Making Cancer Treatments Safer with Mathematics

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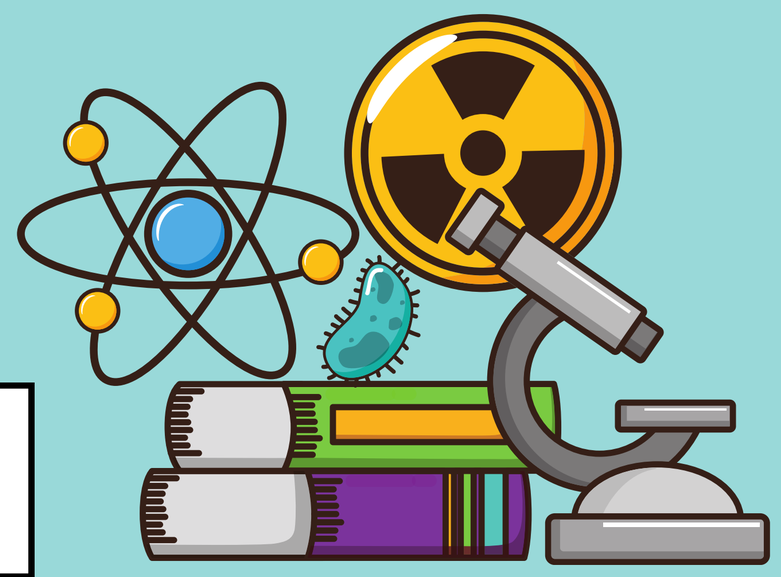
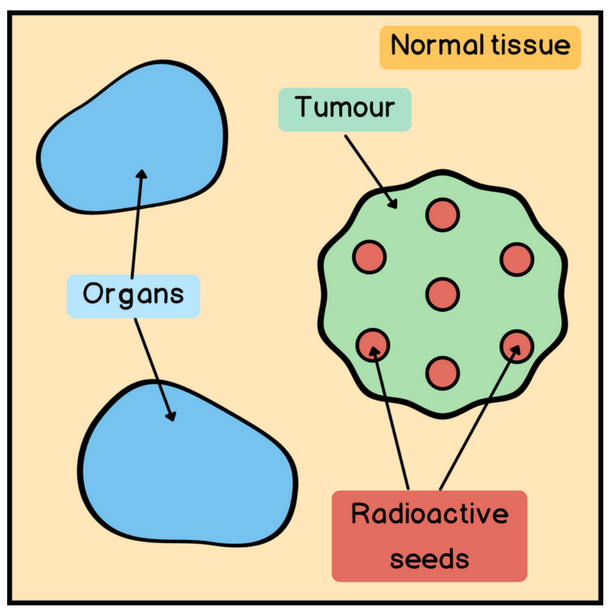


THE PROBLEM

Brachytherapy: a radiation treatment where radioactive seeds are placed directly on the tumour.

Issue: when the tumour is located close to organs, the radiation can damage them, causing further health complications.

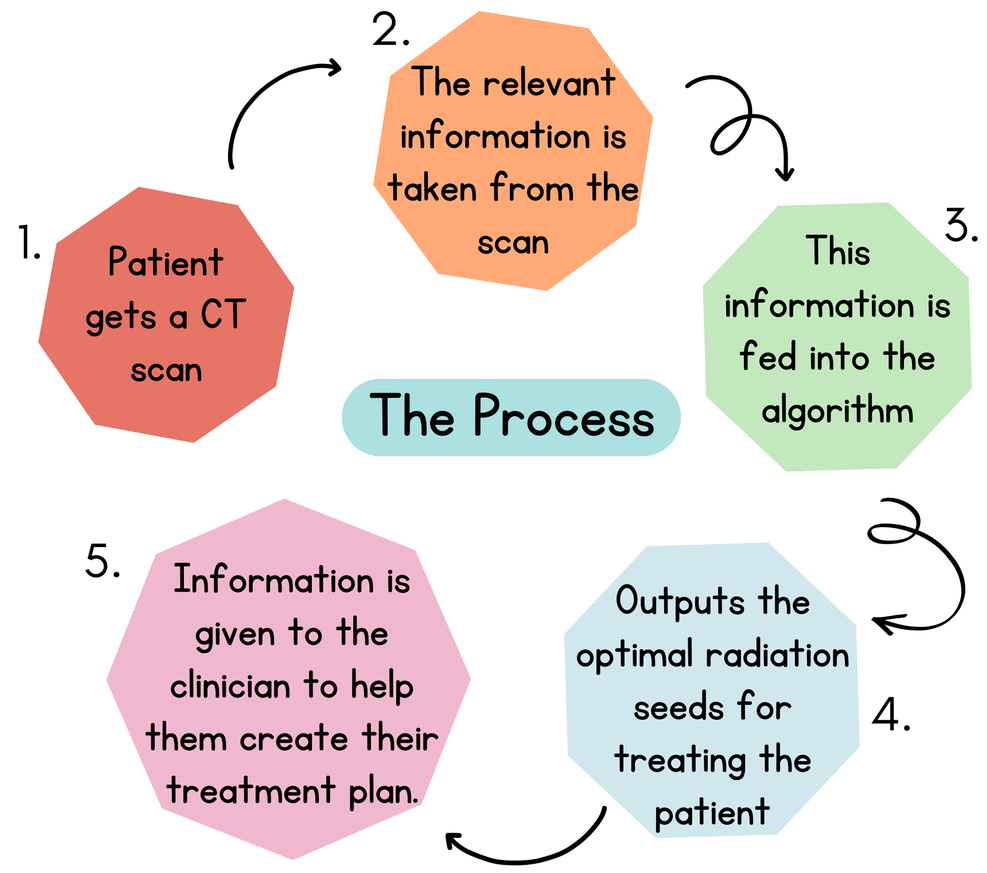


Where to place the radiation to minimise the damage to healthy tissue while still treating the tumour?

