Research and Digital Development of Optimal Training Plans for Intermediate and Advanced Runners

Owen Block
blockowe@grinnell.edu
Grinnell College
Grinnell, Iowa, USA

Connor Heagy
heagycon@grinnell.edu
Grinnell College
Grinnell, Iowa, USA

Sebastian Manza
manzaseb@grinnell.edu
Grinnell College
Grinnell, Iowa, USA

Alexander Pollock
pollocka@grinnell.edu
Grinnell College
Grinnell, Iowa, USA

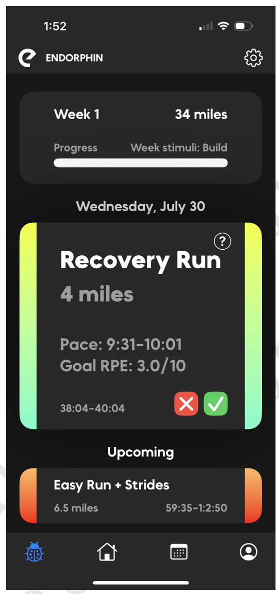

Figure 1: A Snapshot of the Homescreen of Our Application

Abstract

In the span of two months, we have researched optimal training plans for distance runners specializing in 5-kilometer to 10-kilometer races. Our research identified four main subcategories: recovery, volume/intensity distribution, lactate threshold, and neuromuscular training. Additionally, our research process included interviews with coaches, resources given to coaches, and talks given by industry professionals. Utilizing this information, we constructed a framework for professional running plans tailored to people of different ages, experience levels, and other characteristics. Furthermore, this research guided the development of an application designed to connect runners with training plans, allowing both to develop in tandem. This application seeks to utilize a neural network to modify and enhance an athletes training plan. To do this, the athlete's personal information is used to form an initial training plan. This is then modified based on the differences between the athlete's experience executing the assigned plan in comparison to what we expected their experience to be. In this way, a runner's plan evolves alongside them, replicating the expertise and adaptability of professional coaching while removing the difficulties runners face in meeting coaches of high caliber.

MAP'25, Grinnell, IA, USA

ACM ISBN 978-x-xxxx-xxxx-x/YYYY/MM
https://doi.org/10.1145/nnnnnnn.nnnnnnn

Keywords

Application, Individualized, Neural Network, Running, Training Plans, Trio

ACM Reference Format:
Owen Block, Connor Heagy, Sebastian Manza, and Alexander Pollock. 2025. Research and Digital Development of Optimal Training Plans for Intermediate and Advanced Runners. In . ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 Definitions

Useful definitions that will come up within the following information

1.1 Computer Science Related Definitions

- Database: A digital space where large quantities of information can be stored.
- Dictionary: A list of key-value pairs.
- Key-value pair: A type of data that forms a pair. Knowing the value of the first datatype, referred to as the 'key', allows access to the value of the second datatype, the 'value' of the pair.
- List: A datatype formed of smaller datatypes put in an order.
- Neural Network: A program that takes in a series of inputs, usually numeric, and makes a prediction based on those inputs.
- Object: A datatype made of a collection of smaller datatypes that is meant to represent something specific within a program.
- Overfitting: An issue where machine learning fails to recognize underlying patterns due to having too much data.
- Queue: A type of list where only the oldest item can be retrieved.
- String: A means of storing and outputting text.
- Trio: A set of three values stored together.
- Stack: A type of list where only the last item placed in can be retrieved.

1.2 Running Related Definitions

- Build week: A week that increases either mileage, intensity or, on occasion, both.
- Down week: A week where mileage and intensity decrease.
- Easy Tempo Run: A run meant to build the aerobic capacity of a runner while simultaneously not putting an intense strain on the runner's body.
- Fartlek Run: A workout that alternates between a faster and slower pace at set time or distance interval.
- Flat Sprints: Short speed interval meant to focus on form and fast-twitch muscle fibers.
- Hill Sprints: Short speed interval uphill, which allow for less force on the body while maintaining a high level of intensity.
- Intensity: A measure of how much physical strain an activity puts on an athlete.
- Intervals: A workout involving repeatedly running at race pace for intervals shorter than the race distance. Often used to build familiarity with the pace.
- Lactate Threshold: generally defined as the point in which your body is producing more lactate (through the anaerobic respiration process) faster than it is able to clear/use it, leading to lactate buildup.

