Android

Heat Quiz

Game-based Learning in Heat and Mass Transfer

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STIFTERVERBAND

Institute of Heat and Mass Transfer

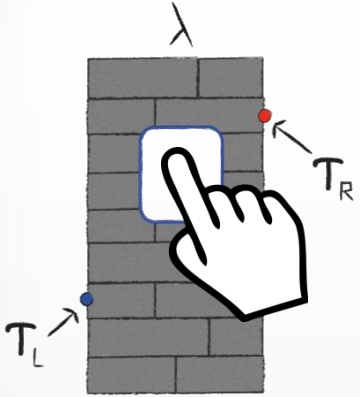
RWTH AACHEN UNIVERSITY

Motivation

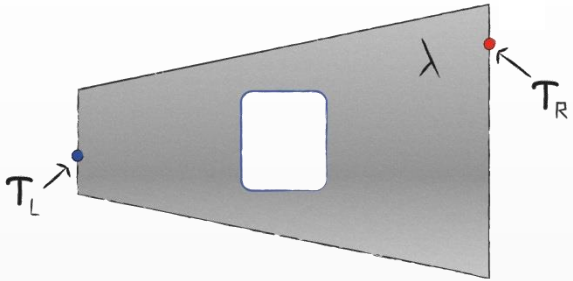
- Bachelor mechanical engineering (5. Semester)
- At RWTH Aachen University up to 1500 students each year
- Pass rate ~60%
- One-to-one tutoring impractical

- Improve teaching
- Decrease fail rate
- Support fun to learn
- **Facilitate training complex physical relationships**

