Simulation lifecycle

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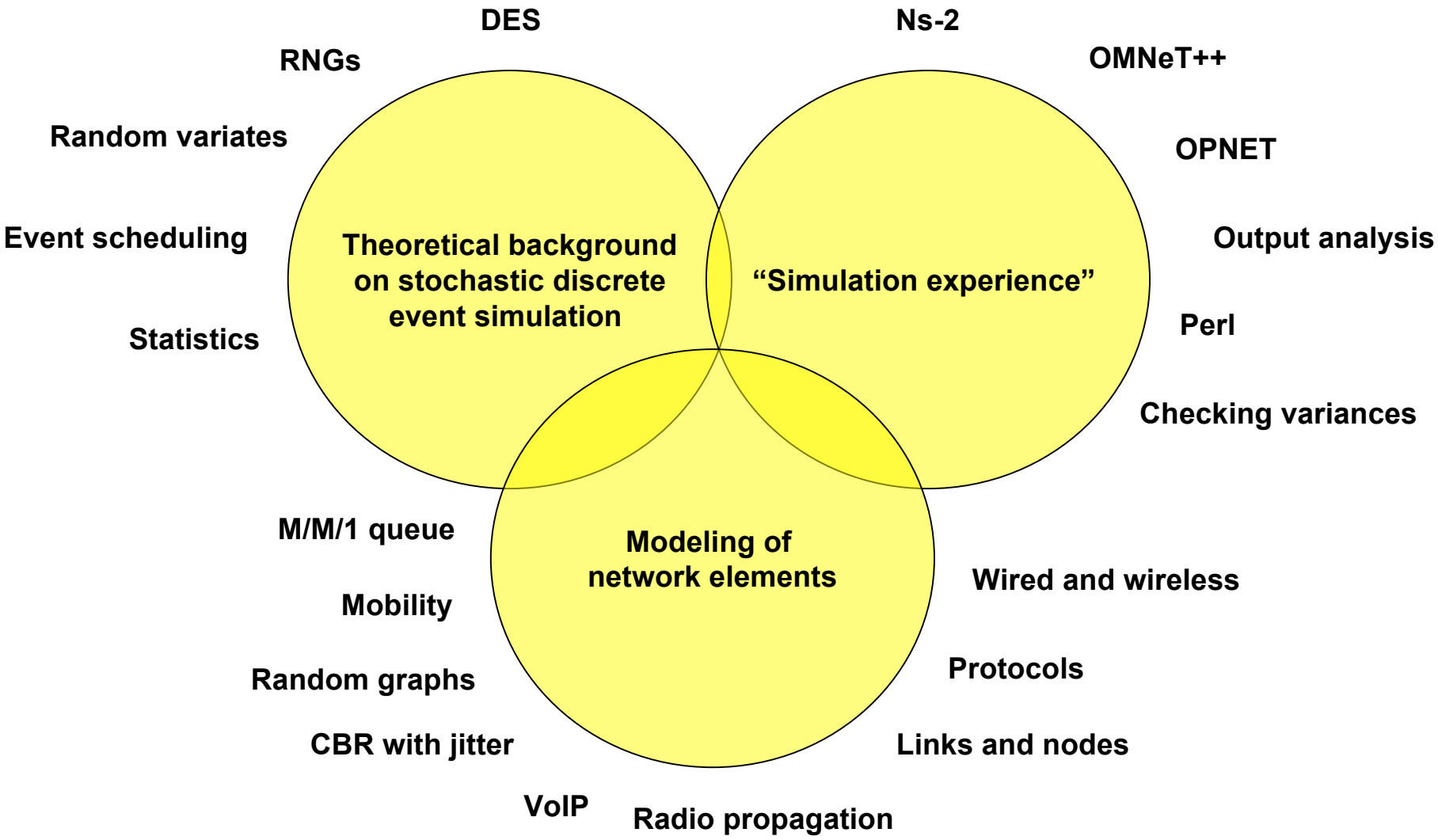
Lecture overview

- **Retrospection**
  - **Tour d'horizon**
  - **Simulation life-cycle (recap from another perspective)**

