

# STEM Games Day 2

## 1 Introduction

Sometimes it is difficult to write down the entire matrix, this is especially the case in  $2D$  problems. For this reason it is important to develop methods that can be used when there is a way to quickly calculate  $Ax$  for any  $x$ . A good example of this is  $2D$  convolution.

## 2 Iterative methods

Assume you have a linear system  $Ax = b$ . Define each step of the iteration as projecting the current guess onto the hyperplane defined by the  $i$ -th equation (or by the  $i$ -th row of the matrix).

**Task 2.1** *Sketch first 5 iterates for the system*

$$\begin{bmatrix} 7 & 8 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 11 \\ 3 \end{bmatrix}$$

*starting with iteration  $(0, 0)$ .*

**Task 2.2** *Show that the sequence of errors  $\|x_i - x_{gt}\|_2^2$  is strictly decreasing.*

**Task 2.3** *Apply deconvolution using this method to `konv1`, `konv2` and `konv3` problems.*

## 3 Non-fixed projections

Cosine functions are a good subspace candidate for many problems, but it may be an even better idea to generate a subspace using the problem itself.

Look at the  $k$  dimensional subspace spanned by

$$\{b, Ab, A^2b, \dots, A^{k-1}b\}$$