Lab 5:
Puzzling Prolog

Due on the day of your final exam.

In this lab, you will write a solver for a game related to Sudoku called KenKen. You will also write a solver for two logic puzzles similar to the ones shown in class.

KenKen

KenKen is a mathematics puzzle game similar to Sudoku, in which a $N \times N$ grid of numbers must be solved so that each square contains a number from 1 up to N. As in Sudoku, every row and column of KenKen can contain a particular number only once, and every number from 1 to N **must** be in each row and column. KenKen does not use the "3x3 squares" uniqueness rule of Sudoku; instead, each KenKen puzzle breaks up the squares into various irregular **"cages"**, and in each cage a single **target value** and a single **operator** is placed. When the operator is applied to the squares of the cage, the given value is obtained. The order that the operator is applied to the squares is not fixed, which is important for division and subtraction. See Wikipedia for an explanation.

Adapt the Sudoku solver from lecture to solve then KenKen puzzle shown at the end of this lab. (The colored squares don't mean anything.)

You need to retain the code that forces unique values for each entry in a row/column, but do not need the "3x3 squares" code. You will need to directly encode the **values** and **operators** for each cage into the logic itself. For example, if the first two squares in the first row are a cage with **3**+ written in the puzzle, then you would need a relation forcing the sum of `A1` and `A2` to be `3`.

Implementation notes:

1. The library `clpfd` used in the Sudoku solver will be needed here. This library uses its own syntax for checking arithmetic values for equality. **Do not use `is` or `=` for enforcing cage constraints; you need to use `#=`.**
2. If a cage is marked **3-**, then you will need an OR relation because the order of the squares is not fixed, e.g., `(A1 - A2 #= 3; A2 - A1 #= 3)`. Likewise for division.
3. The website puzzle linked above uses $\div$ for division. You will need to use `//` in Prolog.

It can be difficult to diagnose errors in Prolog code, so you might want to start by solving a smaller 4x4 "easy" puzzle from an online source. It will require fewer constraints and you can make sure your ideas are working before spending a lot of time on the much larger puzzle.

Logic Puzzles

Write a Prolog program to solve two new logic puzzles, given on the next page. The first, "Imaginary Friends", will be similar to the Ties example from lecture. The second, "Star Tricked", is harder – you will need a way of writing facts for "occurred earlier in the week". You can use simple clauses like `earlier(tuesday, wednesday).` or you can encode days as numbers and use arithmetic, then translate the output.

Deliverables

Turn in the following when the lab is due:

1. A printed copy of your code, **printed from your IDE when possible.** If you cannot print from your editor, copy your code into Notepad or another program with a fixed-width (monospace) font and print from there.
2. A printed copy of the output solutions for each of the 3 programs.

IMAGINARY FRIENDS BY KEITH KING ★

Grantville's local library recently sponsored a writing contest for young children in the community. Each of four contestants (including Ralph) took on the task of bringing to life an imaginary friend in a short story. Each child selected a different type of animal (including a moose) to personify, and each described a different adventure involving this new friend (one story described how an imaginary friend had formed a rock band). From the following clues, can you match each young author with his or her imaginary friend and determine the adventure the two had together?

Solution is on page 54.

1. The seal (who isn't the creation of either Joanne or Lou) neither rode to the moon in a spaceship nor took a trip around the world on a magic train.
2. Joanne's imaginary friend (who isn't the grizzly bear) went to the circus.
3. Winnie's imaginary friend is a zebra.
4. The grizzly bear didn't board the spaceship to the moon.

	Grizzly bear	Moose	Seal	Zebra	Circus	Rock band	Spaceship	Train
Joanne								
Lou								
Ralph								
Winnie								
Circus								
Rock band								
Spaceship								
Train								

