

Modeling Narrative Decisions and Trajectory Optimization in "5 Centimeters per Second" Using Weight-Directed Graphs

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Abstract—This paper presents a discrete computational approach to analyzing qualitative narrative structures by mapping plot trajectories as weighted directed graphs. Using Makoto Shinkai’s film *5 Centimeters per Second* as a behavioral case study, we formalize life choices, environmental disruptions, and emotional states as nodes and edges within a unified network topology. The state-space is exhaustively evaluated using Depth-First Search (DFS) to log the global probability space across 16 distinct alternative timelines, while Dijkstra’s algorithm is deployed to isolate the absolute cost-minimized path of emotional self-preservation. Our simulation indicates that the film’s canonical trajectory represents a highly suboptimal cascading failure driven by compounding low-probability stressors ($P_{\text{joint}} = 1.3\%$), yielding a massive trauma accumulation of 310 units. Comparing this to the optimized Dijkstra baseline ($C = 70$) yields a Path Efficiency Coefficient (η) of 22.6%. These findings mathematically demonstrate the severity of the protagonist’s maladaptive coping mechanisms and expose the inherent boundary conditions of applying rational cost-minimization algorithms to existential human behavioral matrices.

Keywords—graph theory, weighted directed graphs, state-space simulation, Dijkstra’s algorithm, depth-first search, narrative modeling, *5 Centimeters per Second*

I. INTRODUCTION

Human life trajectories are governed by many complex factors, both internal and external. When evaluating narrative decisions that form stories, the stories themselves are often viewed as linear sequences of cause and effect. However, they can also be modeled as branching state machine topologies where a transition or a decision is defined by a person’s psychological state and coping mechanism. This paper presents a quantitative approach to modeling human psychology, trauma accumulation, and mental resilience using weight-directed graph theory, Dijkstra’s algorithm, and Depth-first Search (DFS) path traversal techniques.

To validate this computational model, this paper utilizes the narrative of Makoto Shinkai’s film, *5 Centimeters per Second*, as a case study. This film is ideal as it showcases life trajectories based on early childhood attachment and detachment, catalyzed by environmental trauma, such as an acute commuter train delay caused by a severe snowstorm. By encoding these narrative events into graph vertices and modeling emotional burden as edge costs, this paper bridges discrete mathematical structures and human psychology.

There are two objectives of this research. First, it applies Dijkstra’s algorithm to determine the mathematically optimal "survival strategy" that yields the absolute minimum cumulative trauma score across a lifecycle. Second, it utilizes a DFS to evaluate the compounding global probability and cumulative trauma debt of every individual timeline. Through this algorithmic evaluation, this paper demonstrates how discrete network structures can quantify human resilience, proving whether an individual’s long-term psychological outcome is a product of unavoidable destiny or an accumulation of discrete, certain choices.

II. CASE STUDY: “5 CENTIMETERS PER SECOND”



Fig. 1. The iconic railroad crossing scene from the film, captured from *5 Centimeters per Second*.

To validate the proposed quantitative network model, a clear context about the narrative must be established. *5 Centimeters per Second* (2007) is a film directed by Makoto Shinkai that serves as an ideal source for our state analysis. The narrative

functions as a behavioral study on how geographic displacement, environmental shock, and individual coping mechanisms combine to alter a person's long-term psychological trajectory.

The story follows the protagonist, Takaki Tono, across three distinct developmental phases from childhood to adulthood. The primary conflict stems from his deep emotional attachment to his childhood soulmate, Akari Shinohara. To ensure the computational model can be understood by a general reader, the plot architecture is broken down into three core chronological eras or what the film calls "Acts", mapping narrative actions directly to graph state transitions:

A. Act 1: Cherry Blossom

The story is set in the 1990s, showing Takaki and Akari attending a primary school in Tokyo, where they share a profound emotional bond due to both being transfer students. The first major external problem occurs after the primary school graduation, when Akari's parents must relocate to Tochigi due to work. The children attempt to preserve their attachment through a simple communication method: traditional letter-writing.

The next critical event of the lifecycle occurs a year later, when Takaki learns that his own family is moving to Kagoshima, a remote southern island of Japan, making future physical contact practically impossible. Takaki plans a final, single-day transit route via the Japanese railway system to meet Akari at an isolated train station in Tochigi.

