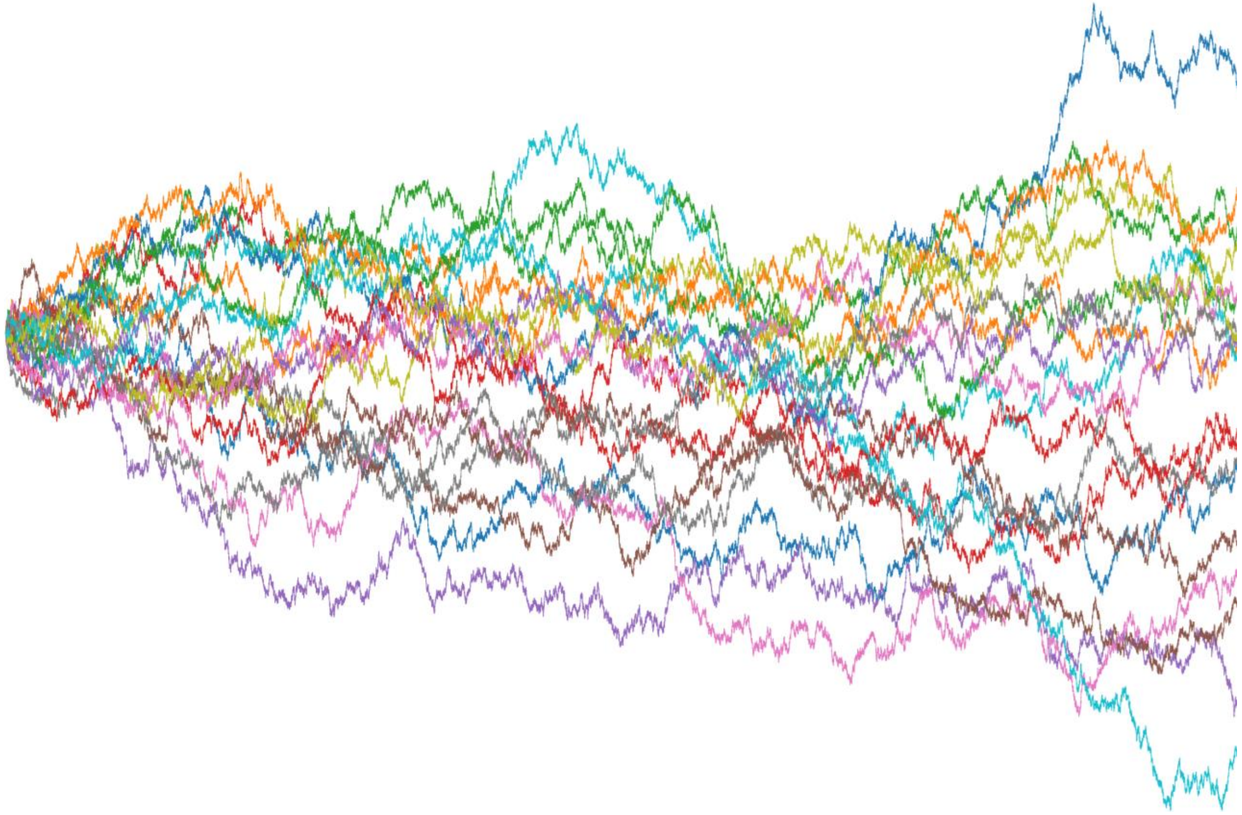
CZECH TECHNICAL UNIVERSITY IN PRAGUE

DEPARTMENT OF LANDSCAPE WATER CONSERVATION



Random walk

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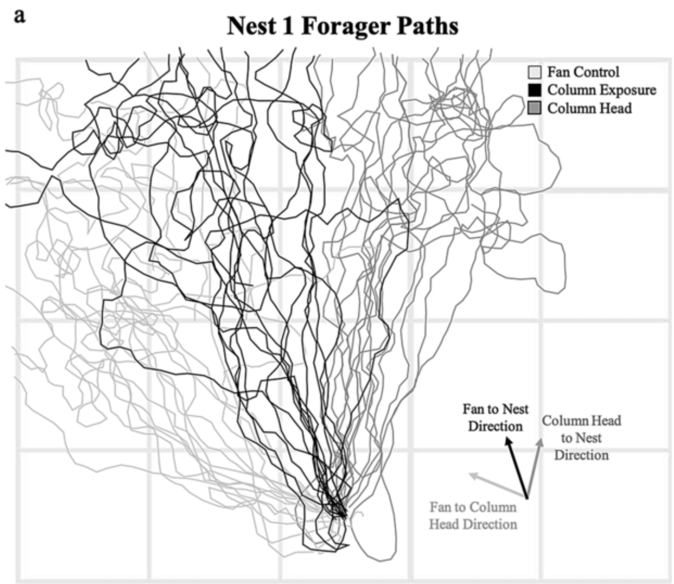
Outline

- What is “random walk”?
- 1D “random walk” example
- Application of “random walk” in solute transport model

Random walk

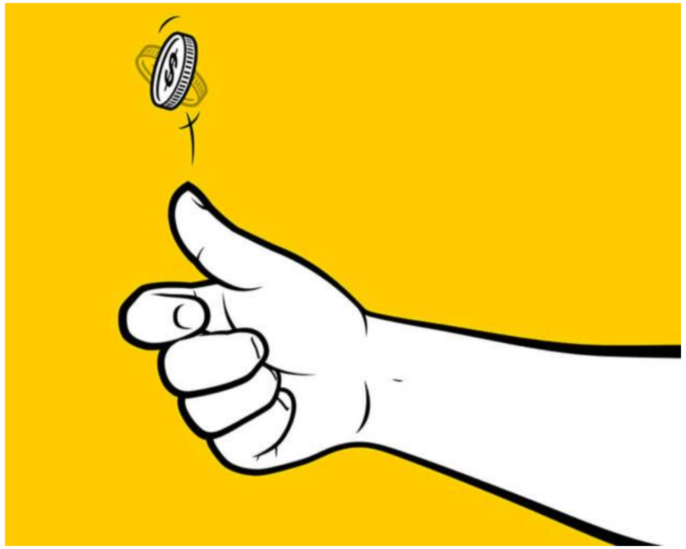
- A random walk is a stochastic or random process

E.g. Diffusion; pathway of foraging animals; fluctuation of stocks



1D Random walk example

- Flip coins
  - Heads (+1 step)
  - Tails (-1 step)



Random walk Application

- Particle-tracking

$$
\begin{array}{ll}
p(x) = 0 & \text{pro } x < (A - B) \\
p(x) = 1/2B & \text{pro } (A - B) < x < (A + B) \\
p(x) = 0 & \text{pro } x > (A + B)
\end{array}
$$

$$m = A$$

$$\sigma^2 = B^2/3$$

Random walk Application

- Particle-tracking

$$P(x) = \frac{1}{\sqrt{2\pi S^2}} \exp\left(-\frac{(x-M)^2}{2S^2}\right)$$

$$M = Nm = NA$$

$$S^2 = N\sigma^2 = NB^2/3$$

Random walk Application

Particle-tracking method

- Simulation of solute transport
  - ❑Advection
  - ❑Dispersion

$$\frac{\partial c}{\partial t} = D_L \frac{\partial^2 c}{\partial x^2} + D_T \frac{\partial^2 c}{\partial y^2} - v \frac{\partial c}{\partial x}$$