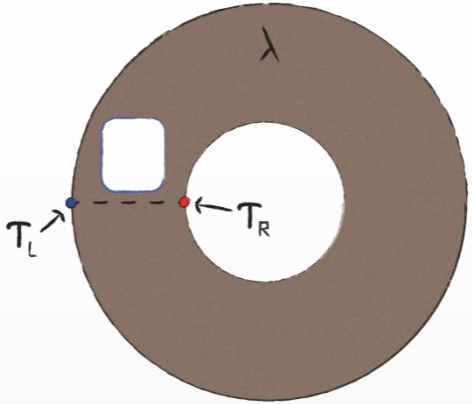
Conduction: Single body systems



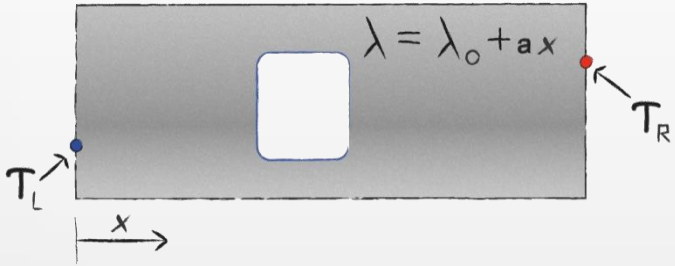
Variable area



Cylinders and spheres

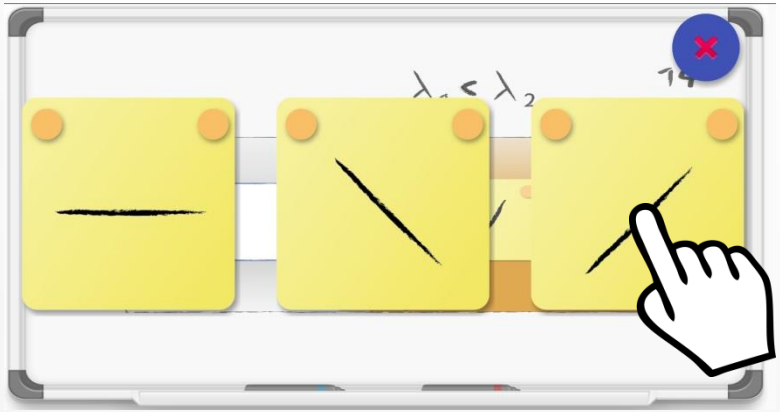


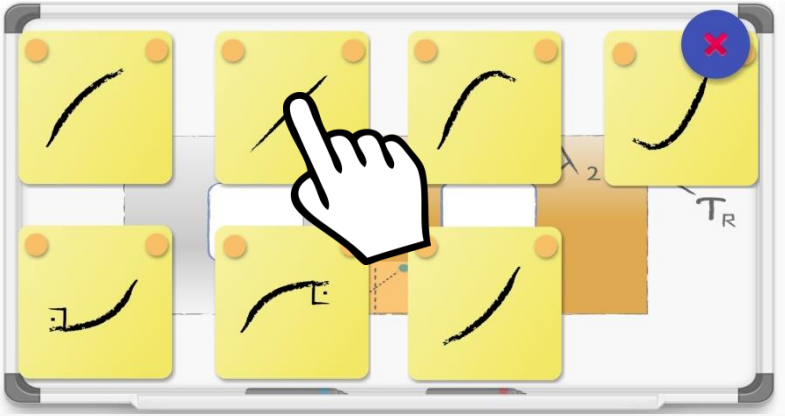
Variable material properties



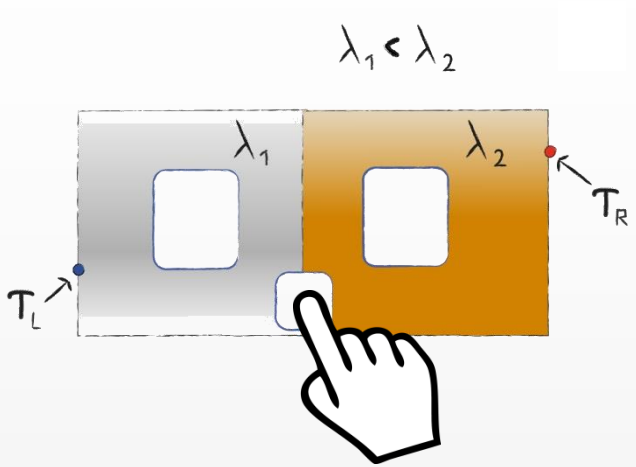
$$\dot{Q} = \text{const.} = -\lambda \cdot \frac{\Delta T}{\Delta x} \cdot A$$