However, a severe snowstorm strikes mid-journey. The trains are repeatedly delayed, stranded for hours on dark tracks in the middle of nowhere. With no mobile phones or way to contact Akari, Takaki sits in helpless isolation, watching the hours slip away while internalizing a sense of despair and the brutal reality of absolute distance. When he finally arrives at the station hours past midnight, he finds Akari still waiting for him. They share a brief, bittersweet night together beneath a snow-covered cherry blossom tree. This hard-to-accomplish meeting also made them realize that inevitably, time and distance are pulling them apart. The next morning, Takaki leaves for Kagoshima, and their regular communication will eventually stop over time.

B. Act 2: Cosmonaut

The second act shifts to Takaki's high school years on the rural island of Kagoshima. He has grown into a quiet, introverted teenager who spends his time practicing archery and staring longingly out at the horizon. While he appears polite to his classmates, he has actually constructed an invisible emotional wall around himself. He frequently writes long text messages on his phone to express his loneliness, but he never actually sends them to anyone, choosing to delete the drafts instead.

This act focuses heavily on Kanae Sumida, a local classmate who has been deeply in love with Takaki ever since he arrived at Kagoshima. For years, she walks home with him, buys drinks with him, and tries to find the courage to confess her feelings. However, she eventually notices that even when Takaki is standing right next to her, his mind is always searching for something far away, out in the sky, anchored to a past memory

he cannot let go of. Realizing that his heart is closed off and that he will never look at her the way she looks at him, Kanae ultimately chooses to keep her confession to herself, leaving Takaki isolated in his own thoughts as he graduates and moves to Tokyo for university. Ultimately, this is mostly a result of Takaki still secretly longing for Akari.



Fig.2. Takaki and Kanae at dusk in Kagoshima.

C. Act 3: 5 Centimeters per Second

The final act shows the adult life of Takaki, where he is living a burnt-out life as a programmer in Tokyo. He drowns himself mindlessly into corporate work, feeling a persistent emotional exhaustion. His inability to be emotionally present causes his current girlfriend, Mizuno, to break up with him. Eventually the burden becomes too crushing to handle to the point that he decides to quit his job. Concurrently, the film shows that Akari has moved on from their brief relationship in the past. She is currently preparing to move to Tokyo from Tochigi as she is about to marry her fiancé.

The climax happens during a walk that Takaki takes to clear his mind from all the mental burnout. Wandering around Tokyo, he eventually crosses a certain railway crossing, passing an unnamed woman coming from the opposite direction. Suddenly, he turns around as a spark of recognition and familiarity hits him, only for a train to pass and block his view. When the train finally clears, he sees that the woman has walked away without waiting. After a brief moment of shock, Takaki himself turns around and continues his walk with a smile on his face, accepting the present and achieving his long-awaited closure.

III. THEORETICAL FOUNDATIONS

To analyze the narrative trajectory mathematically, we must establish the core discrete structures and algorithms that form the foundation of our calculation engine.

A. Graph Theory and State Transition Models

A graph $G = (V, E)$ consists of a non-empty set of vertices V representing states, notated as $V = \{v_1, v_2, \dots, v_n\}$. E meaning edges, are connections between vertices, which in our model represent transitions between those states. A set of edges, E , can be notated in a similar way, $E = \{e_1, e_2, \dots, e_m\}$. However, E can be an empty set. An edge itself is

written as $e = (u, v)$ where u and v are the vertices that the edge is connecting.

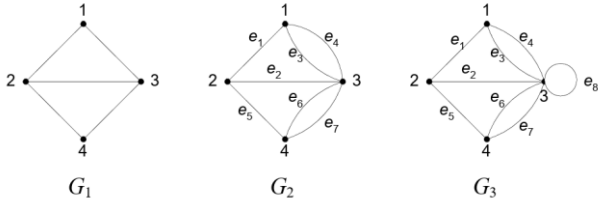


Fig. 3. Examples of Graphs.

In this study, we utilize a directed graph, meaning that each edge has a direction to where it points. The direction of each edge (u, v) enforces chronological order and narrative flow, where u is the source vertex and v is the target vertex. Additionally, we also implement a weighted graph, where each edge has a numerical value.

