evinlo

EVINLO EXPLAINERS

The overnight layer, explained

How Evinlo turns what your Apple Watch records while you sleep into five nightly values, a usual range for each, and one heart signal.

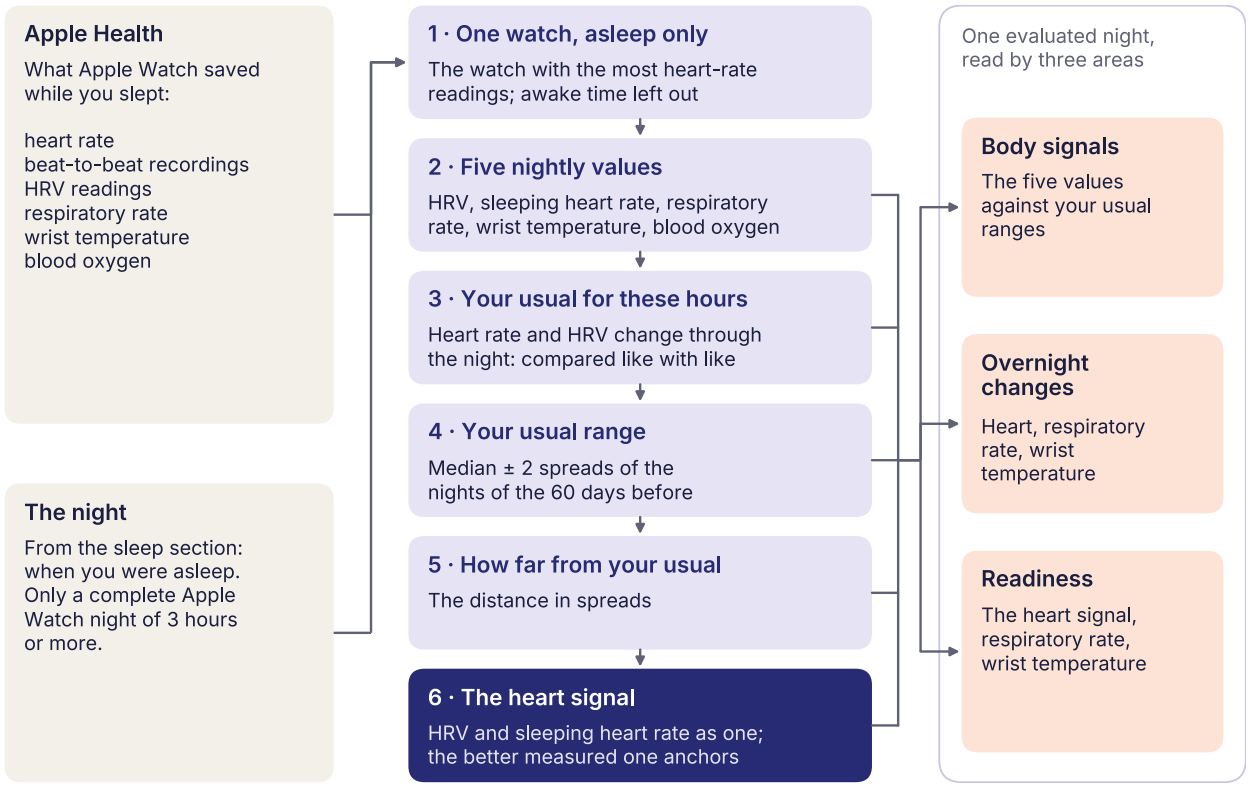


ALGORITHM
Overnight layer 1.0.0

WRITTEN
October 2026

The one-minute version

While you sleep, your Apple Watch records your heart rate, short beat-to-beat recordings, your breathing, your wrist temperature and your blood oxygen. The **overnight layer** turns one night of that into a handful of numbers, and compares each with **your own usual**. You never see the layer itself: Body signals, Overnight changes and Readiness all read the one night it evaluated, so they can never disagree about it.