Retrospection

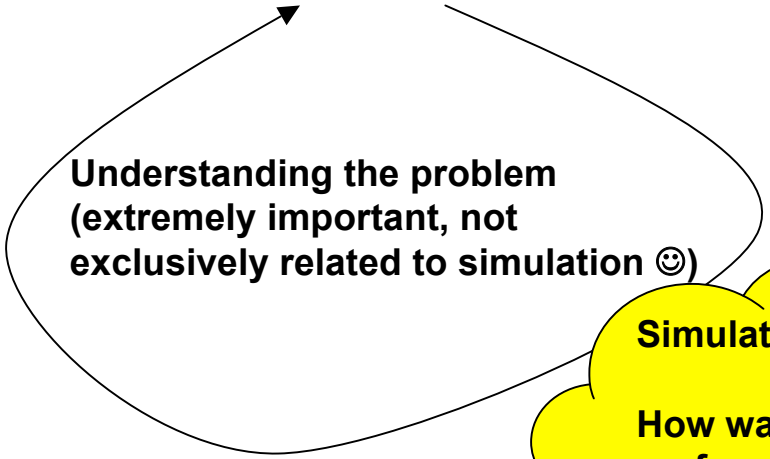


Simulation life-cycle

Generic

» **Communicated problem**

» **Formulated problem**



Example

» **Wireless multi-hop communication between vehicles to increase safety and comfort**

» **Routing/Forwarding in a highly dynamic mobile ad hoc network: which protocol/protocol class is optimal?**

– **Topology-based: AODV, DSR**

– **Position-based: GPSR, …**

Simulation literacy:

How was the study performed?

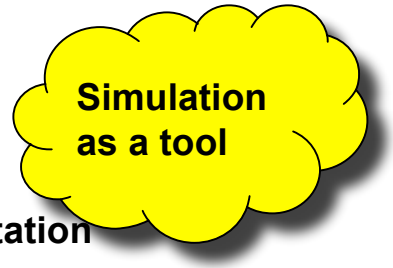
Do I trust the results?

Simulation life-cycle

» **Proposed solution technique: simulation**

» **System and objectives definition**

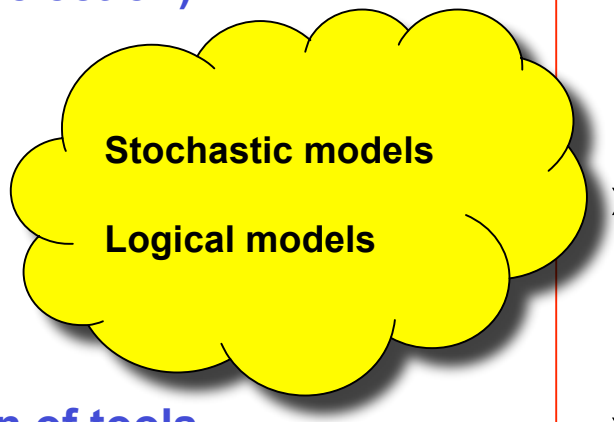
» **Why?**
- **Scalability**
- **Ease of experimentation**



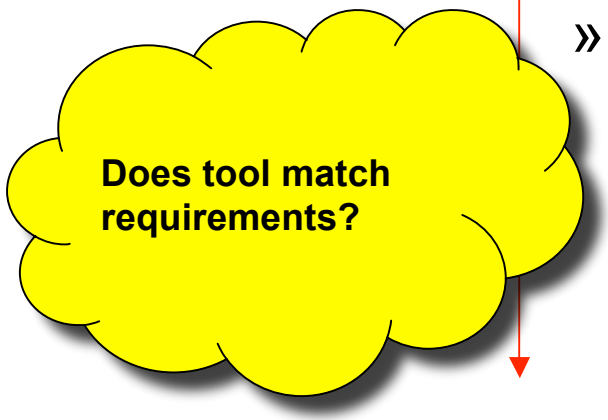
» **System: vehicles equipped with radio hardware and computing facility**
- **Need realistic movement patterns**
  - **Highways**
  - **Cities**
- **Need realistic DLC/MAC modeling**
- **Protocols under evaluation: …**
- **Performance measures:**
  - **Packet delivery ratio**
  - **Delay**
  - **Overhead/costs**

Simulation life-cycle

» Conceptual, communicative model (selection)



» Selection of tools



» A: Modeling vehicular traffic
- There exists a whole world of models; which one is appropriate?
- Selection of 'driver-behavior models'
- Our criterion: realism

