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**Tutorials for “Automated Reasoning”**  
**Exercise sheet 7**

**Exercise 7.1:** (4 P)

Refute the clauses  $\{r(x, f(a)), \neg p(g(x, a), y), r(h(y), f(z))\}$ ,  $\{\neg r(u, v), s(g(h(u), v))\}$ ,  $\{p(g(h(w), w), w), s(g(h(h(w)), f(a)))\}$ ,  $\{\neg s(g(h(h(z)), f(z)))\}$  via the general resolution calculus.

**Exercise 7.2:** (7 P)

Consider the following puzzle “Cold Season”:

- (1) The apartments of Mr. Gruenberg and Felix are both bigger than the apartment which is heated by electric current.
- (2) Daniel has 35  $m^2$ . He doesn't heat with gas like Mr. Planek.
- (3) Mr. Monschein lives in Mariahilf, but not on 55  $m^2$  like another person.
- (4) One apartment has been heated with utility-supplied heat for years. It is smaller than the noble apartment in Doebbling but bigger than Martin's apartment. None of these three apartments belongs to Mr. Horvath.
- (5) Either the apartment in Mariahilf or the one in Hernals belongs to Felix.
- (6) The apartment in Leopoldstadt which is heated by oil does not belong to Mr. Horvath.
- (7) One of the apartment owners is named Werner.
- (8) One apartment has 90  $m^2$ , another has 95  $m^2$ .

Who lives where, how big are the apartments and who of the 4 apartment owners heat with gas?

Formalize this puzzle on paper using only the predicates

<i>Person</i> ( $x$ )	$x$ is a person
<i>Mariahilf</i> ( $x$ )	$x$ lives in Mariahilf
<i>Doebling</i> ( $x$ )	$x$ lives in Doebling
<i>Leopoldstadt</i> ( $x$ )	$x$ lives in Leopoldstadt
<i>Hernals</i> ( $x$ )	$x$ lives in Hernals
<i>ElectricCurrent</i> ( $x$ )	the apartment of $x$ is heated by electric current
<i>Gas</i> ( $x$ )	$x$ heats with gas
<i>Oil</i> ( $x$ )	$x$ has oil heating
<i>UtilitySupplied</i> ( $x$ )	$x$ heats with utility-supplied heat
<i>SQM35</i> ( $x$ )	$x$ lives on 35 $m^2$
<i>SQM55</i> ( $x$ )	$x$ lives on 55 $m^2$
<i>SQM90</i> ( $x$ )	$x$ lives on 90 $m^2$
<i>SQM95</i> ( $x$ )	$x$ lives on 95 $m^2$
<i>Aib</i> ( $x, y$ )	the apartment of $x$ is bigger than the apartment of $y$
<i>Daniel</i> ( $x$ )	the first name of $x$ is Daniel
<i>Martin</i> ( $x$ )	the first name of $x$ is Martin
<i>Felix</i> ( $x$ )	the first name of $x$ is Felix
<i>Werner</i> ( $x$ )	the first name of $x$ is Werner

and only the constants *gruenberg*, *planek*, *monschein*, *horvath*. Once you have done that, write the corresponding input file for SPASS and try to answer the question. If you formalize correctly, SPASS will find a model, calling SPASS with option `-DocProof` (or taking the provided empty input file which already includes this option) will print the saturated set of clauses and by inspection of these clauses you will find the answer.

Provide paperwork and final answer by paper, but the SPASS input file as well as the proof output electronically to your tutor.

**Challenge Problem:** (2 Bonus Points)

Consider two linear and variable disjoint terms  $s, t$ . Show that

$$s \doteq t \Rightarrow_{SU}^* E \text{ iff } s \doteq t \Rightarrow_{SU'}^* E$$

where  $\Rightarrow_{SU'}$  is  $\Rightarrow_{SU}$  without the occur check rule  $x \doteq t, E \Rightarrow_{SU} \perp$  if  $x \neq t, x \in \text{var}(t)$ .

Submit your solution in lecture hall 002 during the lecture on June 05. Please write your name and the date of your tutorial group (Mon, Tue, Thu) on your solution.

**Note:** Joint solutions, prepared by up to three persons together, are allowed (but not encouraged). If you prepare your solution jointly, submit it only once and indicate all authors on the sheet.