The overnight layer in six steps. It takes the samples of one watch, from the time you were asleep, makes five nightly values, compares each with your usual for the same hours of the night, and merges HRV and the sleeping heart rate into one heart signal. Body signals, Overnight changes and Readiness all read this one evaluated night.

IN SHORT

- **One night, one watch, asleep only.** Readings from the time you were awake, from other devices and from other apps are left out.
- **Five values a night:** overnight HRV, sleeping heart rate, respiratory rate, wrist temperature and blood oxygen. Each needs a minimum number of readings.
- **Like with like.** Your heart rate falls and your HRV rises over the first hours of sleep, so a night is compared with your usual for the hours that were measured.
- **Your usual range** is the middle of your nights of the last 60 days, plus and minus two spreads. It appears after 7 nights and settles after 28.
- **One heart signal.** HRV and the sleeping heart rate count once, together. The better measured of the two leads.

What goes in

The layer reads only what Apple Watch saved to Apple Health while you slept. It never writes anything.

What	From	What the layer makes of it
Heart rate	Apple Watch's readings, taken at irregular times	The **sleeping heart rate**: the average while you were asleep
Beat-to-beat recordings	Apple Watch's recordings of single heartbeats, each about a minute long	**Overnight HRV** (heart rate variability: how much the time between heartbeats varies), as RMSSD (below)
HRV readings	Apple Watch's own RMSSD readings (newer watches) and SDNN readings (the standard deviation of the intervals between beats)	HRV by another method, each with its own usual
Respiratory rate	Apple Watch, while you sleep	The night's average
Wrist temperature	Apple's one value per night, on watches with the sensor	Kept as it is, shown only as a difference from your usual
Blood oxygen	Apple Watch, where available	The night's average
Resting heart rate	Apple's daily estimate	Shown next to the sleeping heart rate; stands in for it only on a night without one

Two things come from inside Evinlo:

- **The night itself**, from the sleep section: when you fell asleep, when you finally woke up, and every stretch you were asleep in between. The layer counts readings from the asleep stretches only.
- **The nights before**, for your usual: every night of the 60 days before, evaluated by the same rules.

Nothing else goes in. The layer reads no workouts, no daytime heart rate and nothing you type.