Rating	Description	Purpose
0 – 2	Very Easy	To warm up or cooldown.
3 – 4	Easy	Maintain aerobic training while still being able to recover from previous training.
5 – 6	Moderate	Increases aerobic capacity while still not being a difficult training day
6 – 7	Challenging	Overloads the aerobic system, forces the body into accruing lactate, requires recovery after an activity of this difficulty.
8 – 9	Difficult	Improves anaerobic ability and VO2 Max, surpassing aerobic threshold.
9 – 10	Hard	Improves anaerobic system

Figure 2: A Table that Displays the Different Levels of Perceived Exertion

- Long Run: The longest run an individual will do in a week, usually done at a relaxed pace.
- Maintain week: A week where mileage and intensity are maintained.
- Off Day: A day without running or other athletic stimulus such as lifting.
- Overtraining: The process of doing excessive physical activity that increases injury risk and fatigue.
- Peak phase: A phase where mileage and intensity decrease in order to prime the body for a fast race. Generally, speedwork is also increased throughout this period.
- Progression Run: A run where the pace increases at set times or distances.
- Race Pace: The pace at which you run a given race.
- Rate of Perceived Exertion: A self-reported measure of how difficult an activity is to an athlete.
- Recovery Run: A run meant to help a runner's body recover from previous exercise by flushing the system.
- Threshold Run: A run meant to force the body to accrue lactate faster than it can flush it, forcing athletes to run under duress.
- Time Trial: An all-out effort in a non-race environment. Often used to gauge an athlete's capabilities and measure growth outside of formal competition.
- Strides: A short (no more than 200m) run at between 800m and mile pace meant to focus on form.
- Training Load: The accumulated physiological stress on the body due to external stimuli.[11]

2 Background Research

As a part of our research into creating an application to help intermediate and advanced runners, we investigated the key factors of professional running and the applications currently on the market.

2.1 Hole in the Literature

The current market for running training applications lacks accessibility, fails to provide a space for intermediate and advanced runners, and exhibits suboptimal precision. Runna, a mainstream adaptive endurance training app, primarily markets to athletes at a beginner level. According to the 2025 AI review of the app by elite endurance athlete Lost Pace, advanced and specific goals may require manual adjustments.[15] Thus, results for intentional athletes on an advanced level are diluted. Couch-to-5k, an app that primarily markets to new and inexperienced runners, focuses on a user base who are looking to complete basic goals. Another popular application, None to Run, is an app that offers a basic 12-week training program to prioritize consistency and provide motivation for recreational runners. A common theme with current applications is focusing on the user interface psychology to encourage user motivation in regard to consistent usage.

Accessibility within the market of individualized running training plans is limited for intermediate to advanced athletes. For example, Runna's subscription of $17 per month after a 7-day free trial limits accessibility to potential users. Shifting from AI applications to privatized coaching, Runcoach is an app that connects you with an experienced running coach who manually creates a training plan for you. According to the Runcoach official website, a membership will cost $33 per month.

Current AI agents have been proven to be suboptimal when tasked with artificially generating endurance training plans. ChatGPT has been shown to successfully create training plans, but after in-depth analysis by expert coaches concluded the generated plans were suboptimal.[6] Free applications, such as Garmin Coach, offer adaptive training plans but fail to provide algorithmic adjustments based on standardized user input. As a result, uncalculated biometrics may hinder adjustment precision.

2.2 Our Contributions to the Market

Our application improves accessibility within the market of artificially generated endurance coaching by presenting an economical option for intermediate and advanced runners. Our framework allows users to be presented with relevant quantitative data and adjusts based on user input. Additionally, our adaptive algorithm tailors training plans at the most micro level to keep individuality paramount. Intermediate and advanced endurance athletes require minute adjustments to enhance running performance and training optimality. To account for this, our application prompts users to complete post activity surveys to maximize data analysis and progression implications. As a result, we return training control to athletes by using prompted metrics such as RPE to adapt training. Intermediate and advanced runners may expect data analysis to visualize progression and training load. Our user interface displays paramount data, while providing easy-to-navigate interactions and usability. Additionally, information is displayed in a minimalist approach, maximizing functionality.

2.3 Volume and Intensity

To implement our application, a study of training philosophies and plans was required. In our research, we found a few key aspects of training that we wanted to incorporate in our application.