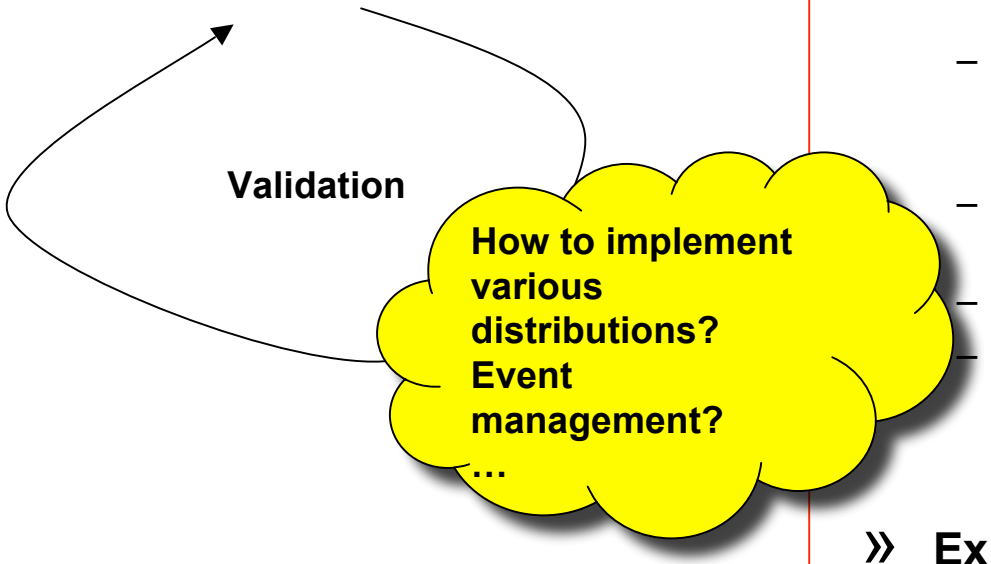
» B: Networking aspects
- Driven by network layer models
- How to model data traffic/applications?

» A: FARSI, a DaimlerChrylser simulator for vehicle movements

» B:
- Which one has already most of the required functionality?
- What about the RNG?
- Efficient event management?
- Selection of ns-2

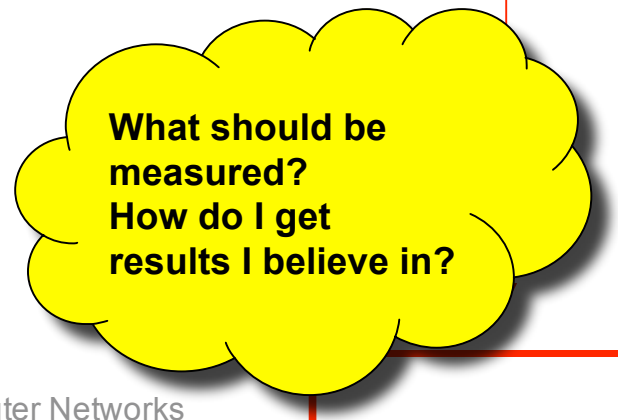
Simulation life-cycle

» Programmed model



– Generated and validated vehicular movement patterns
– Implemented position-based routing approach (and location service)
– Enhanced ns-2 to cope with our scenarios …
– Tcl scripts …
– Run time efficiency!

» Experimental model



» Experimental design

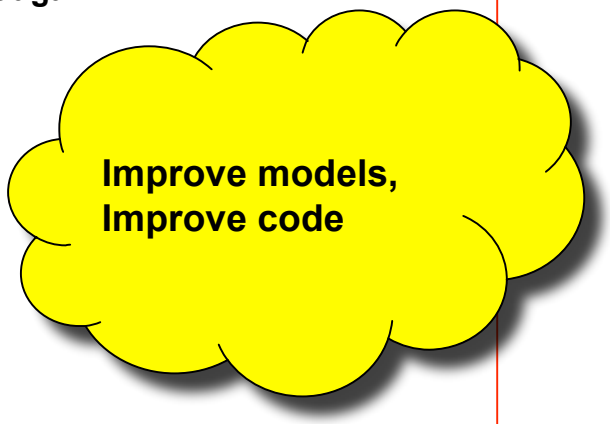
– Factors?
– Responses?
– Third variables?

