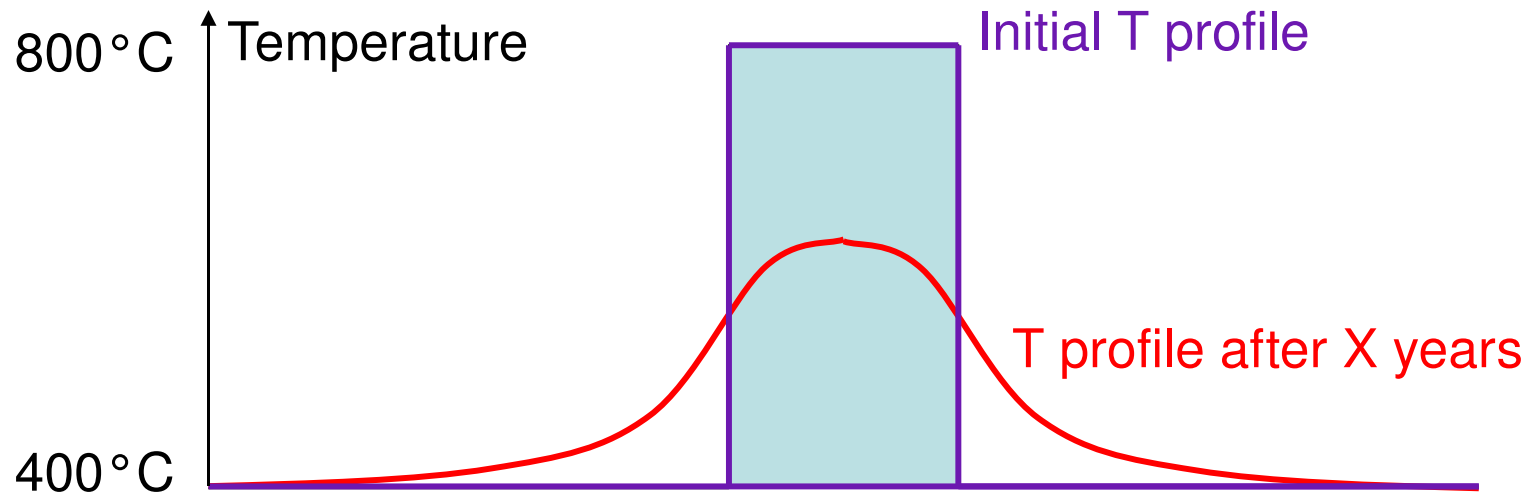


Programming assignments

- Write a program to answer certain questions
- Groups of 3-4 (4 assignments)
- Each group presents results on February 10th
 - ≤15 minute presentation
 - Submit the source code

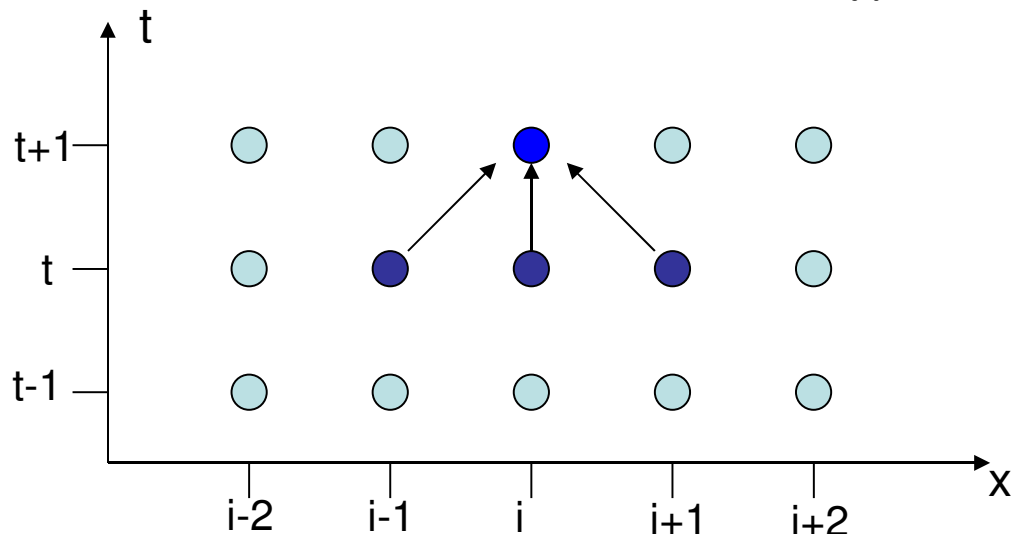
3. Cooling dyke

- A 10 metre wide, hot (800°C) magmatic dyke intrudes in colder rocks (400°C)
- How long does it take for the centre of the dyke to cool down to 600°C ?