Training load is characterized as the distribution of intensity and volume and is the backbone of optimal training in distance running. Endurance athletes primarily balance intensity and volume through adjustments in distance, pace, and duration during activity. However, studies have shown progressive overload can lead to

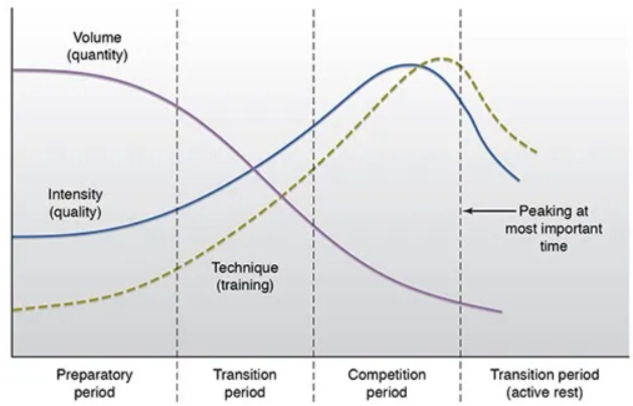

Figure 3: Optimal Intensity and Volume Levels Throughout a Season [16]

overtraining. According to Lehmann, volume dominant training that progresses linearly leads to stagnation in performance and increased risk of overtraining.[12] Similarly, intensity dominant training has been shown to minimize recovery and maximize the risk of injury.[4] Thus, balancing intensity and volume is imperative to avoid overtraining and plateaued performance.

As shown by Esteve-Lanao, the training methodology of US national level endurance athletes is 71% low intensity stimuli (60% of VO2 max).[8] This suggests that low intensity activity is positively correlated with running performance, as it allows recovery of the body's systems and maximizes adaptation. While low intensity activity is key to improving running economy, high intensity activity is necessary to build speed and endurance. Casado studied the intensity levels of 85 elite world-class endurance athletes and found a strong association with tempo and short interval training in regard to performance.[3]

Training load is primarily dependent on the athlete's stage in training within a training cycle. On the macro level, the training cycle is generally split up into four distinct stages: periodization, transition, competition, and the recovery phase. Observing the four stages respectively, the distribution of training volume and intensity showcase an inverse relationship. During the periodization phase, training volume peaks and intensity is low. This allows for slowly building the aerobic capacity necessary for high volume while reducing the risk of long-term injury.[5] This is followed by the transition phase where training volume decreases and intensity builds. The competition phase is characterized by the maximum intensity and minimum volume. Finally, the recovery phase is marked by minimum volume and low intensity.[16]

Intensity in training not only varies on the macro scale but also on a week-by-week basis. Training loadis often managed in week cycles, with training intensity divided into easy and hard stimuli.[13] Easy days, those focusing on aerobic activities and slower paces, create flexibility in the recovery process and improve performance long-term through volume. Hard days, often called workout days, have high training intensity and load leading to increased V02max, Supramaximal, and lactate threshold.[13]

2.4 Lactate Threshold

Lactate threshold (LT) training has gained popularity recently, likely due to its strong correlation with race times. Nicholson found a correlation of r = 0.86 between LT velocity and 10 km race pace, indicating that LT can be a very strong predictor of race pace.[14] Training at or below LT causes several crucial adaptations for distance running. This is demonstrated in a study by Vijay, which showed a 12% increase in time to exhaustion at LT intensity after an 8-week tempo program.[17] This delayed fatigue allows for better endurance and improved recovery time. In practice, this means a well-trained individual can have longer training sessions at a greater frequency.

Furthermore, LT training enhances metabolic efficiency during runs, allowing for a greater flow of oxygen to muscles, improved ATP production, and increased mitochondrial density.[2] In modern-day training, these adaptations make LT one of the most utilized types of workouts, as a great deal of volume can be achieved at this intensity, particularly in well-trained individuals where fatigue is delayed. However, lactate threshold's most notable feature is that training at or above LT has been shown to increase both VO2 max and LT in amateur runners[18] and increase LT in elite athletes.[13] It is for these reasons that elite athletes have frequently incorporated LT training in their training plans.