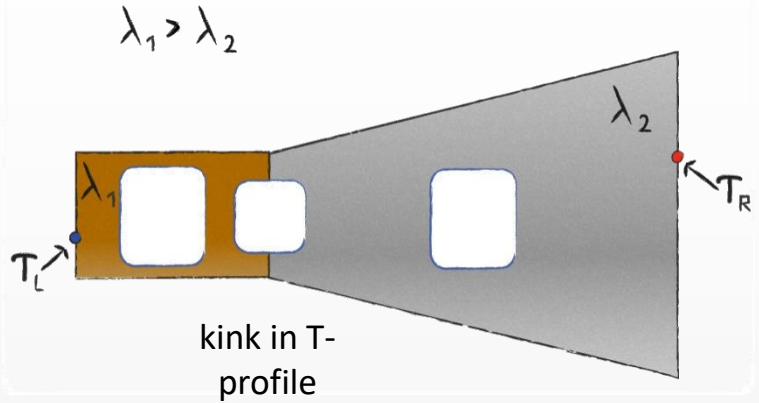
Game engine: Define temperature profile





Conduction: Multi-body systems

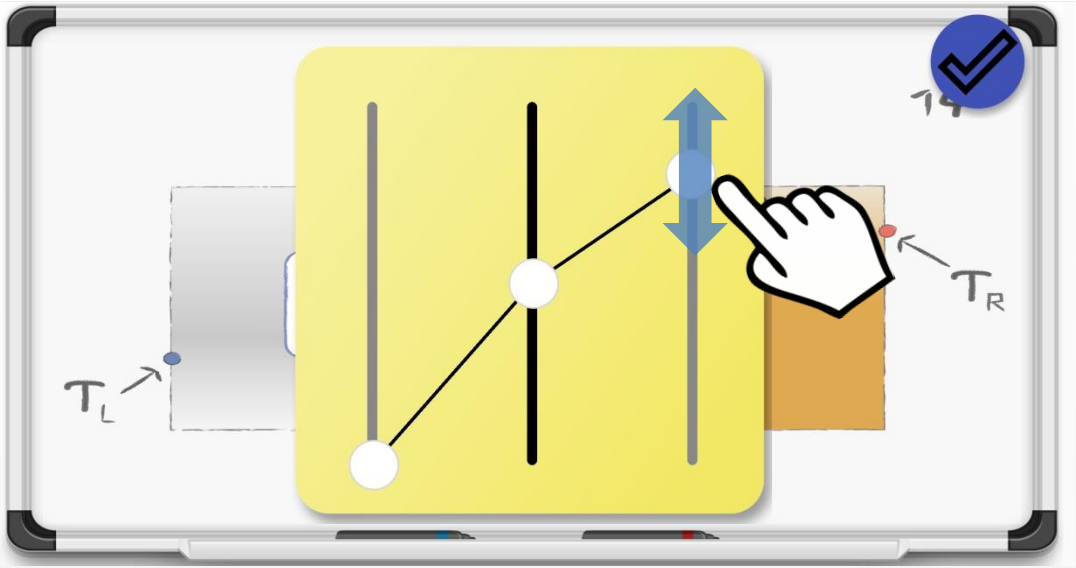




kink in T-profile

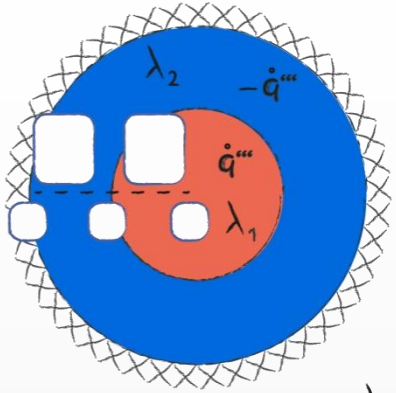
$$\dot{Q} = \text{const.} = -\lambda \cdot \frac{\Delta T}{\Delta x} \cdot A$$

Game engine: Define temperature gradient

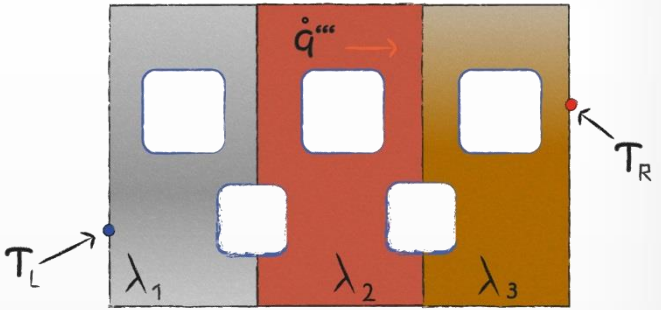


Conduction: Heat sinks and heat sources

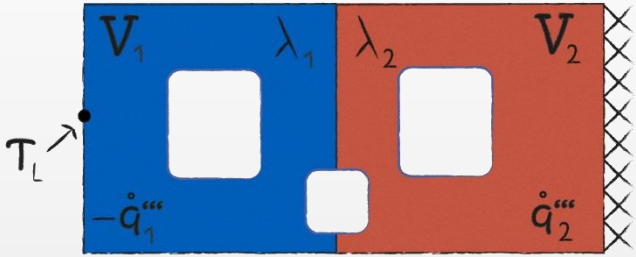
$\lambda_1 < \lambda_2$



$\lambda_3 < \lambda_2 < \lambda_1$

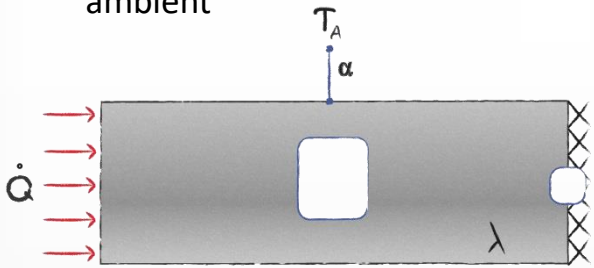


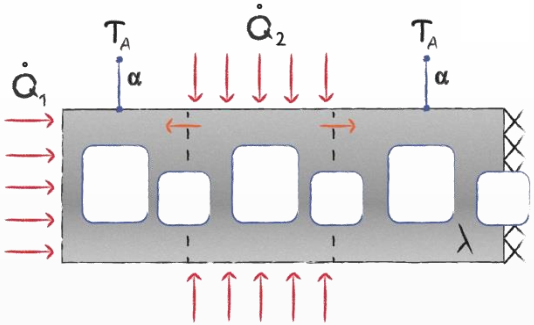
$\lambda_1 < \lambda_2 \quad V_1 = V_2 \quad \dot{q}_1''' = \dot{q}_2'''$



