

Optimized Marathon Pacing

A Pacing Tool for World Major Marathons

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Optimized Pacing for the Abbott World Major Marathons

Optimized by data. Personalized for you.



Tap a city above to start building your pacing plan

Introduction

We are developing a **data-driven pacing optimization** platform designed to help marathon runners execute their goal times on race day.

Marathon courses vary drastically in elevation, terrain, and difficulty, and even small pacing errors in the early miles can lead to significant time losses later in the race. Most existing tools offer generic, one-size-fits-all pacing guidelines that don't account for these course-specific features.

Our platform addresses this gap by integrating **real GPX course data, historical runner performance, and personalized goal times** to produce optimized pacing strategies tailored to each individual and each unique course.

Objectives

- Build a web-based tool that generates marathon pacing plans across the Abbott World Marathon Majors.
- Integrate GPX elevation and terrain data with historical race results to produce course-specific strategies.
- Analyze real finisher data to identify which pacing strategies correlate with the best outcomes.
- Offer course specific advice including water and electrolyte station availability and turn information.
- Deliver race-day resources using downloadable pacing cards and printable wristbands.

Conclusion

We have successfully built and deployed a **live, data-driven pacing platform** covering the 2026 Sydney and Berlin marathons with the 2025 NYC and Sydney marathons as well as the 2026 Boston, London, and Tokyo marathons being archived. **Future work** includes expanding to the **2026 Chicago Marathon** and adding new features to the website.

The platform has already demonstrated **real-world impact**; Australian runner, Alexis Dean, used the tool for the 2025 Sydney Marathon to finish in **3:08:47**, 13 seconds under her goal and in the **top 1% of women finishers**, and plans to use the Boston module as she prepares for the 2026 race.



System Output and Method

Goal Time: 03:18:00

Personal Best: 03:33:33

Preferred Pacing Strategy: Slight Negative Split Effort

Age Group: 30–34

Sex: Male

Preferred Unit: Kilometers

Interval Splits

The following splits are customized based on the unique course profile—including elevation changes, turns, water and electrolyte stations—as well as data from thousands of previous marathon runners and your chosen pacing strategy. If no strategy is selected, the plan defaults to a steady-effort pacing that balances your goal time across the course challenges. [Learn more](#)

| Interval (Kilometers) | Interval Time | Cumulative Time | |
|-----------------------|---------------|-----------------|----------|
| — | 0 - 5 km | 00:23:33 | 00:23:33 |
| + | 0 - 1 km | 00:04:23 | 00:04:23 |
| | 1 - 2 km | 00:04:56 | 00:09:19 |
| | 2 - 3 km | 00:04:50 | 00:14:09 |
| | 3 - 4 km | 00:04:52 | 00:19:01 |
| | 4 - 5 km | 00:04:32 | 00:23:33 |
| + | 5 - 10 km | 00:24:03 | 00:47:36 |
| + | 10 - 15 km | 00:24:07 | 01:11:44 |
| + | 15 - 20 km | 00:23:53 | 01:35:37 |

Data Collection: Marathon results were scraped from official race timing platforms, yielding **tens of thousands of finisher records with split times at 5km intervals**.

- Data includes split times and finish times as well as pacing progression across race segments.
- **GPX course files** were obtained from official race results and Strava.
- **GPX data** was parsed to extract:
 - Elevation profiles
 - Segment-wise grade (incline/decline)
 - Cumulative course difficulty

Platform Implementation

- **Frontend:** HTML, CSS, vanilla JavaScript
- **Backend:** Node.js with Express.js
- **Data Processing and Analysis:**
 - **Python** (pandas for data aggregation and analysis).
 - **gpxpy** for GPX parsing and elevation extraction.

Pacing Model: Pacing strategies were generated using a **blended modeling approach**:

- **70% Terrain-Based Optimization**
 - Elevation and grade are used to estimate effort-adjusted pacing
 - Implemented using GPX parsing via gpxpy
- **30% Empirical Runner Data**
 - Historical split data are used to capture real-world fatigue trends
 - Observed patterns (e.g., late-race slowdown) were incorporated into pacing adjustments
- This blend produces a weighted time allocation per interval that sums up to the runner's goal time. The 70/30 split was chosen to prioritize course terrain as the dominant factor.

Platform Implementation

- **Visualization and Output:**
 - **Chart.js** for pacing comparisons
 - **Folium** for interactive course maps
 - Maps converted to PNG for integration into the web interface
- The platform generates:
 - Interval-based pacing tables
 - Downloadable pacing cards
 - Printable pacing bands for race-day use

| Interval | Advice | Features |
|------------|--|----------|
| 0 - 5 km | The initial km are a fast downhill so try to conserve energy to prevent quad fatigue. Focus on running relaxed and efficient over the major descent. | |
| | Water at 3.22km, 4.82km. Gel station: None in this segment. Electrolyte stations: Near 3.22km, 4.82km. Steepest overall decline up to -9.9%. Net downhill of -47m. Mostly straight with natural road curvature. | |
| 5 - 10 km | This segment is characterized by rolling terrain. It is an excellent time to lock into your goal pace and hydration/fueling routine, preparing for the upcoming climbs. | |
| 10 - 15 km | This is the preamble to the famous hills and the Wellesley area. Use the Wellesley College Scream Tunnel (in this segment) as a major energy boost. Be mentally prepared for the sharp downhill set up for Newton. | |
| 15 - 20 km | This segment contains the steep descent into Newton Lower Falls and the initial uphill sections leading to the Newton Hills. Focus on controlling speed and shifting to an efficient climbing stride. | |
| 20 - 25 km | This segment is the true start of the major challenges. Focus on even effort over pace. Heartbreak Hill is still ahead, but use the downhills for partial recovery. | |

| Strategy | Description |
|--------------------------|--|
| Even-Effort Pacing | Maintain consistent effort throughout, adjusting pace for elevation changes. |
| Even-Timing Pacing | Maintain consistent pace regardless of terrain (the traditional approach). |
| Slight Negative Split | Start conservatively, finish strong. Energy conserved early is spent late. |
| Strong Negative Split | Very conservative start with a strong, sustained acceleration in the second half. |
| Minor Progressive Effort | Subtle, gradual effort increase across the full race distance. |
| Major Progressive Effort | Gradually increase effort throughout the entire race, producing pace acceleration on relatively flat sections. |
| Slight Positive Split | Start slightly faster, finish slightly slower. A conservative fast-start approach. |
| Strong Positive Split | Aggressive start with a controlled fade – front-loads effort into the first half. |