2.5 Neuromuscular Training

We also studied the neuromuscular systems and their effects on distance runners. In Roger Enoka's book *Neuromechanics of Human Movement*, he discusses a holistic approach to training and the necessity of training the body to move intentionally. This includes developing runners through both plyometrics and weight training to advance them as athletes.[7] Distance runners' use of plyometrics is much more nuanced than that of sprinters, who will see immediate benefits after regular neuromuscular training. In most cases, one will not see immediate improvement in speed for the 5 or 10K which might be seen in the 200m or 400m. Still, multiple coaches we interviewed prescribe regular plyometrics and weight training to their distance athletes as it is a valuable tool in helping to prevent injury. Joe Dunham, head coach of the Central College cross country program stated: "Since we implemented plyometrics here two years ago, we have seen a reduction in stress injuries." This is the primary goal when doing plyometric and weight training for distance runners.

Since it was unrealistic for us to implement a full plyometric plan or a weight training plan in our application this early into the process, we have focused on the running elements of plyometrics, primarily hill sprints, and strides. As a result, these intentional routines activate the neuromuscular system while improving form. Hill sprints are short hill ascents lasting no more than thirty seconds and cause fast-twitch muscle fibers to develop. Since hill sprints are a high-stimulus activity, they are done at most once a week to prevent overexerting the body. Strides are effectively 100m repeats at mile pace. Since they are less intense than hill sprints, they are done far more regularly, between three and five times a week. The goal of implementing both into our training plans is to give some baseline neuromuscular stimulus while we develop full plyometric and weight training for our application.

2.6 Recovery

There are many beliefs surrounding what runners should do for recovery. Common practice is to get 8 to 10 hours of sleep each night and to do static and dynamic stretching before running.[9] In addition to these methods of recovery, newer practices have become increasingly popular. These include forms of water immersion, massage, and active recovery.[10] Many of these options come with tradeoffs. For example, cold water causes the body to recover quicker, and massage reduces injury risk, but both have been shown to impair the body's ability to improve.[1] Importantly, we are looking for a recovery plan that can be used regardless of the run before and thus want to mitigate downsides.

The ideal recovery plan, based on our research, is to do active recovery on the day with runs. Active recovery is any form of light aerobic exercise, which most runners already do as a cool-down run after a workout.[10] Biking and swimming are alternatives that do not put stress on a runner's feet and joints. This makes them preferable, though they are limited by access to a pool or bike. As such, our application is designed so that light aerobic activity can be added to any day. These are runs that are generally easier and shorter. We have also made sure that they do not impact our interpretation of the intensity of the day.

2.7 Why Our Specifications

When we first started brainstorming for this project, we had to answer the difficult questions of where to stop? What lines need to be drawn in the sand? In one summer with only four programmers, there was simply too little time to accomplish everything we wanted to. In one of our meetings with a Grinnell Alumnus we were offered an invaluable piece of advice: build something you will use, focus on what you know, and look for the holes in other applications. That pushed us to build an application specifically for intermediate and advanced runners. All four of us being collegiate cross-country and track and field athletes ourselves, we felt that we fell into this category. We are quite knowledgeable on the subject matter and what levels of training intensity would be advisable for advanced athletes.

It is still our intention to include a beginner's guide to running within the app that helps new users who have never run before, but it is no longer our top priority. This is because the differences between a new athlete running for the first time and a seasoned veteran trying to take seconds off their 5K look entirely different. Staying in line with the 'do what you know and build what you would use' advice, we focused on building an application that provides advanced athletes without access to a coach or high-level training plan the tools they need to succeed.

3 Design and Implementation

After our research was completed, we dove into implementing an application that would make it available for everyone. We began designing and implementing a running application for intermediate and advanced runners that focused on advanced personalized training.

3.1 Specifying Users

To personalize training plans for each runner we require them to fill out a survey when they first sign up. This survey asks a series of questions that fall into three types: 1) biological parameters such as age, sex, and injury history, 2) running parameters such as estimated 5K personal best, longest weekly long run, number of days running per week, and 3) their scheduling parameters such as what days are free for running, what day is best served as a long run day, and when is their most important race (if applicable). From this survey we get a baseline understanding of each user without having ever seen them run or tracking any previous running data. At the end of this survey a user object is created to store this information. The user object is inputted into a decision tree which then outputs the runner's initial training plan.