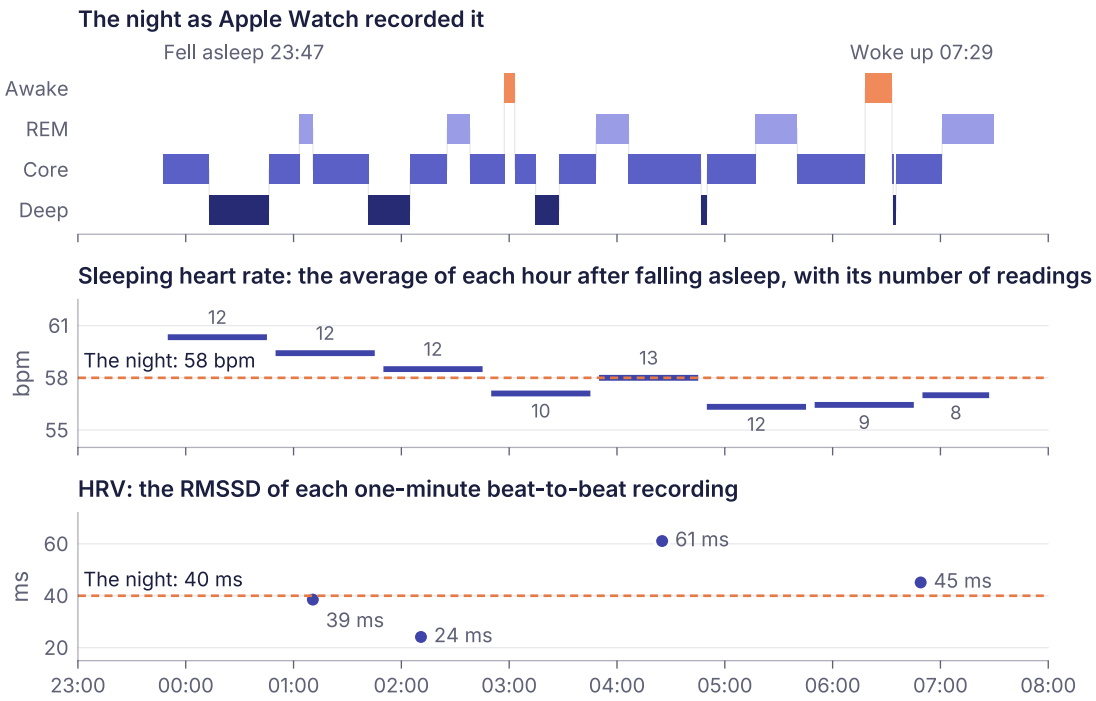
How it works, step by step

Step 1: one night, one watch, asleep only

Which nights. Only a night recorded by Apple Watch, complete, not entered by hand, and with at least 3 hours of sleep. A night from another sleep tracker still gets a sleep score, and the body pages say that it has no body signals.

Which watch. If two watches recorded the same night, Evinlo takes the one with the most heart-rate readings while you were asleep, and only its samples. Samples from other devices and apps are ignored, also when they are of the same kind.

Which readings. A heart-rate, respiratory or blood-oxygen reading belongs to the night when it **starts** while you were asleep; an HRV recording when its **middle** does. Time awake inside the night and time nothing was recorded for are left out. Each reading also keeps how long after falling asleep it came: that matters in step 3.



Maya's night of 12 to 13 October. Top: her sleep stages. Middle: her heart rate, averaged for each hour after she fell asleep; the number above each hour is how many readings it holds. Bottom: her four beat-to-beat recordings. Maya is a synthetic person (see "A worked example").

Step 2: five nightly values

Value	How it is made	Needs at least
Sleeping heart rate	The average of the heart-rate readings while asleep	20 readings, in 3 different hours of the night
Overnight HRV	The average of the logarithms of RMSSD over the night's recordings (below)	2 usable recordings
Respiratory rate	The average of the readings while asleep	10 readings
Blood oxygen	The average of the readings while asleep	3 readings
Wrist temperature	Apple's nightly value that overlaps the night the longest	An overlap of 2 hours

The sleeping heart rate is not Apple's resting heart rate. Evinlo's value is the plain average while you slept. Apple's resting heart rate is a daily estimate, worked out in Apple's own way; the app always labels it "from Apple Health".

HRV from beat-to-beat recordings. Evinlo uses RMSSD (the root mean square of successive differences: how much each interval between two beats differs from the one before, on average), the measure that suits short recordings. For each recording of 30 to 150 seconds it takes the intervals between neighbouring beats (300 to 2,000 ms, none across a beat the watch marks as missing) and the differences between successive intervals. A difference larger than 20% of the average of its two intervals is left out: that is what a missed or an extra beat looks like. A recording counts with at least 20 differences, no more than a fifth of them left out, and an RMSSD of at least 1 ms.

$$\mathrm{RMSSD} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(I_{i+1} - I_i)^2}$$

HRV is skewed: a single high recording would pull a plain average up. So the night's value is the average of the **logarithms**, turned back into milliseconds. Maya's four recordings were 39, 24, 61, 45 ms; her night's HRV is 40 ms, where a plain average would give 42 ms. With 2 recordings the value is shown as "limited data".

