# Laboratory: *Basic Proof Techniques*

## Objectives

1. Installation and usage of `RISC ProofNavigator`
2. Examples of automated proofs from propositional logic/first order logic with `RISC ProofNavigator`

## 1 Installation and usage of RISC ProofNavigator

Website: `http://www.risc.jku.at/research/formal/software/ProofNavigator/`
Installation of a virtual machine on the local computer: `http://www.risc.jku.at/people/schreine/courses/software/#virtual`
After installation:

- login with user `guest` and password `guest`
- open a terminal and execute the commands:
  - `cd examples-ProofNavigator-CVC3`
  - `ProofNavigator &`

Explanation of some important commands of RISC ProofNavigator (see `https://moodle.risc.jku.at/pluginfile.php/5291/course/section/1019/01-logic.pdf`).
Useful command: `setxkbmap us` (the keyboard in the VM is German so we change it to US).

## 2 Examples

1. $\left(sum(0) = 0 \wedge \underset{\substack{n \\ n>0}}{\forall} sum(n) = n + sum(n-1)\right) \Rightarrow sum(n) = \frac{((1+n)*n)}{2}$
   - Proof by induction: `examples-ProofNavigator-CVC3/sum.pn`
     - Explanation of `sum.pn` in text and ProofNavigator mode
     - Manual proof
     - Automated proof using the commands: `induction`, `instantiate` $n$ by $n_0 + 1$.
2. $\underset{x\,y}{\exists\forall} P(x,y) \Rightarrow \underset{x\,y}{\forall\exists} P(x,y)$
   - Exemplification of proof techniques:
     - `examples-ProofNavigator-CVC3/quant.pn`
     - Explanation of `quant.pn` in text and `ProofNavigator` mode.
     - Manual proof
     - Automated proof using the commands `decompose`, `expand`, `flip`, `scatter`, `instantiate`
3. *If Superman were able and willing to prevent evil, he would do so. If Superman were unable to prevent evil, he would be impotent; if he were unwilling to prevent evil, he would be malevolent. Superman does not prevent evil. If Superman exists, he is neither impotent nor malevolent. Does Superman exist?*

4. From book Chang and Lee, page 15, Example 2.10
5. From book Chang and Lee, page 25, Exercise 13
6. From book Chang and Lee, page 40, Example 3.15
7. From book Chang and Lee, page 44, Exercise 11