After the initial training plan is received, it is personalized even further according to the user's scheduling parameters. This is done by first determining which day of the week the user has chosen for their long run and matching it with the long run day in the training plan. Each training plan starts on a seven-day cycle with a mix of easy runs, workouts, long runs, and off days. Each of these individual days is given a weight of how important they are for the week to complete the weekly training goal. This means that after pairing the long run day selected by the user with the long run day of a given training plan an athlete training seven days a week will be complete. For a user who can train any day of the week but only wishes to train five or six days a week the days of the lowest weight are cut. Finally, if a user has conflicts on specific days or days where they are completely unable to train that day will be blocked out of the calendar and the lowest weight run will be cut. Furthermore, the training plan itself will be shifted to match that day as if it were an off day and compensate for other parts of the week around that point as well as the long run point to help prevent injury and boost training outcomes.

Once the user has completed the initial survey and received their training plan it will remain in place until the user deviates from it in some way at which point it will be updated on a day-to-day basis by the neural network to make sure that each individual user has the opportunity to improve even if they can't meet the expected training stimulus for a given day or week.

3.2 Trios

When participating in advanced training there are many classifications for different types of runs. What most people think of as a "standard run," for example, is an easy tempo run. Its purpose is to build your aerobic system without putting too much stress on your body. This contrasts with the "you play the way you practice" mentality of many other sports. In running, that level of exertion would quickly burn out one's body and lead to slower times, increased fatigue, and eventual injury. To that end, an intermediate or advanced runner could do as many as five or six different types of runs in a week ranging from recovery runs to race pace workouts. To support this diversity of run types we developed a method of classifying all runs numerically. To do this we created the trio, a set of three numbers that correspond to a point on a 3D graph (x, y, z). The first, or x-axis, describes intensity on a scale from zero to seven. Zero being no effort and seven being running all out. The second, or y-axis, describes RPE on a scale of zero to ten. Zero being no effort and ten being race pace or all-out effort. The third, or z-axis, describes the total distance of a run as a percentage of the users longest long run from zero to ten. Zero being no distance and a ten being 100% of a user's long run. With a trio we can assign a goal stimulus to anything we want that can be tracked in terms of intensity, RPE, and distance. This includes things as small as workouts and individual days to larger items such as weeks and months. Even workout types are classified in this way.

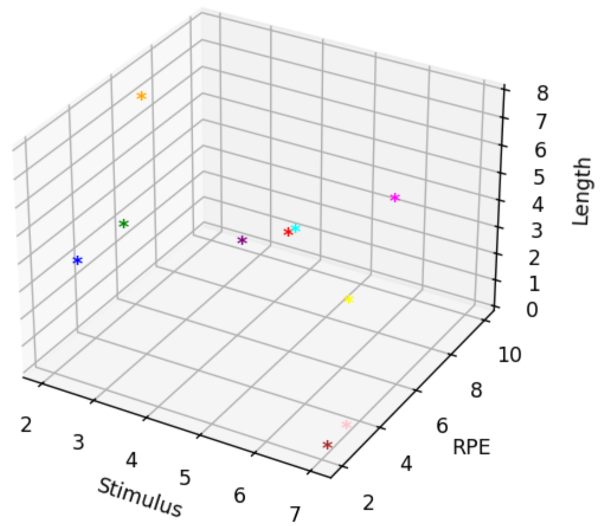

Figure 4: A Three-Dimensional Representation of Our Workout Database

The trio universalizes categorization across our entire program making it far easier to denote the differences between runs. This means the difference between an easy run and a workout is not a complex mesh of pace, reps, and distance, combined with measurements on how the athlete is feeling. Rather it is three numbers that encapsulate all of those elements on a uniform scale. This makes it simple to develop accurate training plans because each day's collection of runs is a list of trios. Furthermore, with the intended development of a neural network to create daily changes in an individual's training plan describing days as a list of trios is invaluable. This is because it is much easier for a neural network to understand the connections between three numbers than the connection between ten workout types and how they all correspond to each other.

In order for our training plans to be effective as a list of trios we need something to compare them to. To that end we created two libraries, one for workout types and one for individual workouts. These libraries consist of key-value pairs pairs that match trios to what we consider to be their corresponding running values. Visually, this can be displayed as Figure 4.