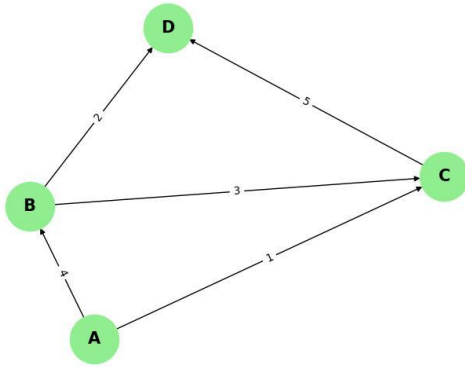


Fig. 4. Example of a Weighted Directed Graph.

While graph theory encompasses a vast range of subtopics from the simple graphs illustrated in figures above to complex ones such as cyclic graphs and isomorphism, this section limits its scope strictly to the core theoretical foundations required for our calculation engine. To maintain clarity and analytical focus, we omit foundational variants that lack directional or weight properties. Instead, this review focuses exclusively on weighted directed graphs, Dijkstra's shortest path algorithm, and Depth-First Search (DFS) path traversal, as these specific discrete structures are necessary to map chronological timelines and quantify psychological states.

Every edge in the model possesses two parameters, which are the numerical values that each edge possesses:

1. **Cost ($c \geq 0$):** A quantitative measurement representing the emotional trauma or psychological resistance accumulated during a state transition.
2. **Probability ($0 \leq p \leq 1$):** The conditional likelihood of entering a specific transition node, where the sum of all outgoing probabilities from any single vertex must equal 1.0.

B. Dijkstra's Shortest Path Algorithm

Dijkstra's algorithm is a shortest-path algorithm utilized to find the path with the absolute minimum total weight from a designated start vertex to a terminal vertex. The algorithm maintains a priority queue of vertices ordered by the shortest accumulated distance from the source. During initialization, the distance to the source vertex s is set to $d(s) = 0$, while all other distances of $v \in V$ to the source are initialized to $d(v) = \infty$.

As the algorithm traverses through the story, it always picks the lowest-trauma choice it currently knows about (u), looks at the choices right ahead of it (v), and checks if it can lower their current trauma scores that it has kept track of by calculating the cost of moving along those arrows. It does so with the following formula:

$$d(v) = \min (d(v), d(u) + w(u, v))$$

$w(u, v) = c$ represents the local edge cost transition between state u and state v . In our system model, Dijkstra treats the edge cost c as distance, eventually calculating the path of **absolute minimum emotional trauma**.

This represents the mathematically optimal psychological "survival strategy" for the protagonist, Takaki Tono.

C. Depth-First Search (DFS) Path Traversal

While Dijkstra calculates a single optimal path, Depth-First Search (DFS) is used to map out the entire narrative spectrum. DFS uses a traversal strategy to dive deep into a path until it hits a terminal node before backtracking. By tracking the complete historical path during execution, our DFS script computes two values for every independent timeline path T :

1. **Cumulative Trauma Debt:** The sum of all edge costs, which is defined as emotional trauma, that are encountered.

$$C_T = \sum_{(u,v) \in T} c(u, v)$$

2. **Global Probability Matrix:** The product of all compounding edge probabilities p along the path.

$$P_t = \prod_{(u,v) \in T} p(u, v)$$

IV. PROPOSED MODEL AND METHODOLOGY

To compute the behavioral simulations, the narrative structure of *5 Centimeters per Second* is mapped into a state transition system. The complete architectural model is constructed using a weight-directed graph structure, representing all possible life trajectories for the protagonist.

In the model, a vertex represents a narrative state in the story, where an edge is the action that was done to achieve said state. An action can be either internal from the characters or external factors, such as having to move to another city. Throughout the whole graph, there are a total of 20 vertices and 25 edges.