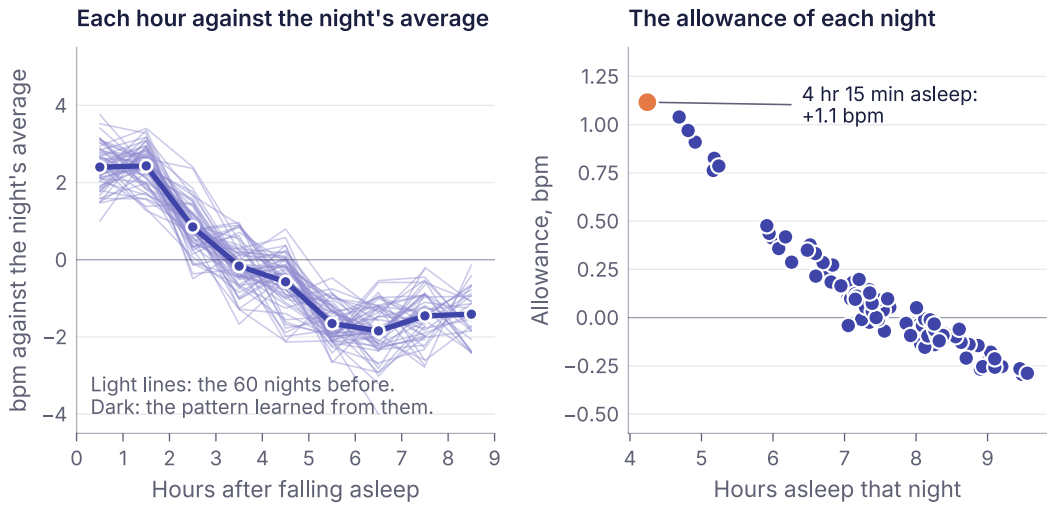
Two other HRV methods are read every night, each with a usual of its own: Apple's own RMSSD readings (at least 6 in the night, "limited" below 12) and SDNN (at least 3, always "limited"). The night's value comes from the first of Apple's RMSSD, the beat-to-beat RMSSD and SDNN whose own usual already rests on 28 nights; otherwise from the one with the longest early usual. A method therefore takes over only once its own usual is established, never because it is new. When Apple's readings take over, the page says for 14 nights that the level differs a little from before.

Step 3: your usual for the hours that were measured

Your heart rate falls and your HRV rises over the first hours of sleep. A short night measures only those early hours, so its average looks worse than the same body would on a full night. Evinlo corrects for that, and it does so with **your own** pattern.

For every day, Evinlo learns how each hour after falling asleep usually sits against the night's average, from the nights of that day's 60 days. The pattern has nine hours: the first hour after falling asleep, the second, and so on, with the ninth holding everything from 8 hours after falling asleep on. Only nights of at least 6 hours teach the pattern, and it needs 20 of them. An hour that too few nights reached takes the value of the nearest hour that has enough.

A night's **allowance** is that pattern, weighted with where the night's own readings fell. Evinlo leaves the value as it was measured and moves your usual by the allowance instead: the usual range next to the value is your usual **for the hours that were measured**. When the allowance reaches half a spread, the row says "Usual for the hours measured".



Left: Maya's heart rate in each hour after falling asleep, against that night's average, on the 60 nights before 13 October (light), and the pattern Evinlo learned from them (dark). Right: a synthetic person whose every sixth night is cut short while the body stays the same. The shorter the night, the larger its allowance: its first hours run higher, and Evinlo expects that.

