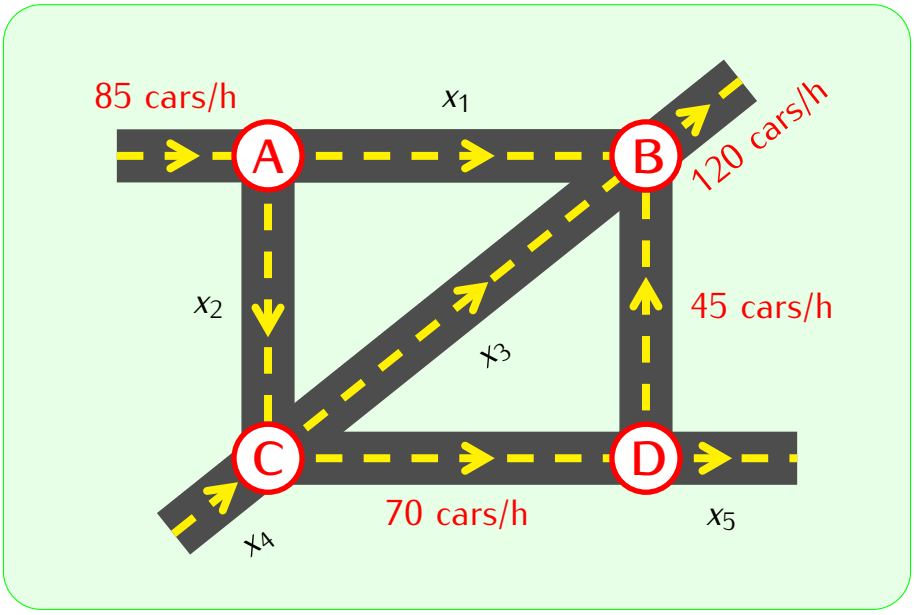
Computations of traffic flow



Problem. Find the flow rate of cars on each segment of streets.

Note:

- flow into an intersection = flow out of that intersection
- total flow in = total flow out

Balancing chemical equations

Burning propane:

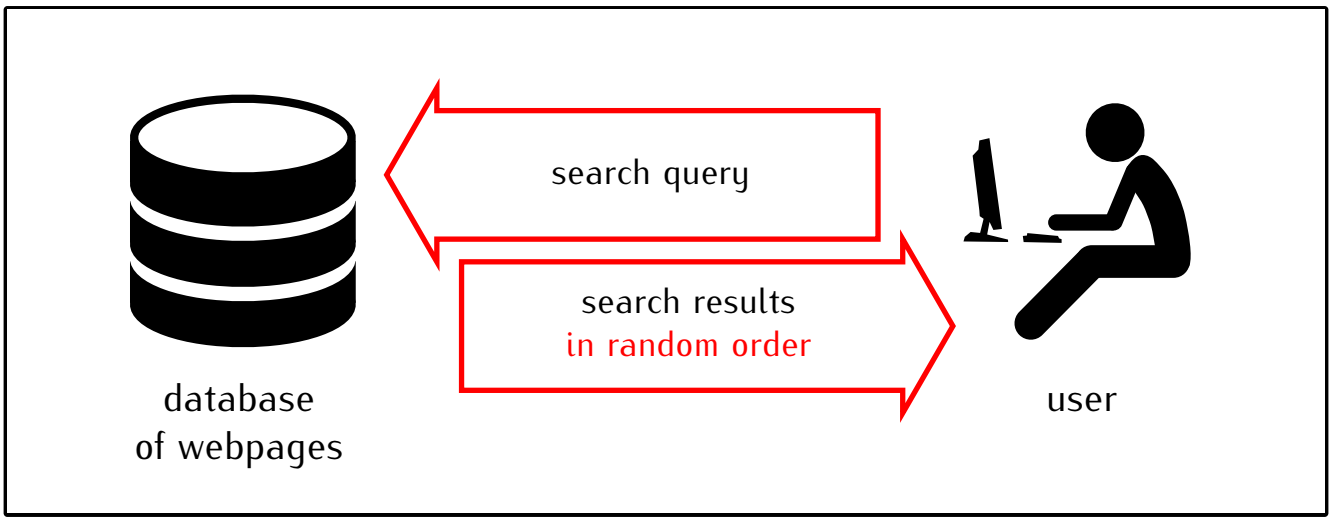
$$x_1C_3H_8 + x_2O_2 \longrightarrow x_3CO_2 + x_4H_2O$$

Note:

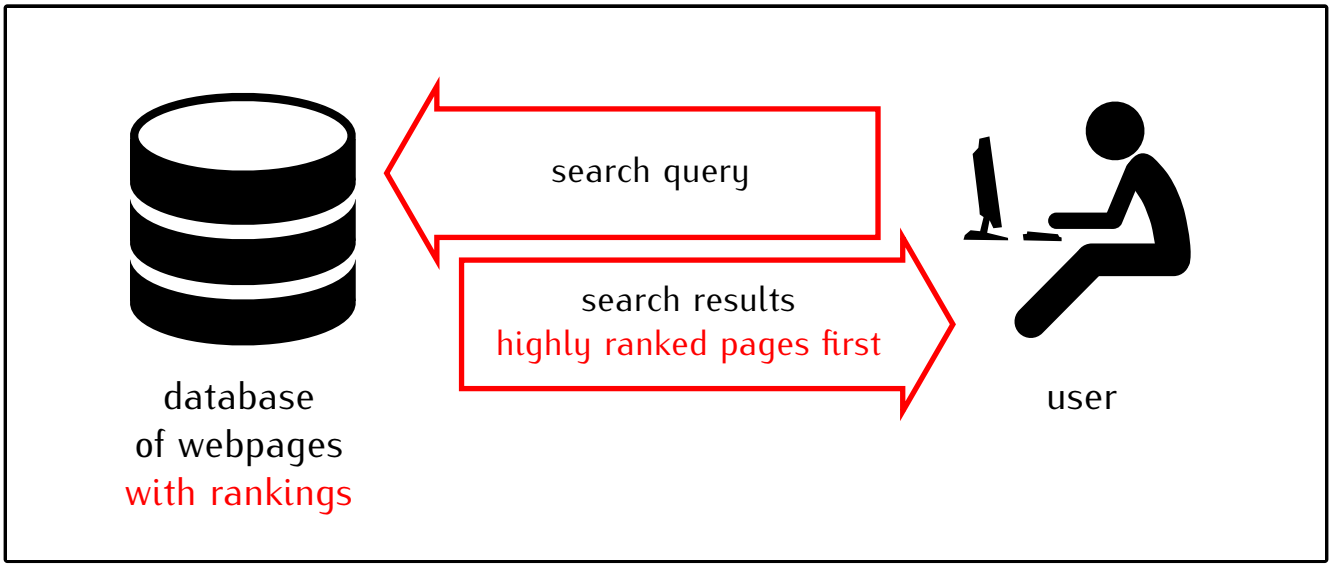
- The numbers x_1, x_2, x_3, x_4 are integers.
- The number of atoms of each element on the left side is the same as the number of atoms of that element on the right side.

Google PageRank

Early search engines:



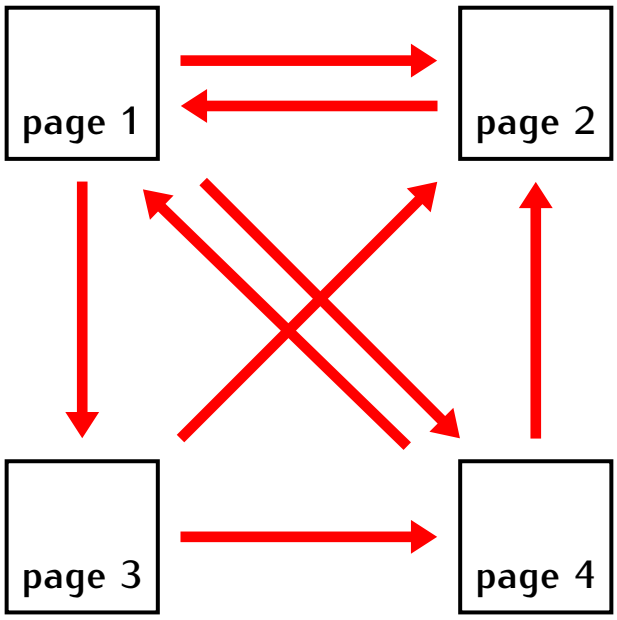
Google search engine:



How to rank webpages?

Very simple ranking:

$$\text{ranking of a page} = \begin{pmatrix} \text{number of links} \\ \text{pointing to that page} \end{pmatrix}$$



Network of web pages.

Problem. This is very easy to manipulate.

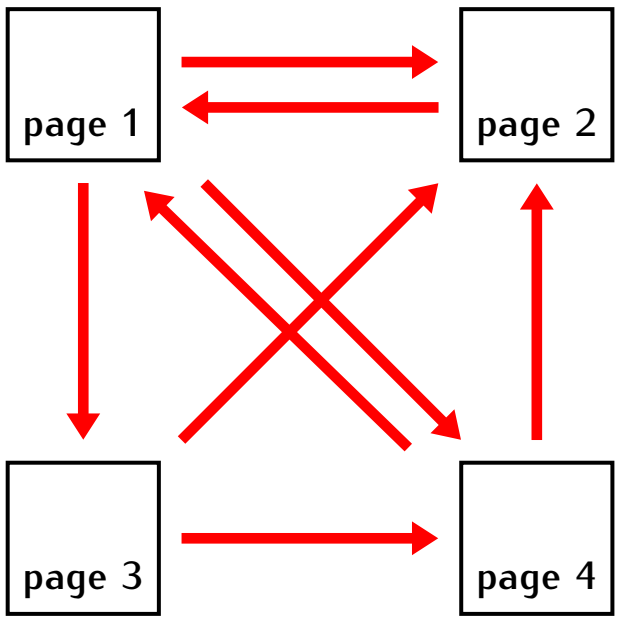
How to rank webpages?

Google PageRank: Links from highly ranked pages are worth more than links from lower ranked pages.

If:

- the rank of a page is x
- the page has n links to other pages

then each link from that page is worth x/n.



Next: From systems of linear equations to vector equations.

$$\begin{cases} x_1 + 2x_2 = 4 \\ 2x_1 + 7x_2 = 9 \\ 4x_1 + x_2 = 0 \end{cases} \quad \Rightarrow \quad x_1 \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} + x_2 \begin{bmatrix} 2 \\ 7 \\ 1 \end{bmatrix} = \begin{bmatrix} 4 \\ 9 \\ 0 \end{bmatrix}$$

Why vectors and vector equations are useful:

- They show up in many applications (velocity vectors, force vectors etc.)
- They give a better geometric picture of systems of linear equations.