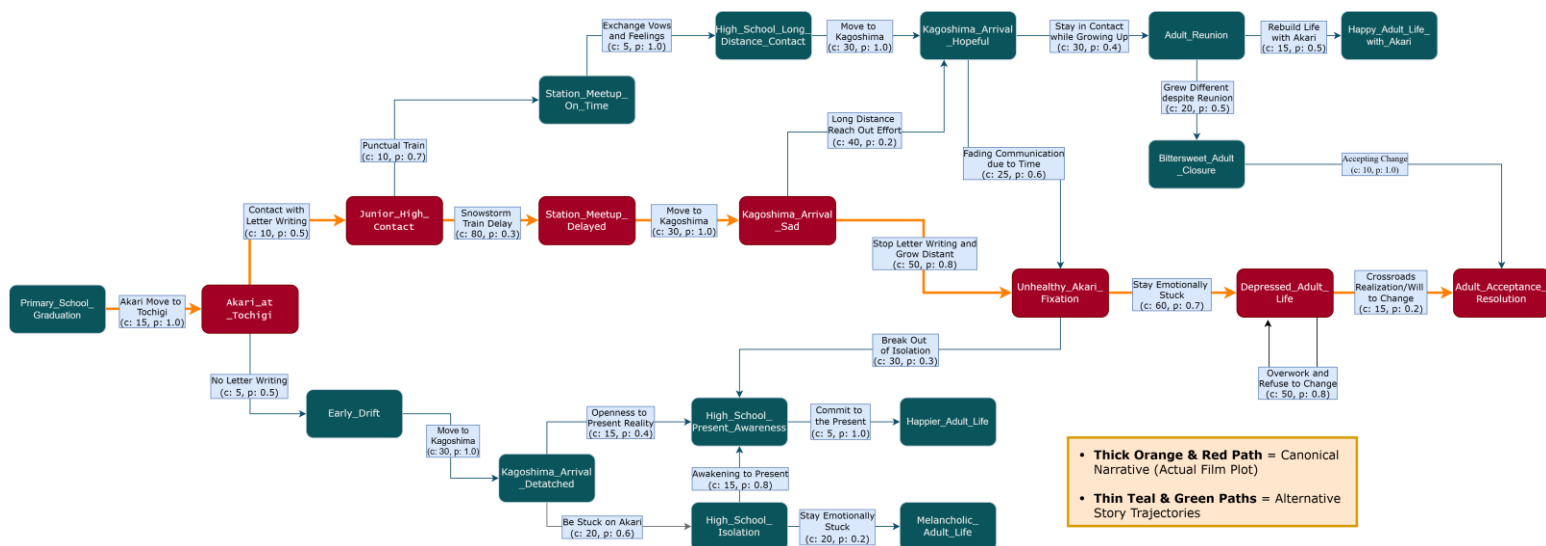


Fig. 5. The complete weight-directed graph model showing psychological state transitions, trauma costs (c), and conditional edge probabilities (p) across all life tracks.

To ensure objectivity and consistency, trauma cost allocation is governed by a standardized system. Rather than arbitrary assignment, points are distributed within a range ($c \in [0,100]$) and quantified by the degree of external environmental disruption as well as documented psychological distress shown by the protagonist. This of course involves some creativity and research, for example figuring out the probability of a snowstorm severe enough to leave a commuter train stranded for hours. Low-tier costs, such as standard narrative transitions and communication efforts are capped within a baseline range ($c \leq 15$), exemplified by the node (Contact with Letter Writing, $c = 15$). Medium-tier costs are reserved for more traumatic but not yet acute events ($c \in [15,40]$). Finally, high-tier costs ($c \in [41,100]$) are for psychologically toxic events, which are heavily anchored to the narrative markers provided by the film itself. For instance, being stranded in a train for hours caused the protagonist to internalize a depressing monologue, which is a high-tier cost (Snowstorm Train Delay, $c = 80$), while the emotional toll of adult psychological paralysis is somewhat milder (Overwork and Refuse to Change, $c = 50$). By maintaining this proportional baseline across all trajectories, the graph topology provides a mathematically objective environment for algorithmic execution.



Fig. 6. The internal state of acute isolation inside the stranded commuter train.

The probability values (p) on the other hand, are defined in a way that all outgoing branches from a single node must all add up to one. This reflects the rule in statistics which state that the probability of an event happening is always in a range ($0 \leq p \leq 1$). A $p = 0$ means that said event is impossible, $p = 1$ is a guaranteed to occur event, and anything between has a chance to happen.