Random walk Application

- Particle-tracking

$$c/c_0 = \frac{1}{\sqrt{2\pi Dt}} \exp\left(-\frac{(x - Vt)^2}{4Dt}\right)$$

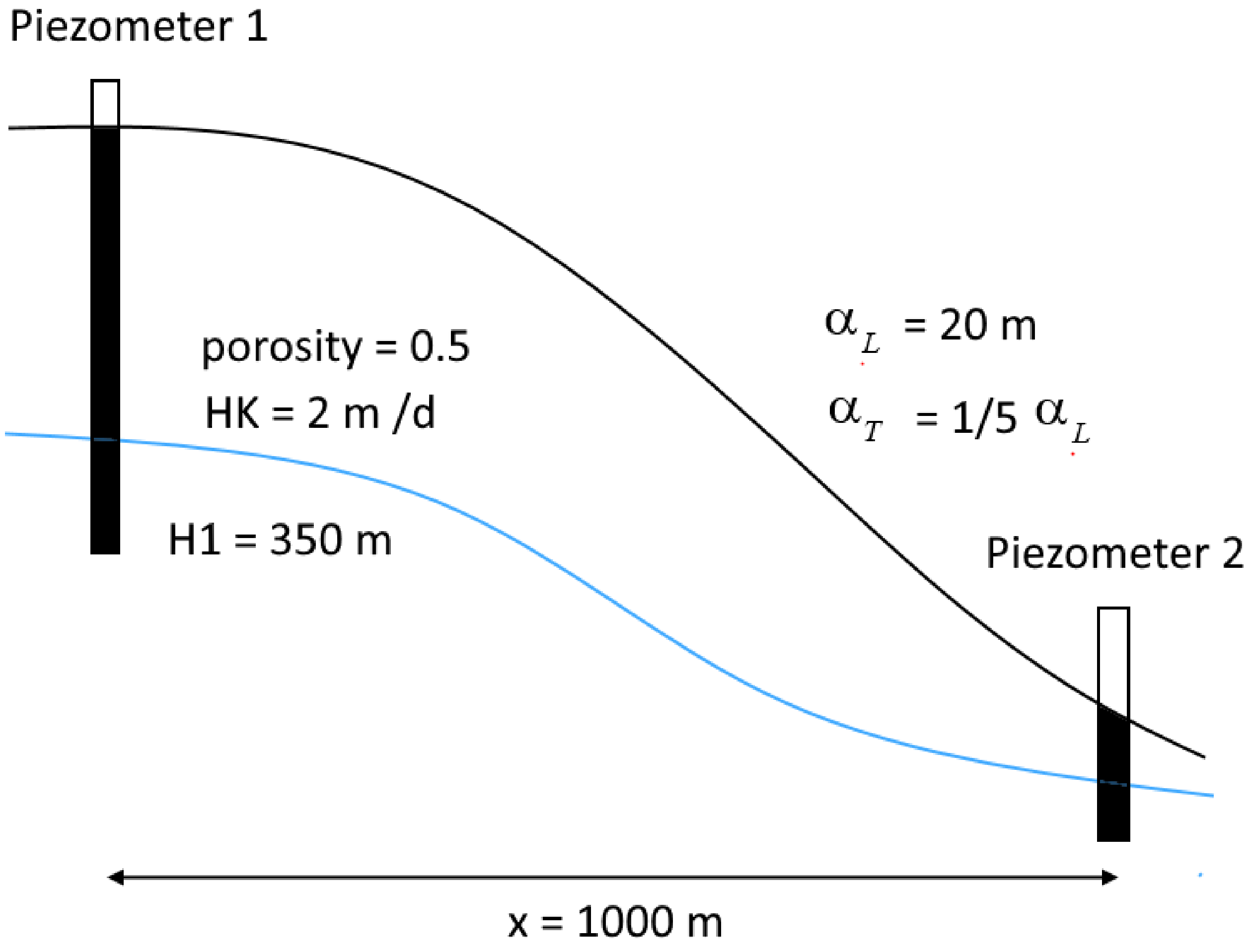
$$M = Vt$$

$$S^2 = 2Dt$$

$$NA = Vt \; -> \; A = Vt/N[L]$$

$$NB^2/3 = 2Dt \; -> \; B = \sqrt{(6DA/V)} \; [L]$$

Random walk Application



1. Mean pore velocity?

2. If we detected pollutants at P1. Here we simplify the pollutants to 6 particles. After 3000 days, how many particles will arrive at P2?

And how about after 4000 days, 5000 days?

* Distribution of the particles at the end of the timestep