The modeling of the process of film development is not fully understood, but is of an interest to many industries. A color film negative is a group of photographic emulsion layers in between layers of gelatin. The emulsion layers contain tiny oil droplets that act as a coupler as well as suspended silver halide grains. These grains, when exposed to light, acquire latent image sites, and then can be chemically converted to a picture using an oxidized developer. This situation can be classified as a ‘diffusion and drift’ process.

For convenience, this project will deal solely with the bulk reaction problem, as opposed to microscopic reactions, in order to gain a basic understanding of the situation. The governing differential equations are as follows:

\[
\frac{\delta A}{\delta t} = D \frac{\delta^2 A}{\delta x^2} - kAB + \gamma E(x)
\]

\[
\frac{\delta B}{\delta t} = -kAB
\]

for \(0 < x < L, t > 0\), with the following initial conditions

\[
A(x, 0) = A_0(x) \\
B(x, 0) = B_0(x)
\]

for \(0 \leq x \leq L\) and \(A_0, B_0 \geq 0\), and boundary conditions

\[
A(0, t) = 0 \\
A(L, t) = 0
\]

for \(t > 0\). For this system, \(A = \) oxidized developer, \(B = \) oil coupler, \(k = \) reaction rate, \(D = \) diffusion scalar, \(\gamma = \) chemistry coefficient, and \(E(x) = \) exposure function.

The work to be done for this system is to solve it numerically using explicit finite difference methods. It will also be numerically solved using implicit difference methods and then the two methods will be compared and contrasted.

We will also consider an even simpler system in which the presence of the coupler is ignored:

\[
A_t - A_{xx} = \sin(\pi x)
\]

\[
A(0, t) = A(1, t) = 0 \\
A(x, t = 0) = 0
\]

inside the rectangle \((0, T) \times (0, 1)\). Once again, \(A\) is an oxidized developer, and from the presence of the sine function, will behave in an oscillatory manner.

For this system, we can find an exact (computational) solution. We will also find a numerical solution using implicit difference methods. We can then compare the computational and numerical solutions.

A progress report can be expected on April 27, followed by a final report on May 7.

\footnote{Information taken from “Industrial Mathematics: A Course in Solving Real-World Problems”, Friedman and Littman, 1994 ©}