“A model is a representation of the structure of a real-life system”. [1]

Types of models [1]:
• Iconic – exact replica in smaller scale
• Analogue – the properties of one physical system are used to represent another one
• Symbolic – mathematical expressions and computer code for an abstract representation

Models describe the natural world using idealizations that
• simplify …
• capture …
• match …
• enable predictions …


Which idealized models do you remember from your physics classes?
• Simple pendulum
  •
  •

In which ways were they idealized?
• Massless string
  •
  •

How did you work with these models? How did you find solutions?
•
•
•
What are simulations?
Example for an analogue simulation:
Simulation of traveling waves with the aid of a crowd in a stadium.
• How would you instruct the spectators in a stadium to simulate a pulse traveling along a string?

• How would you tell them to simulate a traveling wave?

• How would you tell them to simulate, a standing wave?

• How would you simulate a two-dimensional plane wave or a spherical wave

Simulations require:
• a model, i.e. a representation of the physical system
• a set of instructions

Simulations provide an alternative to exact or approximate analytical solutions.
They are often used
• for complex systems, where exact solutions are not available and approximations difficult to find
• to test approximations used in analytical solutions
• to explore a system and find out where “interesting things” happen
• as an alternative to costly experimentation

Examples for simulation techniques:
• Monte Carlo
• Molecular dynamics
• Finite element methods
• Variational methods
• Finite difference methods
• Spectral methods
Flow diagrams (flowcharts)

Elements:

<table>
<thead>
<tr>
<th>flow line</th>
<th>connector</th>
<th>statement</th>
<th>question</th>
<th>input/output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Structures:

- **Sequence**
  - `statement_1`
  - `statement_2`
  - `statement_3`

- **Blocked sequence**
  - `statement_1`
  - `statement_2`
  - `statement_3`

- **Selection (if-then-else)**
  - `false`
  - `condition`
  - `true`
  - `else-part`
  - `then-part`

- **Selection (if-then)**
  - `false`
  - `condition`
  - `true`
  - `then-part`

- **Repetition (while loop)**
  - `false`
  - `condition`
  - `true`
  - `loop body`

- **Repetition (for loop)**
  - `initialize`
  - `update`
  - `false`
  - `condition`
  - `true`
  - `loop body`