Istanbul Technical University - Computer Engineering
BLG 458E - Functional Programming
Homework 2
Prepared by: Dr. Yusuf H. Şahin
E-mail: Erdi Sarıtaş - saritas21@itu.edu.tr
Deadline: 08.05.2025

Figure 1: Abdullah the Tortoise always adored Lale.

Lale, the young girl, stood at the door of the study that day, casting hesitant glances inside so her father could better host Yakup Bey. With growing embarrassment, she sensed that Yakup Bey's true reason for visiting wasn't the tortoise, but herself. Fearing that some misfortune might unfold, she listened intently to the conversation, going up and down the two-story mansion, and each time she returned, she would gaze at her father with pleading eyes, then watch him with pity as he stared at the İğdişbaşı.

"Yakup Bey," said Seymur Efendi, "watch now what Abdullah can do! I swear you've never seen anything like it. If you, too, would vouch for him, I could present Abdullah to our sultan. Who knows, the sultan may fancy him and have him perform at the palace events. I can even teach him new patterns, if His Majesty so desires. A few purses of gold would suffice. My whole life has gone into training tortoises, yet I've never been rewarded."

Yakup Bey studied the wrinkled face of the man who had converted after the conquest of the city. Seymur Efendi, originally of Turcopole descent, had never been respected nor supported, even when the city was a Crusader stronghold. Though he was learned, he had never managed to prove it. His proof amounted only to a stack of nearly twenty books, eyes diminished from reading, and minor contraptions designed for animals. He had barely learned the new script himself, and in those years, could never teach it to his senile father before he passed. That must be why the tortoise was named Abdullah...

"Of course," murmured Yakup Bey, watching the man, hunched with age, almost tortoise-like himself. A tortoise holding another tortoise... How had such a silken daughter come from this man?

Seymur Efendi secured the reed pen to the hook on Abdullah's back and placed him gently

1

on the floor. He tapped the shell: three long taps, then two short.

"The hyacinth motif... I saw it once in Kirman," he said excitedly as he returned to his seat. After a moment, Abdullah began to tremble. Then he started moving rapidly in a straight line. Thanks to the contraption on his back, the pen dragged a clean black line across the floor as he went. Yakup Bey, though surprised at the tortoise's speed and obedience, remained expressionless.

When the straight line was complete, Abdullah began to swerve side to side, drawing the petals of the first hyacinth at the tip of the branch. Lale saw the pride in her father's eyes as he looked at the tortoise. Then she thought of the others: the stupid creatures her father would agonize over just to teach them to walk straight. As they moved, he would follow behind them with a sharp stone in hand. When one veered off course, he'd scrape its shell with the stone. The tortoises were too lazy even to cry out in pain. Instead, they would slowly pivot in the direction of the scrape and continue their sluggish march. But Abdullah...

How proudly her father looked at that animal! She herself had never received a gaze like that.

Seymur Efendi picked up Abdullah, cradling him like a beloved son, and rewarded him with a piece of lettuce. Looking at Yakup Bey, he sensed that he had made the desired impression. Then he kissed his lion of a son on the head. So attached was Abdullah to his father that, for once, he didn't retract his head at the kiss.

Seymur Efendi picked up Abdullah and carried him over to the enclosure, placing him among the other tortoises. The peaceful mood among the tortoises was disrupted the moment Abdullah arrived. For his presence had already caused a divide: those who admired him, and those who loathed him. Until then, the little creatures had been lounging about in random corners, idle and indifferent. But as soon as Seymur Efendi set Abdullah down at the very center of the space, the others began to drift apart subtly, yet unmistakably, splitting into factions that either drew near with silent admiration or slowly edged away in quiet rejection.

...and even he was tossed among the others, Abdullah's gaze never left Lale, whom he adored.

The Schelling Segregation Model

Once Abdullah the Tortoise was pushed into the enclosure, the admirers (blue) and haters in (red) began to shuffle about, obeying the quiet logic of the Schelling segregation model.

The Schelling Segregation Model is a pioneering agent-based simulation introduced by Thomas Schelling in 1971 to study how individual preferences, even when relatively mild, can lead to large-scale social segregation. It captures how local interactions between individuals with slight preferences about their neighbors can lead to emergent patterns like clustering or spatial segregation in a society. The world is modeled as a 2D grid, where each cell can be: empty, occupied by blue or occupied by red. Each agent prefers to live among neighbors of the same type. Agents are "happy" if the proportion of similar neighbors exceeds a given tolerance threshold (e.g., 40%). If an agent is unhappy, it tries to move to a new location where it would be happier. The model iterates this relocation process over multiple steps.

For a random field of size 200×200, the simulation results obtained from "schelling.jl" is given in Figure 2. The simulation is directly taken from your Julia coursebook [1].

With the homework file, there are two other files given: "schelling_withhaskell.jl" and "haskell_schelling.hs". The "schelling_withhaskell.jl" script generates a grid map for given parameters as in "schelling.jl" and calls "haskell_ schelling.hs" with required arguments.

---

[1] Julia Quick Syntax Reference, 2nd ed.., Antonello Lobianco. Apress, 2025.
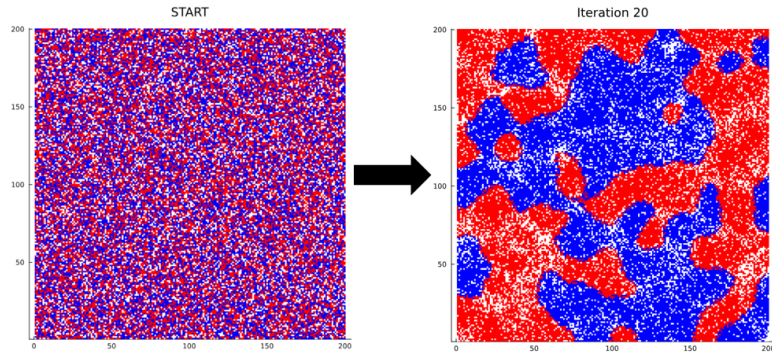
Figure 2: Schelling Simulation results

In this homework, you are required to write the Schelling simulation functions in Haskell. Using necessary amount of iterations on the given grid, you should make **all** the tortoises happy!