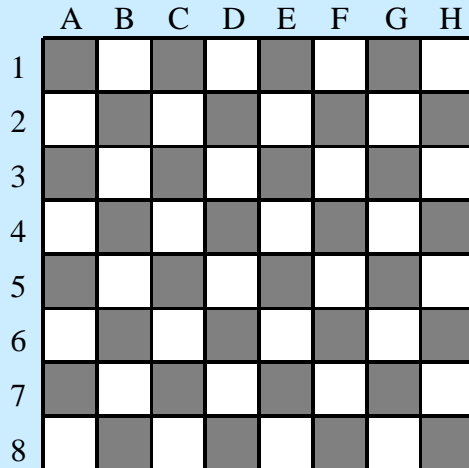


The 8-Queens Constraint Satisfaction Problem

- Task: to put 8 queens onto the board such that no queen attacks others
- No two queens appear in the same row, column and diagonal



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Exercise – Problem Formulation

- Formulate this as a CSP
 - Note: Separate *formulation* from *solving*: no need to solve it here
 - Note: just because nobody suggests that 1 is A, say, doesn't mean that 1 cannot be A



These are photos of 5 suspects, A, B, C, D & E. Each of the 5 witnesses made two assertions. Exactly one assertion per witness is correct (and the other is wrong):

Witness 1:	2 is A	3 is B
Witness 2:	1 is C	2 is D
Witness 3:	3 is D	5 is C
Witness 4:	2 is A	4 is E
Witness 5:	4 is E	1 is B

Exercise – Encryption Modelling

$$\begin{array}{r}
 S \ E \ N \ D \\
 + \ M \ O \ R \ E \\
 \hline
 M \ O \ N \ E \ Y
 \end{array}$$

Formulate this as a CSP

- Each of the eight letters S, E, N, D, M, O, R, Y represents a unique digit
 - i.e. each letter takes a number between 0 and 9 and no two letters represent the same number.
- When the letters are substituted by the numbers that they represent, the arithmetic shown holds.
- The task is to find out what digit each letter represents.

Constraint satisfaction modelling in portfolio optimization

- A fund manager wants to invest in a maximum of 10 stocks.
- He wants to choose the stocks from a set of 100 candidate stocks
- He has to decide the proportion of his investment in each of the stocks that he has chosen
 - E.g. 10% in Barclays, 15% in Tesco, ...
- Each stock belongs to a sector, e.g. banking, mining, etc.
- He does not want to invest more than 50% of all his money in the same sector
- The choice of his stocks and the amount that he has decided to hold is called his *portfolio*
- Given any portfolio, his experts will be able to evaluate the portfolio and tell him what its risk and return are
- The expert will tell him whether the risk is acceptable or not
- The fund manager wants to maximize his return (e.g. 6%, 8%, etc)

Modelling Timetable Scheduling

- Given 40 examinations
- You have to schedule the times for them over 10 days
- There are four slots per day
- Subject to complex constraints, which are not discussed here
- What are the variables and domains?

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Field workers scheduling 1

- Given 100 technicians, 300 jobs
- Each technicians will do exactly 3 jobs
- You have to decide the order in which they do their jobs
- Subject to complex constraints, which are not discussed here
- What are the variables and domains?

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Field workers scheduling 2

- Given 100 technicians, 300 jobs
- **Each technician may do any number of jobs**
- You have to decide the order in which they do their jobs
- Subject to complex constraints, which are not discussed here
- What are the variables and domains?

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Exercise – Modelling Tangram



- Tangram:
 - Given 7 pieces with *edge-lengths* specified
 - Given shape to create, with *proportions* specified
 - Task: to find out how to arrange the pieces
- Formulate the Tangram as a Constraint Satisfaction Problem