Thermal diffusion: Fourier's law

- The thermal diffusion can be described with:
$$\frac{\partial T}{\partial t} = k \frac{\partial^2 T}{\partial x^2}$$
- For a numerical model, we can rewrite:
$$T_i^{t+1} = T_i^t + k \frac{\partial^2 T_i^t}{\partial x^2} \Delta t = T_i^t + k \frac{T_{i+1}^t - 2T_i^t + T_{i-1}^t}{(\Delta x)^2} \Delta t$$

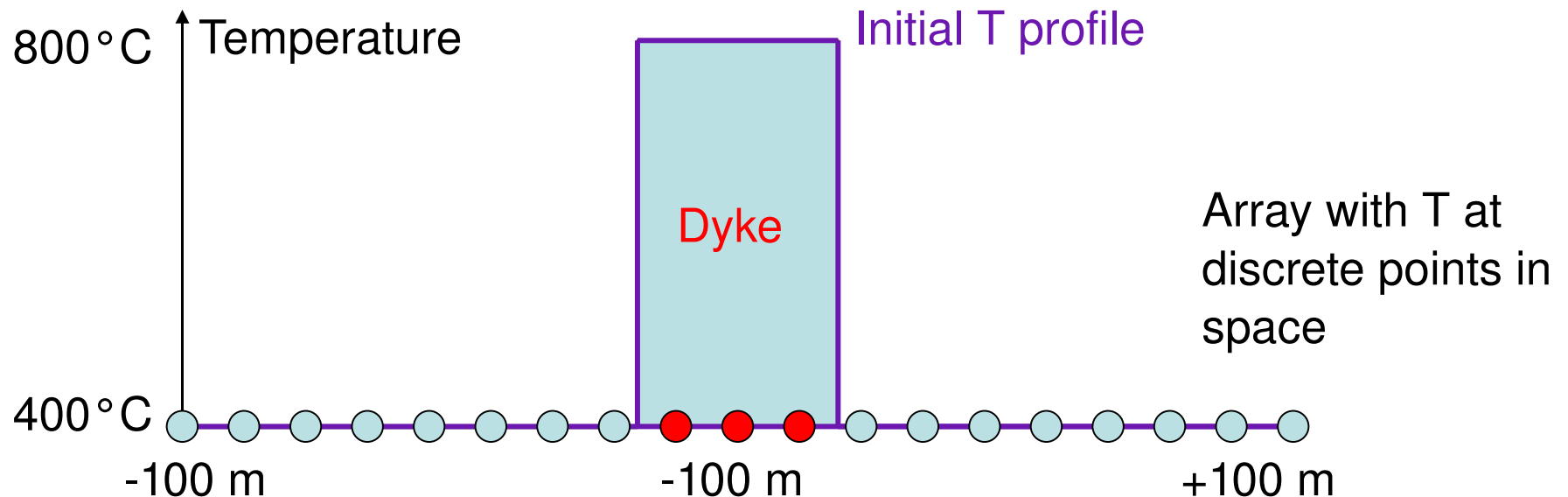


Always use:

$$\frac{k\Delta t}{(\Delta x)^2} < 0.5$$

Create the model

- Create an array with discrete points in space,
 - Say one metre apart
 - Centred on the dyke
 - From -100 m to +100 m
- Set the temperature for each point



Strategy

- Loop through time
 - Use the thermal diffusion equation to calculate the new T for each point
 - You have to have special rules for left- and right-most point: keep their T constant at 400°C
 - Store the new temperatures for $t+1$ in temporary storage (array)
 - After all points are updated, copy temperatures back in original $T(x)$ array

Strategy continued

- Loop until temperature in central point in dyke has dropped below 600 °C (do-while loop)
- Output:
 - The graph showing the temperature profile
 - The time needed to reach this point
 - Can you vary the dyke width (W) to calculate cooling time as a function of W ?
- Settings:
 - Model -100 to +100 m, $W=10$ m, minimum 100 points
 - For thermal diffusivity use: $\kappa = 10^{-6} \text{ m}^2\text{s}^{-1}$

General strategy

- Consider which variables are needed
 - Constants (e.g. Δt , P , κ , etc.)
 - Arrays to store data
- Draw a flow diagram for the program
 - Which loops do you need?
 - Which "jobs" can be put in separate functions?

Good luck!