Puzzles style Traverser la rivière

River crossing puzzles have been a recurrent theme in recreational mathematics. The best-know is The fox, the goose, and the grain which was popularized by Lewis Carroll, who often presented it to young children. He did not take credit for its creation. It apparently originated in the 8th century. which attests to the staying power of the puzzle.

River crossing puzzles span a range of difficulty. Here are more than you will ever need, beginning with Carroll's, and continuing with increasing difficulty

**The fox, the goose, and the grain**

A farmer has to transport a fox, a goose, and some grain across a river. He has a boat which he can row back and forth from shore to shore. He can take himself and one other thing in the boat. However, unless he is present, the goose will eat the grain and the fox will eat the goose. How can he transport all three things across the river?

### The fox, the goose, the grain, and the dog

This time, the farmer has to transport a fox, a dog, a goose, and some grain across a river. He has a boat which can carry himself and either the fox, dog, goose, or grain. If the farmer isn't present, the fox cannot be left with either the dog or the goose, or both. If need be, the goose can be left with the grain provided the dog is present because the dog will guard the grain and won't eat the goose. Help the farmer cross the river.

(This puzzle is from The New Puzzle Classics by Serhiy Grabarchuk, Sterling publishing company, New York, 2005.)

### The mouse, the elephant, the dog, and the cat

Just to illustrate how exactly the same puzzle can be presented in a different setting, here is the above puzzle dressed up differently.

A circus owner wants to transport his elephant, his dog, his cat and his mouse across a river. He can take one at a time across the river. But, unless he is there, the cat will fight with the mouse, the dog will fight with the cat, and the elephant will fight with the dog. However, as everyone knows, the elephant is frightened of the mouse, and if the mouse is present, the elephant will not fight with the dog.

By taking the animals back and forth, how does the circus owner get all across without any fighting breaking out?

For yet another variation and a nice discussion of it, see The lettuce-fearing leviathan in the book A fine math you've got me into by Ian Stewart.

### Soldiers and children

Two soldiers have to cross a river. They have discovered a small boat in which is being rowed by two children. The boat can only carry two children or a single soldier. How did the soldiers get across the river and afterwards leave the two children with their boat?

This is from 536 puzzles and curious problems by H. E. Dudeney, edited by Martin Gardner. Scribners, 1967. Dudeney's puzzle is called Crossing the river, and had 358 soldiers and asked for the total number of trips required. If you can solve it for 2 soldiers, you can solve it for 358.

### Animal crossing

There are three dogs and three cats that have to be transported across a river: a big dog, a medium dog and a small dog, a big cat, a medium cat, and a small cat. The boat can carry two animals, and all of the animals can row.

The medium dog cannot be left alone with either of the other dogs, nor can the medium dog be transported with another dog, because if the two are by themselves they will fight. The big dog will not fight with the small dog. Also the medium cat cannot be left alone with either of the other cats, nor can the medium cat be transported with another cat for the same reason, and the big cat never fights with the small cat.

To make matters worse, if ever there are more dogs than cats together on the shore, the dogs will fight with the cats.

How can the animals get across the river without a fight breaking out?

This is from 536 puzzles and curious problems by H. E. Dudeney, where it is called Crossing the ferry. Dudeney's problem featured squabbling families rather than cats and dogs. The solution provided in the book is incorrect.

### The three thieves

Tom stole a mug worth $3000. Dick stole a jug worth $5000. Harry stole a rug worth $8000. To escape, they had to cross a river in a boat which either held two people or one person and one item. No person was to be left alone with objects worth more than what he stole, but two people could act as checks for each other, and could be trusted with objects worth more than what they stole. How would they cross the river, given that all three could row?

(From Henry Dudeney's Amusements in Mathematics.

### The missionaries and the cannibals

Three missionaries and three cannibals had to cross a river in a boat which held two people. If some missionaries were outnumbered, on either shore, by the cannibals, their missions were over. How would all six cross the river, given that all of them could row?

(From T. H. O'Beirne's Puzzles and Paradoxes

### Quarrelsome boys

A father took his sons out for a picnic and had to cross a river in a small boat. The boys were born one year apart. Two boys would fight each other if their ages differed by one year, provided that the father was not around to stop it.

Given that only the father could row, how could this family cross the river peacefully, if

1. there were three boys and the boat held two people;
2. there were five boys and the boat held three people, and the father could stop fights on the boat;
3. there were five boys and the boat held three people, but the father could not stop fights on the boat?

(From T. H. O'Beirne's Puzzles and Paradoxes.)

**Jealous husbands**

Several couples went on a picnic and had to cross a river in a small boat. No husband would leave his wife in the company of another man unless he himself was present. Given that everyone could row, how could this party cross the river without jealousy arising, if

1. there were three couples and the boat held two people;
2. there were four couples and the boat held two people, and there was an island in the middle of the river;
3. there were five couples and the boat held three people?

(From Henry Dudeney's *Amusements in Mathematics*.)

### A handful for the farmer

A farmer was trying to cross a river in a boat which held him and two items, to be chosen from two wolves, one dog, one goat and one bag of grain. When the farmer was not around, either wolf would eat the dog or the goat, the dog would eat the goat and the goat would eat the grain. How could the farmer transport all five items across the river to his home, where he would eat them himself?

(From the May 1990 issue of Quantum.)

### The farmer, his children, and their pets

A farmer, his son and daughter and their pets need to cross a river. The pets are a fierce dog, two hamsters, and two rabbits. There is a small two-seater boat that they can use. All three people can row the boat, but none of the animals can.

If the farmer is not around, the dog will bite everybody and everything.
If the son is not around, the daughter will tease the hamsters.
If the daughter is not around, the son will tease the rabbits.
The hamsters and the rabbits get along fine with each other.

Help everyone cross the river without any biting or teasing.

This is a problem on the web (http://freeweb.siol.net/danej/riverIQGame.swf). The instructions are in Chinese and the setting is a bit different. To start the game, click the big blue button. To move the people, click on them. To move the raft, click on the pole on the side of the river.