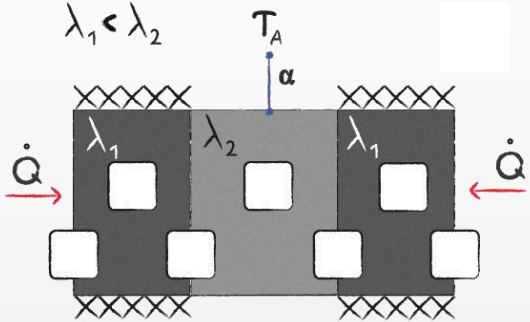
Conduction: Fins

Heat transfer to the ambient



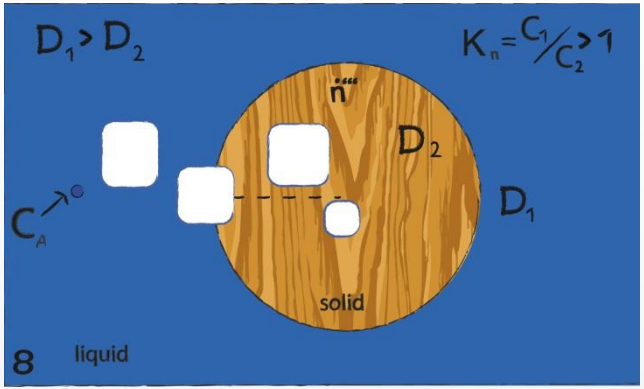


Body with section-wise boundary condition

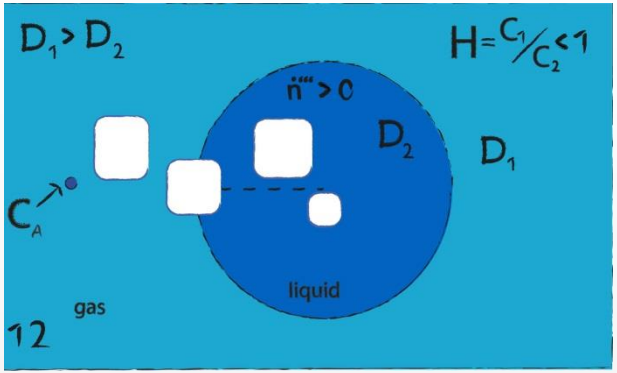


Diffusion: Multi-body systems with concentration jumps

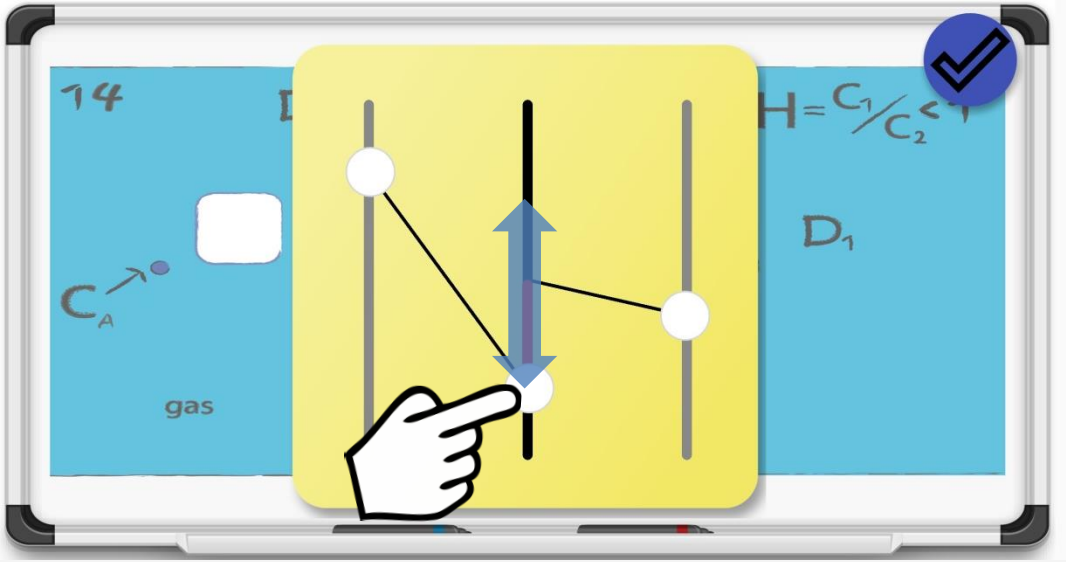
Nernst coefficient describes concentration jump at the liquid-solid interface



