

## Non-Transitive Dice

Consider a set of three dice, A, B and C such that

- die A has sides  $\{2,2,4,4,9,9\}$ ,
- die B has sides  $\{1,1,6,6,8,8\}$ , and
- die C has sides  $\{3,3,5,5,7,7\}$ .

Then:

- the probability that A rolls a higher number than B is  $5/9$
- the probability that B rolls a higher number than C is  $5/9$
- the probability that C rolls a higher number than A is  $5/9$

Thus A is more likely to roll a higher number than B,

- B is more likely to roll a higher number than C,
- C is more likely to roll a higher number than A.

The relation "is more likely to roll a higher number" is not transitive so we say this is a set of non-transitive dice

### Questions to consider

- Are there any more interesting sets of 3 non-transitive dice with equal probability?
- What is the largest set of non-transitive dice you can find?
- What other questions can you answer about non-transitive dice using CP techniques?

## Assignment

You should undertake some experiments to find out what the best model and solving method for this non-transitive dice problem is. In particular, you should experiment with some of the techniques discussed in lectures including:

- Eliminating Symmetry
- Adding Implied Constraints
- Reformulating Constraints
- Changing the Variable and Value Ordering
- Preprocessing

## Suggested Schedule

### Week beginning Monday 26th of January

In the lab I suggest that you try to get a basic model of the problem working.

### Week beginning Monday 2nd of February

In the lab I suggest you start considering which problems you are going to try to solve in relation to non-transitive dice. The questions above should give you a starting point in this.

### Week beginning Monday 9th of February

In the lab I suggest you try out some of the more advanced techniques such as symmetry and variable and value ordering. In the lecture we will discuss how the assignment will be marked.

### Week beginning Monday 16th of February

There are no lectures or labs this week so you can concentrate on finishing your programming and writing the report.

## Hand in

This assignment should be done in groups of up to 5 people.

You should write a report of at most 12 pages on the investigations you have undertaken. It should be in the style of the research paper Scheduling a Rehearsal by Barbara M. Smith.

In particular, I would expect your paper to contain lots of tables of the following type.

Problem Instance	Method 1		Method 2	
	Backtracks	Time (in seconds)	Backtracks	Time (in seconds)
Non-transitive dice instance 1				
Non-transitive dice instance 2				
Non-transitive dice instance 3				

This table can be extended down to contain more instances and extended across to provide comparison between more methods.

Please hand in a copy of the report through Blackboard by 5pm on Monday the 23rd of February, all the code should be submitted as an appendix to the report.