As previously mentioned, Dijkstra's Algorithm is utilized to find the path with the least emotional trauma. The execution of the algorithm is as follows:

- Beforehand, a graph data structure which contains all nodes, their weighted values and connections is defined in a python script, named **story_data.py**. Another script called **analyze.py** imports the structure and works on it.
- The node **Primary_School_Graduation**, becomes the origin vertex. A min-priority queue (min-heap) is initialized, anchoring the baseline accumulated trauma cost at 0, while all other unvisited downstream narrative milestone coordinates are set to infinity.
- During each iterative cycle, the engine pops the state tracking the lowest cumulative cost from the heap. To ensure topological execution safety, the node is

evaluated against a dynamic visited set array to eliminate redundant path evaluations. The code then iterates through all adjacent outgoing target transitions, applying a standard relaxation formula to update the minimum cost required to reach subsequent milestones:

$$d(v) = \min(d(v), d(u) + w(u, v))$$

- The processing loop terminates immediately upon pulling a terminal state containing an empty outgoing connection matrix from the priority queue. The pipeline then outputs a single array containing the mathematically optimal sequence of life decisions alongside the absolute lowest cumulative trauma debt score achievable within the system.

Concurrently, a **Depth-First Search (DFS)**

execution is deployed to map the entire narrative spectrum of alternative life tracks, calculating the probability of each possible path within the system to occur. The sum of probabilities from all timelines combined add up to 100%. The DFS algorithm operates as follows:

- Starting at the **Primary_School_Graduation** root, the script utilizes a recursive call to descend down a linear narrative branch until it hits a dead-end terminal ending. As the search engine travels across each active edge transition, it computes the linear arithmetic summation of edge weights to track cumulative trauma (C_T), while simultaneously computing the compound

product of branching edge weights to calculate the path probability (P_T).

- To accommodate the cycle within the system at the overwork state modeled on the **Depressed_Adult_Life** vertex without triggering an infinite recursion stack, the execution integrates a specialized boolean labeled **loop_executed**. When the search head lands on the depression node, the engine checks the state of the boolean flag. If **loop_executed** evaluates to **False**, the script is granted permission to cross the "Overwork and Refuse to Change" self-loop edge exactly once, adding the localized trauma cost ($c = 50$) and compounding the probability ($\times 0.8$) before immediately toggling the flag to True. On the subsequent recursive pass, the self-loop is blocked, forcing the engine to branch outward toward the exit resolution track.
- Upon reaching a terminal state, the completed history path array, its global joint probability percentage, and its total trauma debt are logged into a global results matrix. The algorithm then backtracks up one level of the execution stack to evaluate alternative adjacent branches, continuing until 100% of the narrative timeline options are fully mapped and quantified.

V. SIMULATION RESULTS AND DISCUSSION

By running the analyze.py evaluation engine on our state transition graph, the exact metrics of each possible timeline are successfully mapped. Every single path is shown in the table below:

Timeline ID	Trajectory	Cumulative Trauma	Probability of Timeline	Narrative Outcome
T-1	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_On_Time -> High_School_Long_Distance_Contact -> Kagoshima_Arrival_Hopeful -> Adult_Reunion -> Happy_Adult_Life_with_Akari	115	7.0%	Happy_Adult_Life_with_Akari
T-2	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_On_Time -> High_School_Long_Distance_Contact -> Kagoshima_Arrival_Hopeful -> Adult_Reunion -> Bittersweet_Adult_Closure -> Adult_Acceptance_Resolution	130	7.0%	Adult_Acceptance_Resolution
T-3	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_On_Time -> High_School_Long_Distance_Contact -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Adult_Acceptance_Resolution	170	2.9%	Adult_Acceptance_Resolution