Henry coefficient describes concentration jump at the liquid-liquid interface

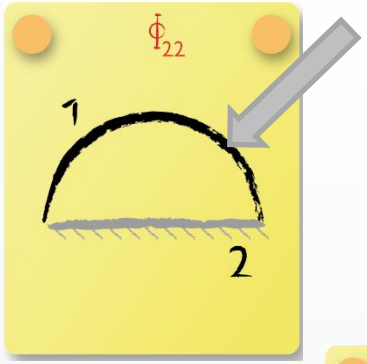


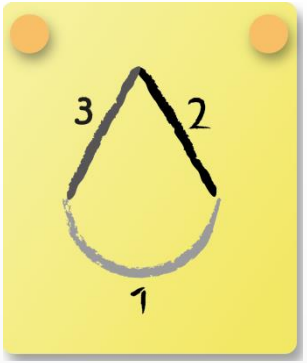
Game engine: Define concentration jump

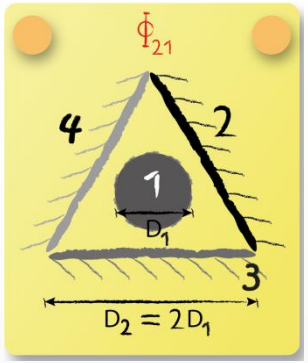


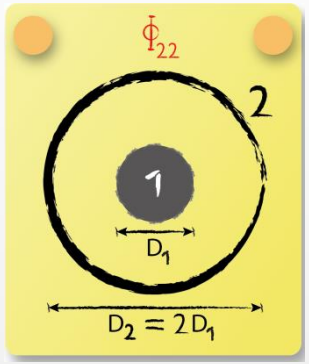
Radiative heat transfer: View factors

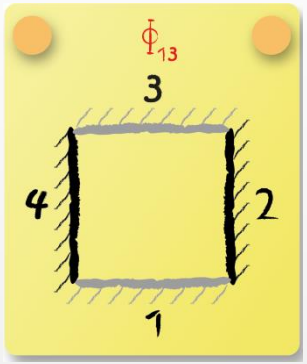
Self viewing body







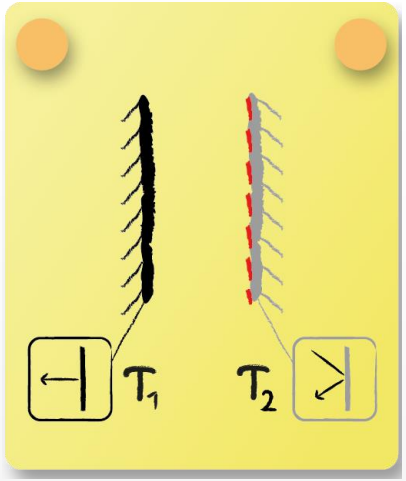




Sum rule
Reciprocity rule
Symmetry
Self-viewing bodies

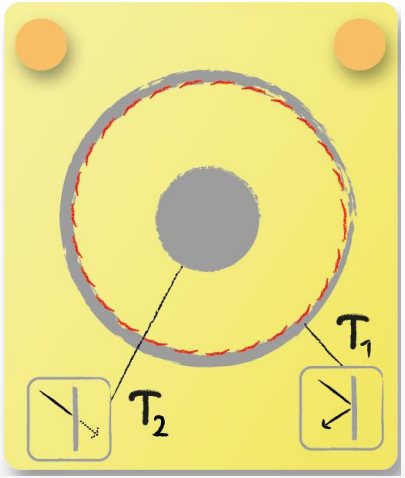
Radiative heat transfer: Surface brightness