Each point in the figure is a workout type defined by stimulus, RPE, and distance. Individual runs function much the same way, with each workout being given a matching trios that best describes its stimulus, RPE, and length. It is worth noting that RPE is only an expected value and may contrast with reality. We cannot assume how specific runs or workout types will affect individuals, which makes assigning runs to users far more difficult. This is why, after each day, a survey is given to the user to record their RPE and completion, which allows the neural network to personalize workouts for them.

With these dictionaries set up and our training plans created it is now a fairly simple matter to give a user workouts for each day as a list of trios. For each trios, we use our own version of the distance formula: $(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2$ to find the run its stimulus is most comparable to. First, we compare each goal trio in our list of triosto each of the trios in run type. We then assign the run type as the run that was the closest (had the lowest output from our distance formula) to our list of trios. Then we repeat the process for each run categorized by that type. This finds the run in our library that is closest to the trio.

Perhaps the best element of the trio is the fact that it does not rely on any biometric data or technology to be successful. This is because RPE handles all of this data by being based on user feel. If it is hot or hilly, the user will feel worse running and will be able to report that. We do not need heart rate data to tell the application that an activity was easier or harder on the user's body than anticipated. The same is true if a run is easy. The user will be able to report that it felt easy, and there will be no need for biometric data. This makes the application far more accessible because users do not need the technology to track statistics like heart rate and heart rate variability.

3.3 Training Plan Creation

Each training plan is broken into six sections. Of these sections' day, week, and month history are all stored as stacks while day, week, and month future are all stored as queues. As the names suggest, day, week, and month history store what has already been completed by the user whereas day, week, and month future store what has yet to be completed by the user.

In our training plans, a day is made up of a list of trios that specify the stimulus needed for the user on that given day. There are also elements in the day object such as completion score, completed mileage, and actual RPE, which allow for the day's stimulus to be updated as it passes from day future to day history. This makes it possible for the neural network to shift the queue of day future as necessary depending on the real stimulus accomplished by the user instead of just using the expected stimulus on the training plan. Each week is then made up of seven days and the week's expected RPE and completed mileage. The same is true for months which contain twenty-eight days coming from four weeks. This allows the program to track user status on more than just a day-to-day basis, creating a far more complete approach to training.

Not only does each day, week, and month track what has been accomplished to that point, but they also have a specific goal in our training plan. A day could be an off day, recovery day, easy day, workout day, or long run day. A week could be a down week, a maintain week, or a build week. Months are broken into base months, pre-competition months, and finally there is a peak phase that is attached to the end of all our training plans. The goal of the peak phase is to prepare a runner for one race in particular.

Initial training plans are all two months long and follow the same setup of one month base and one month pre-competition training. This is because they will be updated depending on the time difference between when the user filled out their initial training survey and the date they gave as their most important race. From those two points the different portions of training will be divided up in accordance with how long the pre-competition and peak phase should be with everything else being the base phase.

Each day, week, and month has a trios of goal stimuli which is the primary way our training plans are designed. Each day the list of trios is sent to our workout database which returns runs for that day specific to those trios. If the user accomplishes those runs as anticipated nothing changes, if they stray from the training plan, which they can do in several ways, the program is designed to update the training plan future to account for the changes. Some ways a user can deviate from the training plan are: skipping a day of training, not completing the expected amount of mileage, not completing the mileage in the expected pace range, not rating the exertion level as easy or as difficult as the program expected it to be rated.

From these deviations our program will look to reclassify days given the updated trios based on completion score, real RPE, and distance. If there is a day in the near future of the training plan that matches that stimulus the days will switch. If there isn't a day that matches what the user has done, then it will update future days to compensate for the changes and maintain the weekly and monthly RPE goals.

3.4 Application Workflow

To create a cohesive user experience, we present this information in the form of an app. This provides a layer of abstraction, allowing runners to utilize the product without knowledge of the underlying processes. The workflow, seen in Figure 5, requires the user to sign up or log in, after which they will receive a unique user identifier number. If it is their first time using the app, we will have them complete a preliminary survey, which will provide us with the information needed to select the correct initial training plan using the decision tree. Once we have assigned the training plan to the user, we package it all together and send it to a database that stores our users. Then, after either the survey or logging in, when the user navigates to the app's home page, we use their unique ID to retrieve their information and store it in the background of our program. It's here that the abstraction comes into play: the information we have retrieved is in the form of our trios and lists of training paces. We then run the functions that extract that information into a processable format, such as 'Easy Tempo Run'. This, along with the training pace corresponding to that run type, is then given to the home page. When the run is completed, we have them complete a brief post-run survey. The results are used to form a trios, which is then sent back to the database.