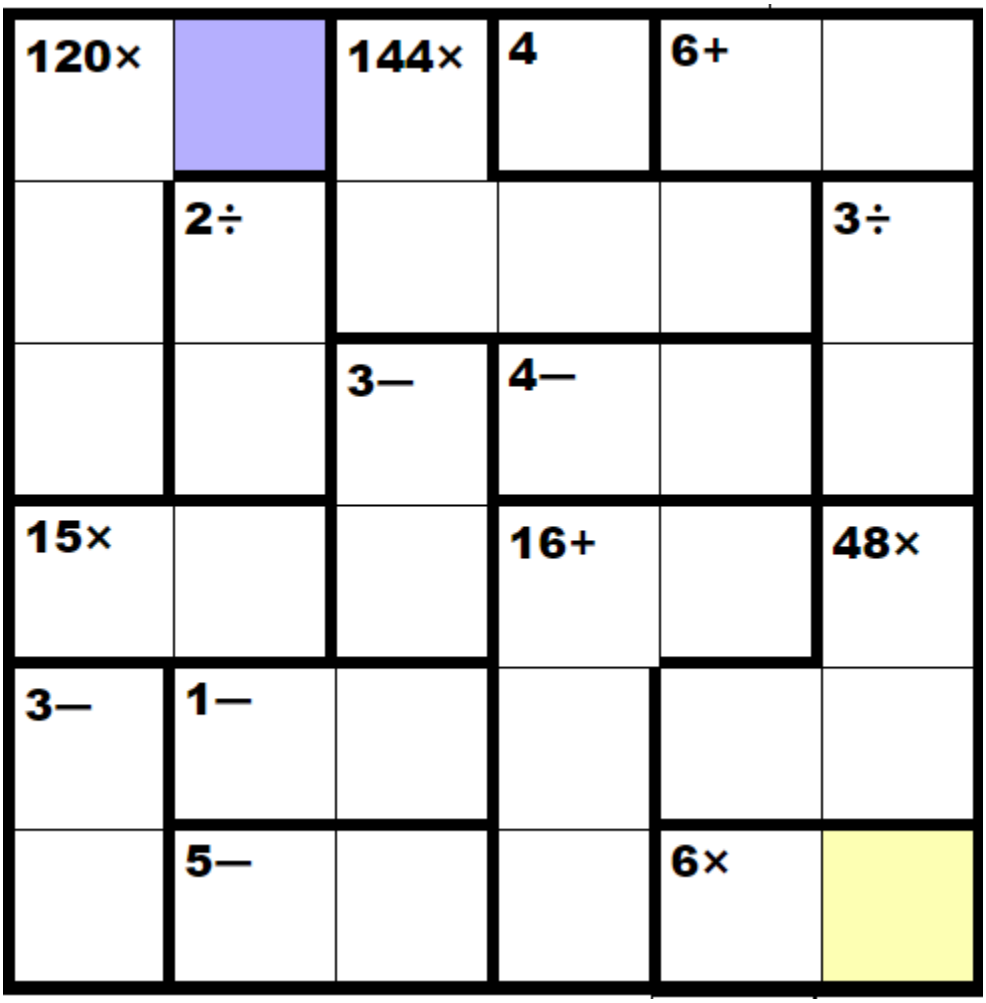
STAR TRICKED BY KEITH KING ★

Last week, four UFO enthusiasts made sightings of unidentified flying objects in their neighborhood. Each of the four reported his or her sighting on a different day, and soon the neighborhood was abuzz with rumors of little green men. By the weekend, though, the government stepped in and was able to give each person a different, plausible explanation of what he or she had "really" seen. Can you determine the day (Tuesday through Friday) each person sighted a UFO, as well as the object that it turned out to be?

Solution is on page 54.

	Ms. Barrada	Ms. Gort	Mr. Klatu	Mr. Nikto	Balloon	Clothesline	Frisbee	Water tower
Tuesday								
Wednesday								
Thursday								
Friday								
Balloon								
Clothesline								
Frisbee								
Water tower								

1. Mr. Klatu made his sighting at some point earlier in the week than the one who saw the balloon, but at some point later in the week than the one who spotted the Frisbee (who isn't Ms. Gort).
2. Friday's sighting was made by either Ms. Barrada or the one who saw a clothesline (or both).
3. Mr. Nikto did not make his sighting on Tuesday.
4. Mr. Klatu isn't the one whose object turned out to be a water tower.


120×
144×
4
6+
2÷
3÷
3—
4—
15×
16+
48×
3—
1—
5—
6×