Black body radiation
Grey body radiation



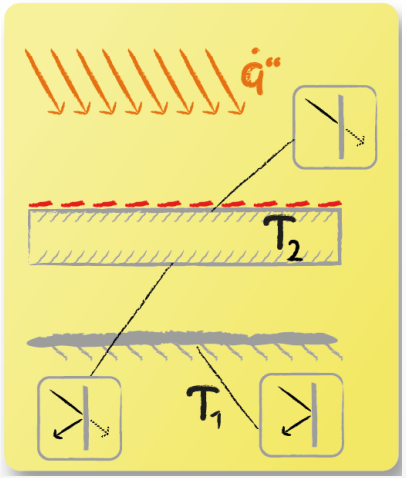
$$\dot{q}_2 = \varepsilon_2 \sigma T_2^4 + \rho_2 \dot{q}_1$$

Self-viewing objects



$$\dot{Q}_1 = A_1 \varepsilon_1 \sigma T_1^4 + \rho_1 \phi_{2\to1} \dot{Q}_2 + \rho_1 \phi_{1\to1} \dot{Q}_1$$

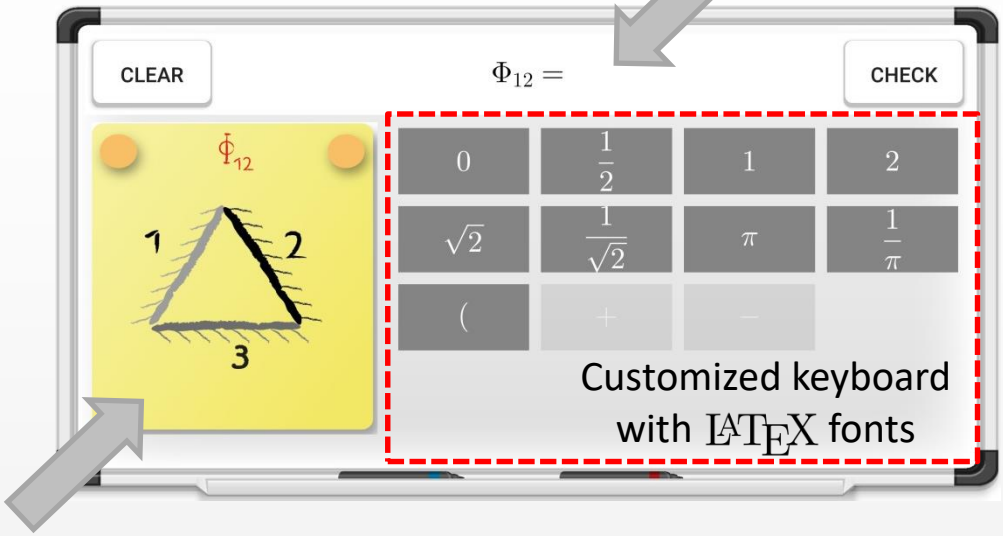
Reflection
Transmission



$$\dot{q}_{2,up} = \varepsilon_2 \sigma T_2^4 + \tau_2 \dot{q}_1$$

