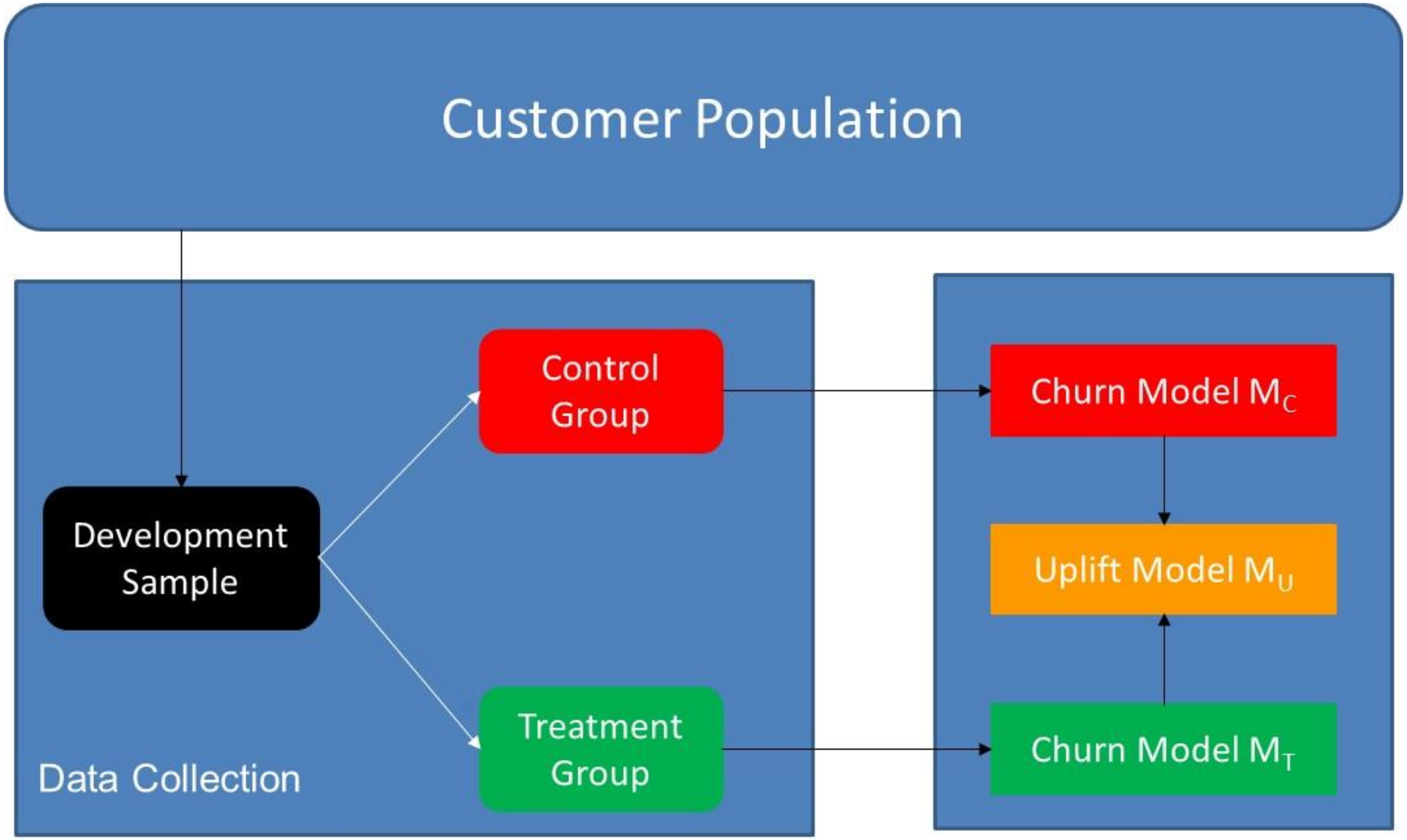
		a		¬a	
		b	¬b	b	¬b
Default	c	0.05	0.5	0.45	0.6
Pay back	¬c	0.95	0.5	0.55	0.4

		c		¬c	
		e	¬e	e	¬e
Security given	d	0.01	0.5	0.75	0.31
No security	¬d	0.99	0.5	0.25	0.69

Specification Risk: Incorrect Target Definition

- Customer Lifetime Value (CLV)
  - $CLV = \sum_{t=1}^{T} \frac{(R_t - C_t) s_t}{(1+d)^t}$
- Fraud detection
  - Suspicion based
- Credit Risk Modeling
  - 90 days in payment arrears

Specification Risk: Uplift modeling



Uplift model $M_U = M_T - M_C$

Specification Risk: Uplift modeling

Customer	Age	RFM	…	Treatment	Churn
Bart	40	221		1	1
Laura	32	551		1	0
…	…	…	…	…	…
Victor	28	243		0	0
Sophie	54	324		0	1
…					

- Lo (2002)
- $\mathrm{p}(y = 1|x_1, \dots, x_k\,, t) = \dfrac{1}{1+e^{-(\beta_0+\beta_1 x_1+\cdots+\beta_k x_k+\boldsymbol{\beta_{k+1} x_1 t}+\cdots+\boldsymbol{\beta_{k+k} x_k t}+\boldsymbol{\beta_{k+k+1} t})}}$

Specification Risk: Multicollinearity

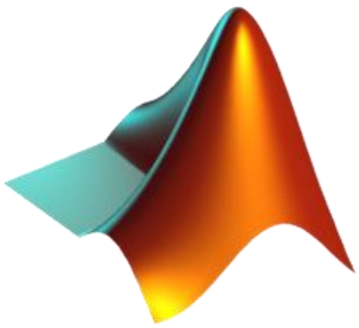
- Regression coefficients will be highly unstable and dependent upon other predictors
- Standard errors will become inflated
  - wide confidence intervals and inflated p-values
- Complicates interpretation
  - impact of variable spread across multiple correlated variables
- Performance driven perspective

Development Risk

- Citizen data scientist
  - ~citizen virologist
- Data leakage
  - Chinese wall between train/test set
- Assumptions
  - Only seldom satisfied

Development Risk

- Technological myopia
  - NoSQL, deep learning
- Programming errors
- Open source versus commercial software



Validation Risk

- Unexpected signs
- Wrong evaluation metrics
  - Profit driven versus statistical evaluation (AUC, lift, …)
  - Höppner S., Stripling E., Baesens B., vanden Broucke S., Verdonck T., Profit Driven Decision Trees for Churn Prediction, *European Journal of Operational Research,* 2020.
- Do complex models still make sense?
- Model auditing

Security Risk

- Model outsmarting
  - fraud detection
- Model exfiltration
  - model theft
- Denial of Prediction (DoP) attacks
  - Overload analytical model to make it crash

Managerial Risk

- Transition risk
- Model governance
- Waste of analytics

Managerial Risk

- Regulation risk
  - GDPR
- Model ethics
  - E.g., call detail records data (CDR) data for credit scoring?
- Climate change and ecological risk
  - Credit risk
  - Weather forecasting
  - Large carbon emission models (e.g., deep learning)

Conclusion

- Not possible to eradicate all model risk
- Qualify model risk as good as possible
- Develop coping mechanisms

More info?

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