THE IMPACT

Currently, clinicians do not have a tool to create treatment plans for brachytherapy.

This would provide them with one.

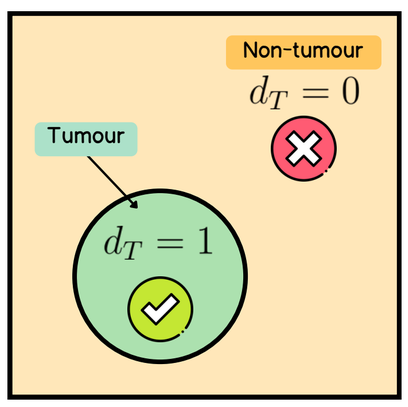


METHODS

Key Tool:
PDE Constrained Optimisation

Optimisation Problem

A required dose for the tumour + A target dose for everywhere else + Physical Laws of Radiation Emission



Method: minimize a function that will enforce required constraints

- Find the f that minimizes

$$J(u,f) = \frac{1}{2}\|u - d_T\|^2_{L^2(\Omega)} + \frac{\alpha}{2}\|f\|^2_{L^2(\Omega)}$$

- While making sure this is true

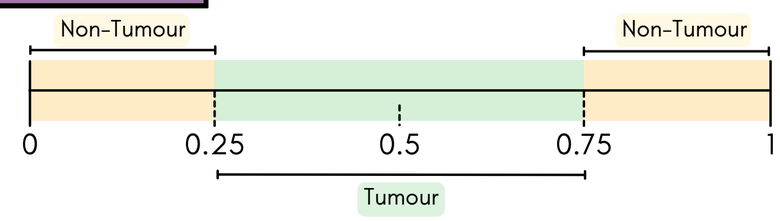
$$\frac{\partial u}{\partial t} + \mu_a u - \nabla \cdot \left(\frac{1}{3\mu_a}\nabla u\right) = f$$

u: dose
Want target dose
$u = d_T$

f : source
Want to find this

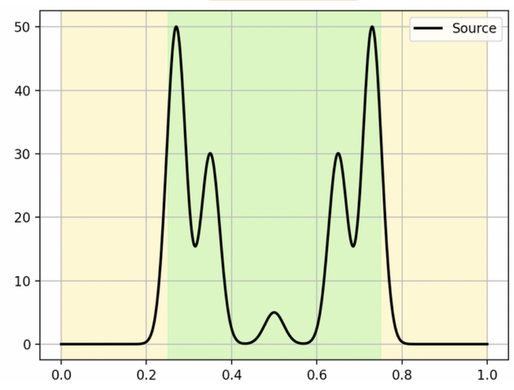
SIMULATIONS

A simplified 1D problem:

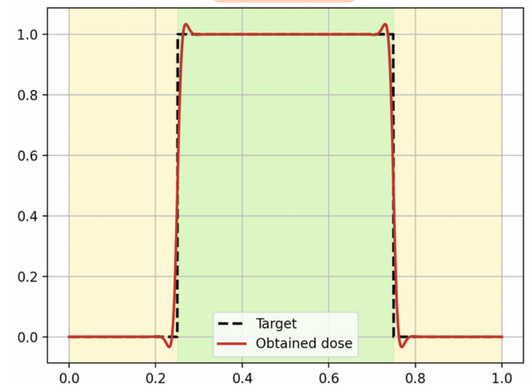


Output the source for the needed dose:

Source f

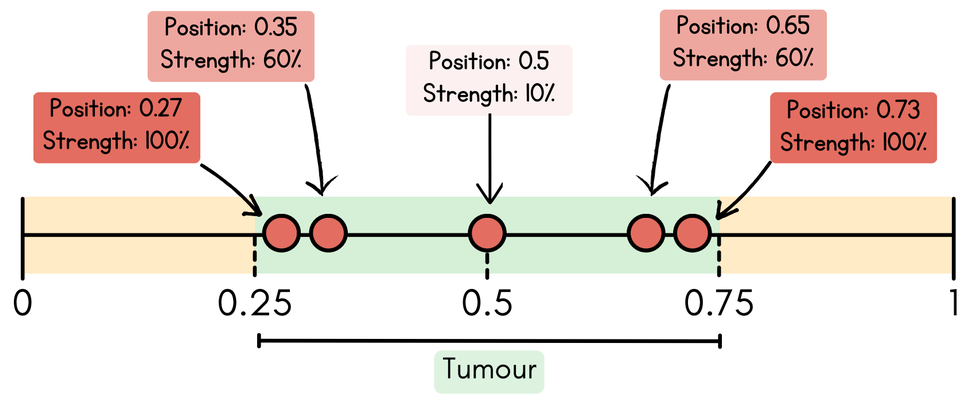


Dose u



Peak location = Seed location

Peak height = Seed strength



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