$$\dot{q}_{2,down} = \varepsilon_2 \sigma T_2^4 + \tau_2 \dot{q}$$

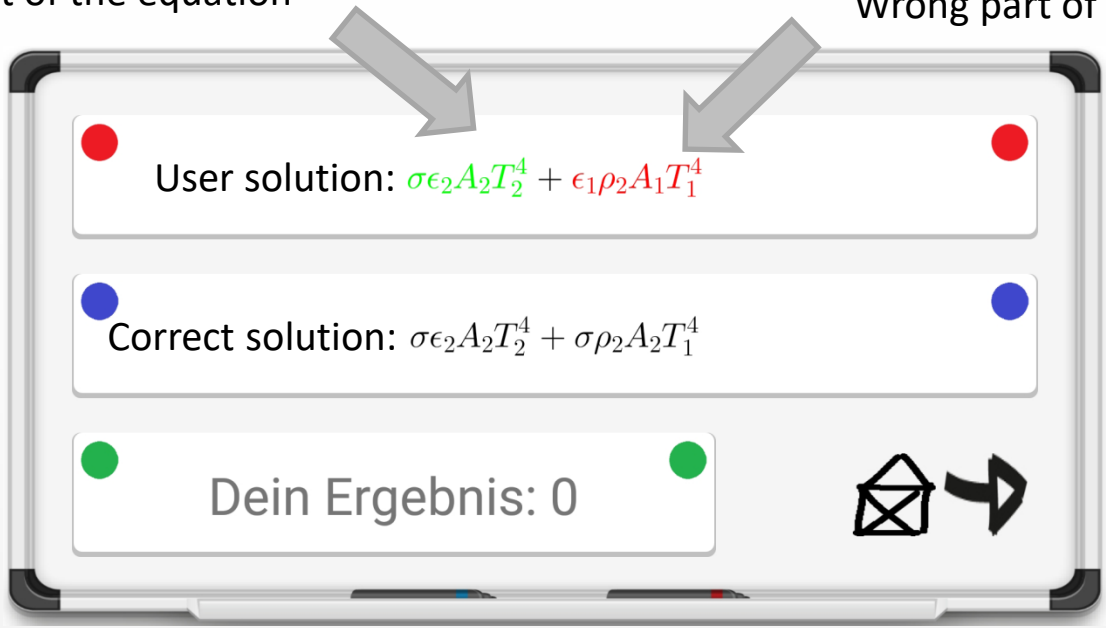
Game engine: Equation with custom keyboard



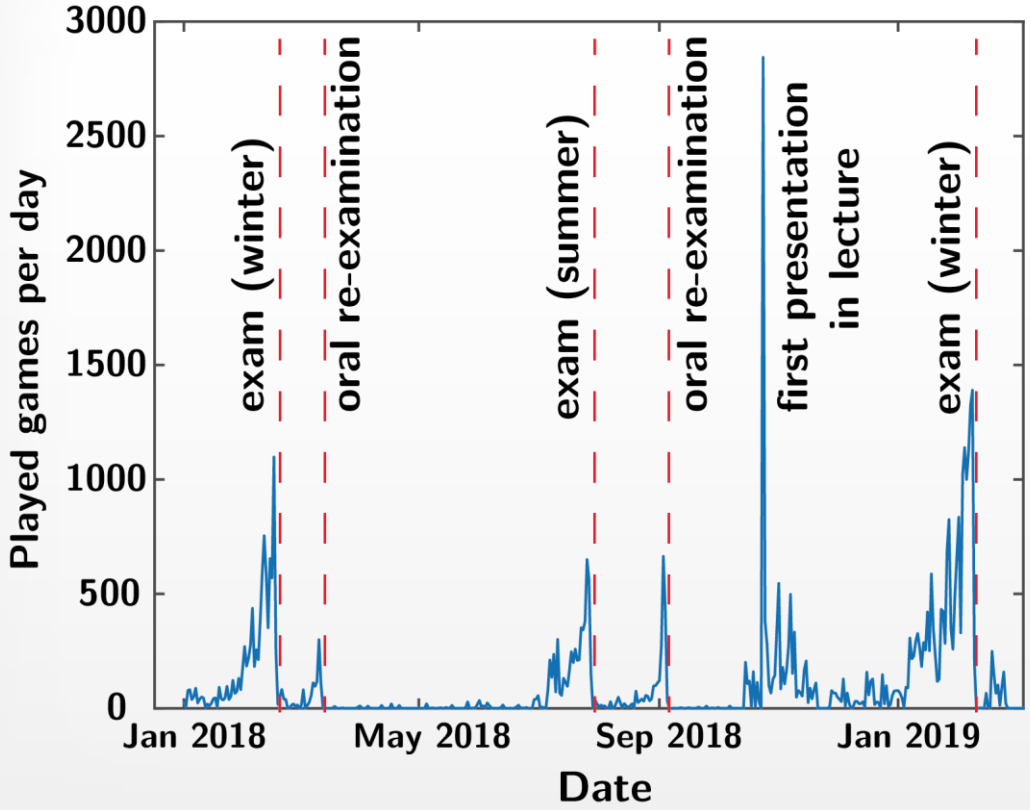
Solution screen

Correct part of the equation

Wrong part of the equation



Statistics



More than 60,000 games played so far

Usage of the APP especially close to the exams

Android
(Free of charge)

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