4 Future Goals

While research into training is complete, our app is far from it. We are still in the process of implementation and, while the groundwork

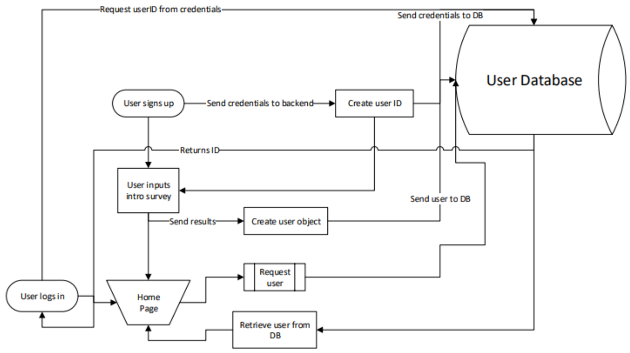

Figure 5: Mapping of the Workflow of Our Application

is sound, there is still a lot of implementation, network training, and beta testing to be done.

4.1 Implementing a Neural Network

Since this application is intended to act as a sort of "virtual coach", arguably the most important feature we plan to add is that of an adaptive training plan. This is based on our assumption that most, if not all, users will stray from our basic training plan, which will therefore need adjustment. Additionally, a user's training may need to change over time even if they followed the basic plan perfectly, such as if their efforts are too hard for a consistent period (over-training) or if their training paces are incorrect.

To address this, our next step is to program a neural network to predict what the next days, weeks, and months' stimuli should look like, in the form of a trios. We have primarily been examining two architectures of neural networks that can do this effectively: recurrent neural networks (RNN) and transformers.

Both models would take in a few key inputs from the user's history: a sequence of day trios, week trios, and month trios indicating the completion of activities, along with a representation of the training phase the user was on. These combine with key information about the user and feed into the neural network to produce the upcoming sequence of days, in the form of trios.

RNNs, which process inputs step-by-step, can be very lightweight and are made for time-series data like ours. However, they tend to struggle with vanishing gradients, where earlier inputs lose influence as the sequence progresses. Variants like Long Short-Term Memory attempt to mitigate this by remembering select features from early on, but the issue remains present. An alternative is a Transformer architecture, which evaluates the entire input simultaneously. This could allow for a more complete and complex understanding of the user and their history, but Transformers are prone to overfitting if their training dataset is too small (because they can "memorize" a lot of data).

We therefore plan to begin with a lighter-weight RNN-based model that can be trained during a beta-phase on a small test-user base. As our dataset grows, we hope to eventually transition to a more nuanced transformer model.

4.2 Beta Testing

For us to fully implement a neural network we will require some training data. This data will be collected during a phase of beta testing in which a small number of runners will have modifications to their plan made by a neural network that is actively being trained. This means that when their information is passed into the neural network it will produce a result that likely contains some errors. Then we, as the ones monitoring the program, will modify the result to be correct and inform the program of this modification. In this way it can adjust the process of creating outputs and learn to better replicate the training plans that we are attempting to create. The goal is that after this beta testing the neural network will no longer require intervention to adjust running plans to better suit the individual.

Acknowledgments

Thank you to Coach Sarah Burnell and Professor Peter-Micheal Osera for being excellent mentors and invaluable guides through all aspects of this MAP. Thank you to Grinnell College for funding our research. Thank you to all the coaches that we interviewed your we could not have done it without your insight. Thank you to all participants who were involved in our surveys.

References

[1] Alisa Bowman. 2024. The science behind ice baths for recovery.

