# Formal Methods in Software Development
# Exercise 1 (October 22)

Wolfgang Schreiner
Wolfgang.Schreiner@risc.uni-linz.ac.at

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The result is to be submitted by the deadline stated above via the Moodle interface as a .zip or .tgz file which contains

- A PDF file with
  - a cover page with the title of the course, your name, Matrikelnummer, and email-address,
  - for each exercise, a section with the number and name of the exercise and a copy of the ProofNavigator file used in the exercise,
  - for each proof of a formula $F$, a screenshot of the RISC ProofNavigator after executing the command `proof` $F$,
  - optionally any explanations or comments you would like to make;
- the RISC ProofNavigator (.pn) files used for the proofs;
- the proof directories generated by the RISC ProofNavigator.

## Exercise 1a (all): RISC ProofNavigator

Take the file "exercise1a.pn" and use the RISC ProofNavigator to prove the formulas A, B, C, and D in this file.

The formulas A–C are simple predicate logic proofs that only require the commands `scatter`, `split`, and `instantiate`.

> Rather than `instantiate`, you may also first try `auto`; the submitted proofs, however, must *not* make use of the `auto` command. Please also try the repeated application of the command `flatten` (rather than `scatter`) to see the gradual decomposition of the proof.

Formula D can be proved by `induction`, `scatter`, and two applications of `instantiate` (again, `auto` must not appear in the proof).

## Exercise 1b (all): Formalizing an Argument

Take the following argument:

- If Superman were able and willing to prevent evil, he would do it.
- If Superman were not able to prevent evil, he would be impotent.
- If Superman were not willing to prevent evil, he would be cruel.
- Superman does not prevent evil.
- Superman is neither impotent nor cruel.
- Thus Superman does not exist.

Formalize and prove this argument with the help of the RISC ProofNavigator (again, the command `auto` may be used on first try but must not appear in the final version of the proof).

Hint: introduce a predicate $S(x)$ ($x$ is Superman) and likewise, for each other property $T$ mentioned above, a predicate $T(x)$ ($x$ has property $T$). Then the sentence "Superman has property $T$" can be formalized as $\forall x : S(x) \Rightarrow T(x)$.