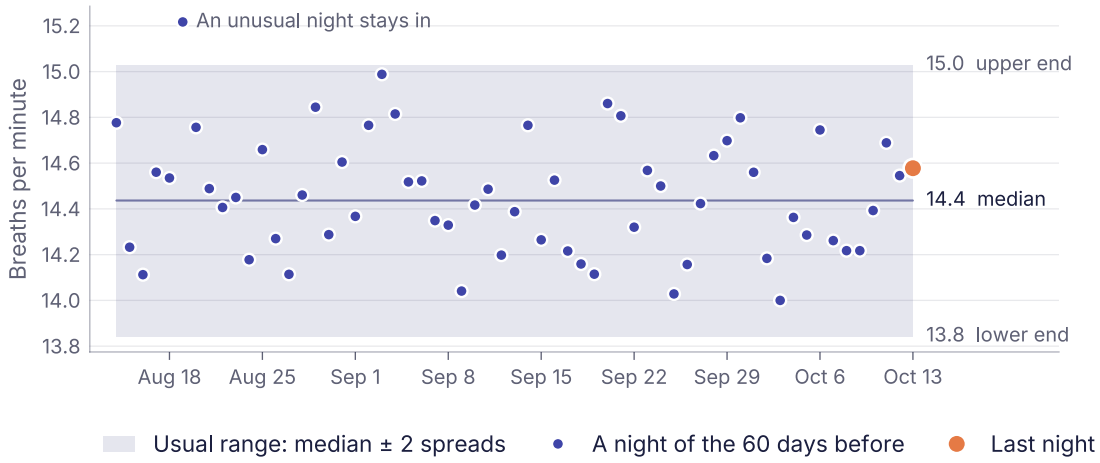
Maya's first hour runs +2.4 bpm above her night's average; her lowest hour runs 1.8 bpm below it. On her full night of 13 October the allowance was 0.12 bpm, close to nothing. On the right, the shortest night, 4 hr 15 min asleep, got an allowance of 1.1 bpm, 0.3 of a spread. The same is done for HRV, with each recording weighed where it fell. The respiratory rate, the wrist temperature and blood oxygen get no allowance.

Before there are 20 full nights, nothing is adjusted. The pattern is learned again for every day from that day's own nights, so nothing is carried from one day to the next.

Step 4: your usual range, and how far a night is from it

For each value, Evinlo takes the nights of the 60 days before (never the night itself, never a later one) and works out:

- the **median**, the middle value;
- the **spread**: 1.4826 times the median absolute deviation, a robust cousin of the standard deviation. A single odd night barely moves it. It is never smaller than a floor per signal, so a person with very steady nights is not told that a tiny change is large;
- the **usual range**: the median plus and minus 2 spreads.



Maya's respiratory rate on the 60 nights before 13 October, and the usual range they give. An unusual night stays in the window: the median and the spread tolerate it, and leaving it out would make the range narrower exactly when it matters.

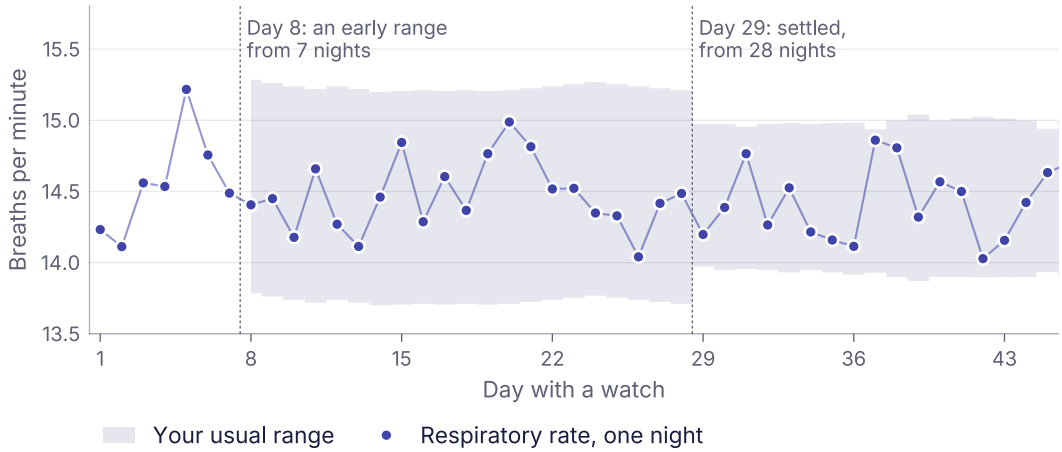
Maya's respiratory rate on those 60 nights has a median of 14.44 breaths per minute and a median absolute deviation of 0.20, so her spread is 0.30 and her usual range 13.8 to 15.0. Last night's 14.58 (the app shows 14.6) sits inside it.