T-4	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_On_Time -> High_School_Long_Distance_Contact -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Depressed_Adult_Life -> Adult_Acceptance_Resolution	220	2.4%	Adult_Acceptance_Resolution
T-5	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_On_Time -> High_School_Long_Distance_Contact -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation -> High_School_Present_Awareness -> Happier Adult Life	130	6.3%	Happier_Adult_Life
T-6	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Adult_Acceptance_Resolution	260	1.7%	Adult_Acceptance_Resolution
T-7	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Depressed_Adult_Life -> Adult_Acceptance_Resolution	310	1.3%	Adult_Acceptance_Resolution
T-8	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Unhealthy_Akari_Fixation -> High_School_Present_Awareness -> Happier Adult Life	220	3.6%	Happier_Adult_Life
T-9	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Kagoshima_Arrival_Hopeful -> Adult_Reunion -> Happy Adult Life with Akari	220	0.6%	Happy_Adult_Life_with_Akari
T-10	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Kagoshima_Arrival_Hopeful -> Adult_Reunion -> Bittersweet_Adult_Closure -> Adult_Acceptance_Resolution	235	0.6%	Adult_Acceptance_Resolution
T-11	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation ->	275	0.3%	Adult_Acceptance_Resolution

	Depressed_Adult_Life -> Adult Acceptance Resolution			
T-12	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Depressed_Adult_Life -> Adult Acceptance Resolution	325	0.2%	Adult_Acceptance_Resolution
T-13	Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Kagoshima_Arrival_Hopeful -> Unhealthy_Akari_Fixation -> High_School_Present_Awareness -> Happier Adult Life	235	0.5%	Happier_Adult_Life
T-14	Primary_School_Graduation -> Akari_at_Tochigi -> Early_Drift -> Kagoshima_Arrival_Detached -> High_School_Present_Awareness -> Happier Adult Life	70	20%	Happier_Adult_Life
T-15	Primary_School_Graduation -> Akari_at_Tochigi -> Early_Drift -> Kagoshima_Arrival_Detached -> High_School_Isolation -> High_School_Present_Awareness -> Happier Adult Life	90	24%	Happier_Adult_Life
T-16	Primary_School_Graduation -> Akari_at_Tochigi -> Early_Drift -> Kagoshima_Arrival_Detached -> High_School_Isolation -> Melancholic Adult Life	90	6.0%	Melancholic_Adult_Life

TABLE I

SUMMARY OF ALL NARRATIVE TIMELINES

We can pull direct facts from the table, such as that the most common ending is **Adult Acceptance Resolution**, occurring 8 times out of the total 16 paths. **T-12** holds the record for inflicting the most trauma cost ($c = 325$). Interestingly, the path with the highest probability to occur (24%) is the one where Takaki and Akari split apart early on, with Takaki eventually forgetting the past and committing to the present ($c = 90$). On the other hand, the lowest-chance to occur timeline (0.2%) is **T-12** again, where Takaki goes through a rollercoaster of psychological states stopping at a somewhat happier ending.

Dijkstra's Algorithm figured out the timeline which creates the least amount of psychological trauma for Takaki, which is **T-14** (Primary_School_Graduation -> Akari_at_Tochigi -> Early_Drift -> Kagoshima_Arrival_Detached -> High_School_Present_Awareness -> Happier_Adult_Life) with a cumulative trauma cost of 70 and the ending **Happier_Adult_Life**. Let us notate this path as **P***. **P*** has a

relatively big global chance to occur, which was calculated to be 20%.

The canonical timeline is shown by ID **T-7** (Primary_School_Graduation -> Akari_at_Tochigi -> Junior_High_Contact -> Station_Meetup_Delayed -> Kagoshima_Arrival_Sad -> Unhealthy_Akari_Fixation -> Depressed_Adult_Life -> Depressed_Adult_Life -> Adult_Acceptance_Resolution). The canonical timeline provides the second highest trauma cost within the system with a value of 310, granting the ending **Adult Acceptance Resolution**. We will call the canonical path **Pc**. It turns out however, that the probability of the canonical event is quite small, **1.3%**. From a systems engineering standpoint, this indicates that the official plot of Shinkai's film does not represent the standard expected outcome of the state machine, but rather captures a catastrophic, compounding sequence of low-probability negative stressors. Consequently, the canonical timeline can be formally classified

as a statistical anomaly, proving mathematically that the protagonist was subjected to a chain of circumstantial bad luck.

Note that the global joint probabilities aggregate to 84.4% rather than 100%; the remaining 15.6% represents the untraversed infinite geometric tail of the cyclic adult overwork loop, which was intentionally truncated to ensure simulation convergence. Had the cycle not been cut off, the state machine would enter an infinite recursive calculation where the cumulative global joint probability would asymptotically approach 100% across infinite iterations.