[2] Arturo Casado, Carl Foster, Marius Bakken, and Leif Tjelta. 2023. Lactate threshold training to improve longdistance running performance: A narrative review. *International Journal of Environmental Research and Public Health* 20, 5 (Feb. 2023), 3782. doi:10.3390/ijerph20053782

[3] Arturo Casado, Brian Hanley, Jordan Santos-Concejero, and Luis M Ruiz-Pérez. 2021. World-Class Long-Distance Running Performances Are Best Predicted by Volume of Easy Runs and Deliberate Practice of Short-Interval and Tempo Runs. *Journal of Strength and Conditioning Research* 35, 9 (2021), 2525–2531. doi:10.1519/JSC.0000000000003176

[4] Alexandra M. Coates, Michael J. Joyner, Jonathan P. Little, Andrew M. Jones, and Martin J. Gibala. 2023. A Perspective on High-Intensity Interval Training for Performance and Health. *Springer Nature* 53 (2023), 85–96. doi:10.1007/s40279-023-01938-6

[5] Moisés de Hoyo Lora and Luis Suarez Arrones. 2022. Programming and Periodisation for Team Sports. *Springer Nature* (2022), 237–258. doi:10.1007/978-3-030-81989-7_13

[6] Peter Düking, Billy Sperlich, Laura Voigt, Bas Van Hooren, Michele Zanini, and Christoph Zinner. 2024. ChatGPT Generated Training Plans for Runners are not Rated Optimal by Coaching Experts, but Increase in Quality with Additional Input Information. *Journal of Sports Science and Medicine* 23, 1 (2024), 56–72. doi:10.52082/jssm.2024.56

[7] Roger Enoka. 2025. *Neuromechanics of Human Movement.* Human Kinetics, Champaign, IL, USA.

[8] Jonathan Esteve-Lanao, Carl Foster, Stephen Seiler, and Alejandro Lucia. 2005. Impact of training intensity distribution on performance in endurance athletes. *National Library of Medicine* 21, 3 (2005), 2525–2531. doi:10.1519/R-19725.1

[9] Will Freeman (Ed.). 2014. *Track & Field Coaching Essentials.* Human Kinetics, Champaign, IL, USA.

[10] Shona Halson. 2013. Recovery Techniques for Athletes.

[11] Franco M. Impellizzeri, Ian Shrier, Shaun J. McLaren, Aaron J. Coutts, Alan McCall, Katie Slattery, Annie C. Jeffries, and Judd T. Kalkhoven. 2023. Understanding Training Load as Exposure and Dose. *Springer Nature* 53 (2023), 1667–1679. doi:10.1007/s40279-023-01833-0

[12] M Lehmann, U Gastmann, K G Petersen, N Bachl, A Seidel, A N Khalaf, S Fischer, and J Keul. 1992. Training-overtraining: performance, and hormone levels, after a defined increase in training volume versus intensity in experienced middle- and long-distance runners. *British Journal of Sports Medicine* 26, 4 (1992), 233–242. doi:10.1136/bjsm.26.4.233

[13] Steve Magness. 2014. *The Science of Running: How to find your limit and train to maximize your performance.* Origin Press, San Rafael, CA, USA.

[14] R M Nicholson and G G Sleivert. 2001. Indices of lactate threshold and their relationship with 10-km running velocity. *Medicine & Science in Sports & Exercise* 33, 2 (Feb. 2001), 329–343. doi:10.1097/00005768-200102000-00026

[15] Lost Pace. 2025. Runna vs Garmin Coach: Which AI Running App is Best for Ultramarathoners?

[16] Michael B. Phillips, Jake A. Lockert, and LaNise D. Rosemond. 2016. Tools and Benefits of Periodization: Developing an Annual Training Plan and Promoting Performance Improvements in Athletes. https://thesportjournal.org/article/tools-and-benefits-of-periodization-developing-an-annual-training-plan-and-promoting-performance-improvements-in-athletes/

[17] Subbarayalu Vijay, Chinnusamy Sivakumar, Purushothaman Kumar, Chittode Krishnasamy, Krishnan Vasanthi, Karuppaiyan Kannan, Mani Pradeepa, Prabaharan Sivasankar, Ameer Mariam, and Udhaya Kumar Anand. 2024. Lactate threshold training to improve longdistance running performance: A narrative review. *Montenegrin Journal of Sports Science and Medicine* 13, 1 (Feb. 2024), 19–29. doi:10.26773/mjssm.240303

[18] A. Weltman, R. L. Seip, D. Snead, J. Y. Weltman, E. M. Haskvitz, W. S. Evans, J. D. Veldhuis, and A. D. Rogol. 1992. Exercise Training at and above the Lactate Threshold in Previously Untrained Women. *International Journal of Sports Medicine* 13, 3 (1992), 257–263. https://pubmed.ncbi.nlm.nih.gov/26618058/