A night's **distance** from your usual is the difference in spreads, after the allowance of step 3:

$$z = \frac{\text{value} - \text{allowance} - \text{median}}{\text{spread}}$$

Maya's respiratory rate is 0.14 breaths per minute above her median: 0.48 spreads, worked out from the unrounded values. Body signals calls a value outside the range above or below your usual, which is the same as a distance beyond 2. Overnight changes and Readiness use the distance itself.

The first weeks. A range appears from 7 nights, as an "early range", and settles from 28. While it is early, the floor of the spread is one and a half times as wide: a week of nights is often steadier than a person is. For the respiratory rate that is a spread of at least 0.375 instead of 0.25 breaths per minute.



The respiratory rate of a synthetic person in their first weeks with a watch. On day 8 an early range appears, wide because its spread is held at one and a half times the floor. From day 29 the range rests on 28 nights and the floor is the plain one.

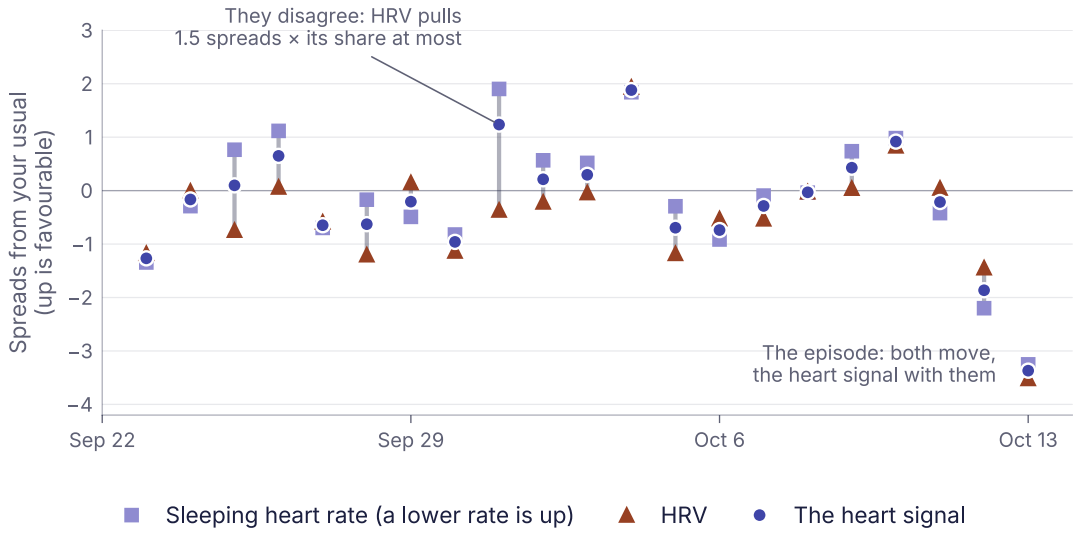
Like with like. A usual never mixes what cannot be compared. Wrist temperature has one per watch: sensors differ between units, also of one model, so a new watch starts a new usual and shows no wrist temperature for 7 nights. Each HRV method has its own usual, Apple's readings also per version of Apple's algorithm, SDNN also per length of its recordings. Apple's resting heart rate has its own usual from the 60 days before the day it belongs to.

Step 5: the heart signal

HRV and the sleeping heart rate mostly say the same thing about your heart. Counting both would turn one cause into "two signals", so Evinlo merges them into one **heart signal**.

1. Each is turned into its distance from your usual, the sign chosen so that **up is favourable**: a higher HRV, a lower heart rate. Each is limited to between 4 spreads below and 3 above.
2. Each gets a weight for how well it was measured. The sleeping heart rate, an average of many readings, weighs 1. HRV from k recordings weighs k ÷ (k + 1): 0.8 with four. Apple's own HRV readings overlap and count as at most 8 recordings; SDNN weighs half.
3. The heavier one is the **anchor**; on a tie, the heart rate. The other moves the result by its share of the weight, and never by more than 1.5 spreads times that share.