From the data that we have gathered, it is possible to establish a **Path Efficiency Coefficient** (η). The formula for the coefficient is described as a ratio between the trauma cost of the least traumatizing path ($C(P^*)$) and the trauma cost of the path we want to figure out the efficiency of ($C(P)$).

$$\eta = \frac{C(P^*)}{C(P)}$$

We can then calculate the efficiency of the canonical path, following the events of the film. Therefore, $C(P)$ is $C(P_C) = 310$.

$$\eta = \frac{70}{310} \approx 0.226 = 22.6\%$$

This small value indicates that the protagonist was acting in a state of extreme psychological suboptimality. Takaki maximized trauma at almost every single crossroads, ending in a lot of cumulative psychological trauma.

It is also fascinating to point out that although Dijkstra's Algorithm found the least traumatic path, the outcome can subjectively be described as not the happiest ending either. P^* ends with Takaki forgetting Akari early and moving on to a neutral-happy ending. But one could say that another ending, such as Takaki eventually reuniting with Akari again or meeting her to only get proper closure is a lot better than what Dijkstra says. It can be worth it in the end, even if it means having to endure the freezing train delays, the agonizing distance, and years of isolation, because the outcome outweighs the pain of the process.



Fig. 7. The shared station waiting room scene in Act 1, capturing the profound childhood bond that serves as the primary psychological anchor for the protagonist's subsequent lifecycle trajectories.

This finding ultimately reveals that a ruthless calculated optimization that minimized pain doesn't always mean that it is the best. Humans are not machines, they act alongside emotion. Takaki demonstrated this by willing to absorb heavy trauma in pursuit of a valuable bond, despite arguably not doing it in the most proper way.

VI. CONCLUSION

This paper successfully demonstrated the application of discrete computational state-space modeling to qualitative narrative structures, mapping the lifecycle trajectories of the protagonist in Makoto Shinkai's *5 Centimeters per Second*. By formalizing emotional and environmental stressors as weighted directional edges between psychological state vertices, the narrative space was exhaustively mapped using Depth-First Search (DFS) and optimized via Dijkstra's shortest path algorithm.

The execution of the simulation yielded two critical insights:

- Dijkstra's cost-minimization engine isolated an absolute optimal trajectory of emotional safety, yielding a minimal trauma cost score of $C(P^*) = 70$. However, this computationally optimized path fundamentally diverges from the film's canonical resolution, resulting in a trauma cost of **310**.
- The DFS traversal revealed that the film's actual timeline represents a highly improbable sequence of compounding negative stressors, operating at a global joint probability of just **1.3%**. This shows that the protagonist was unlucky with the events that occur in his life.

Furthermore, applying these metrics to the Path Efficiency Coefficient equation yielded a final systemic efficiency rate of:

$$\eta = \frac{70}{310} \approx 22.6\%$$

This coefficient mathematically proves that the protagonist's behavioral coping mechanisms were highly suboptimal from a perspective of pure psychological self-preservation.

Ultimately, these findings expose the limitations of modeling human behavior based on purely rational algorithms. Humans inherently act different, taking account of emotion with each step that they take, driven by an existential search for meaning. Takaki Tono's loyalty to hold on to a past memory illustrates that the path of actions humans take are frequently, sometimes intentionally, computationally suboptimal.

ACKNOWLEDGMENT

The author would like to express deepest gratitude to God Almighty for giving the health, wisdom, strength, and

persistence required to successfully conduct this research and complete this paper.

Special thanks and highest appreciation are extended to Mr. Rinaldi for his valuable guidance, continuous academic support, and constructive insights throughout the IF1220 Discrete Mathematics class. His expertise in algorithmic logic and discrete structures greatly contributed to the refinement of the state-space simulation framework proposed in this paper.

Not to forget all the family members, peers, and colleagues within the school cluster who provided encouragement, technical discussions, and support during the drafting of this manuscript.

Finally, the author expresses his sincere appreciation to Makoto Shinkai, for creating *5 Centimeters per Second*, adding interesting insights to his way of thinking and the way he views this life.

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PERNYATAAN

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