– Scripts
– Statistics

Simulation life-cycle

» **Simulation results**

- Decision
- Re-definition
  - Start again

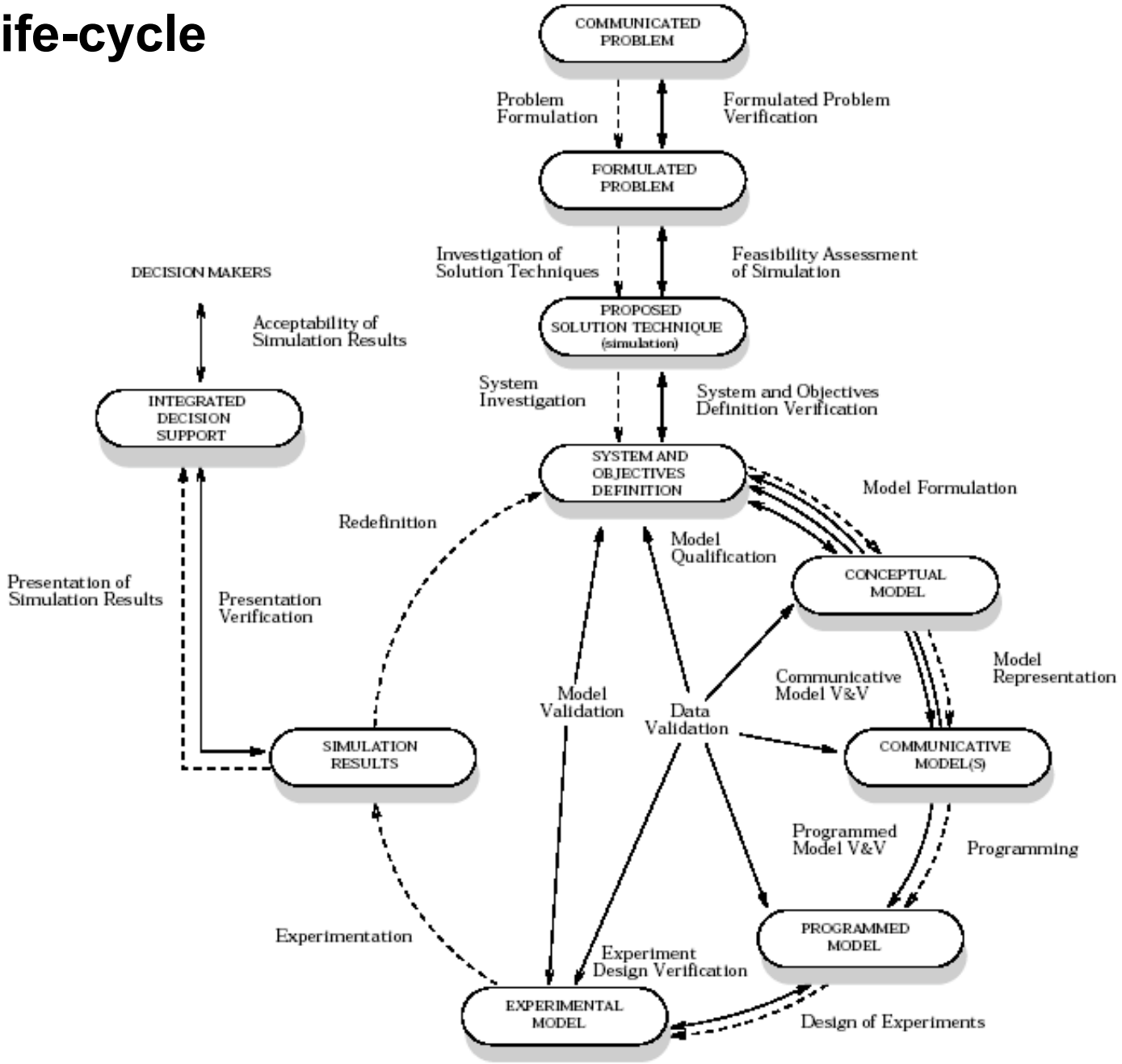


» **Simulation results:**

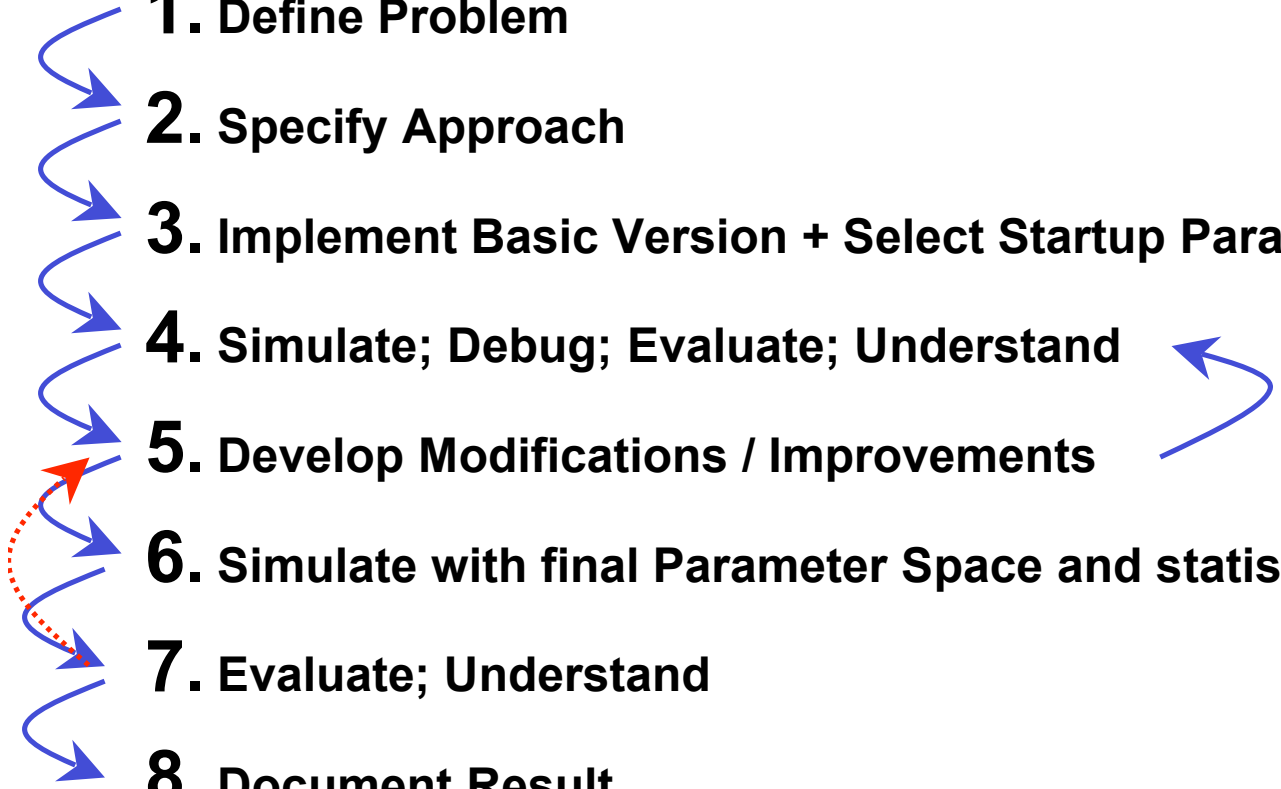
- Position-based routing clearly has advantages over topology-based approaches (decision)
- But: real-world measurements show some problems with radio fluctuations
- Re-definition

Simulation life-cycle

Nance/Balci model
1987



Simulation life-cycle New Network Protocol (U Mannheim)



1. Define Problem
2. Specify Approach
3. Implement Basic Version + Select Startup Parameter Space
4. Simulate; Debug; Evaluate; Understand
5. Develop Modifications / Improvements
6. Simulate with final Parameter Space and statistical Significance
7. Evaluate; Understand
8. Document Result

- Increase Model Granularity
- Adapt Parameter Space

Define the Parameter Space

- Identify „Environmental Factors“
  - e.g. Mobility
  - e.g. Node Energy Level
- Identify „Problem Factors“
  - e.g. Traffic Load the Protocol has to handle
- Identify Protocols
  - Identify Protocol Parameters per protocol

Problem: “Parameter Space Explosion”

- **Every varying parameter adds one dimension to parameter space**

  (if k parameters exist, each with n values, n^k combinations have to be simulated. Problem: Simulation Time)

- **Starting Point: 2^k factorial design:**
  - **select for every parameter a high/low or on/off value**
  - **simulate all (2^k simulations)**
  - **after evaluation reduce the number of parameters to the ones that are interesting and maybe extend parameter values**

- **During Simulation Lifecycle:**
  - **refine n and k**
  - **increase statistical significance**

Last Words

- Hope you have some more tools in your toolbox.
- Lots of thanks for having me as a lecturer.
- Good Luck to those taking the exam.
- „Nice Holiday“ to those who are not.