While the two agree, the heart signal is simply their weighted average. When they disagree, the less well measured one stops pulling. A handful of noisy HRV recordings can therefore neither hide a heart rate that really was high nor make one up.



The two inputs and the heart signal of a synthetic person over three weeks, each night's two inputs joined by a grey bar. The heart signal sits between them, closer to the sleeping heart rate. On 1 October they disagree, and the limit keeps HRV from pulling further. On the last nights, an illness-like episode the generator added, both move and the heart signal moves with them.

On 1 October the sleeping heart rate was +1.90 spreads (favourable) and HRV −0.36, from 4 recordings, a share of 0.44. Their weighted average would be +0.90. The limit lets HRV move the anchor by at most 1.5 × 0.44 spreads, so the heart signal is +1.24.

How far it can be trusted follows from the weights that are there: their sum divided by 1.5, at most 1. That is full with both inputs, about two thirds with the sleeping heart rate alone, and a third when only Apple's resting heart rate of the day before stands in. Apple's value stands in only on a night without any sleeping heart rate, not while the sleeping heart rate's usual is still being built.

A worked example

Meet **Maya**. She is a synthetic person: the app's generator made her nights and days, and no part of her comes from a real person. She falls asleep around half past eleven and wears her watch every night. This is her night of Monday 12 to Tuesday 13 October 2026, as the app shows it that afternoon.

She fell asleep at 23:47 and woke up at 07:29. Her watch saved 88 heart-rate readings while she was asleep, 4 recordings that gave an RMSSD, 45 readings of her respiratory rate and 11 of her blood oxygen, and Apple's wrist temperature for the night.

Signal	Last night	From	Usual range, for the hours measured	Distance
Overnight HRV	40 ms	4 recordings	31 to 65 ms	−0.60
Sleeping heart rate	58 bpm	88 readings	51 to 64 bpm	0.18
Respiratory rate	14.6 breaths/min	45 readings	13.8 to 15.0	0.48
Wrist temperature	−0.1 °C	Apple's nightly value	−0.4 to +0.4 °C	−0.25
Blood oxygen	95%	11 readings	94 to 98%	shown, never used

Her HRV, step by step. The average of the logarithms of her four recordings is 3.689 (ln ms), which is 40 ms. Her usual for these hours: a median of 3.814 over the nights of the 60 days before, an allowance of −0.013 for where her recordings fell, and a spread of 0.187. Her distance:

$$z = \frac{3.689 - (-0.013) - 3.814}{0.187} = -0.60$$

That is a little below her median, well inside her range. Turned back into milliseconds, the range is 31 to 65 ms, which is what the app shows.

Her sleeping heart rate: a median of 57.33 bpm, an allowance of 0.12 bpm for a full night, and a spread of 3.11 bpm. Her 58 bpm is 0.18 spreads above her usual: a range of 51 to 64 bpm.

Her wrist temperature is shown as a difference: −0.055 °C from her usual (the app shows −0.1 °C), with a spread of 0.22 °C, so her range is −0.4 to +0.4 °C. The absolute temperature never appears in the app.

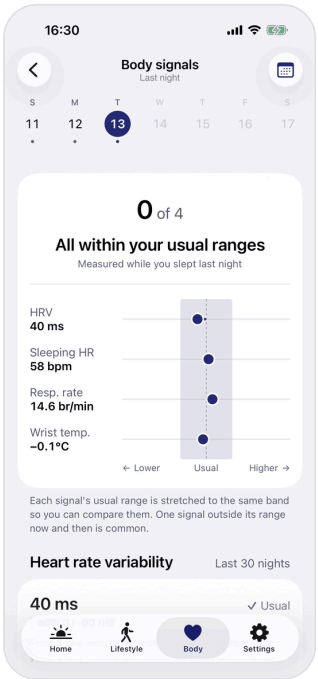
Her heart signal. The sleeping heart rate is the anchor (weight 1), at −0.177 in the favourable direction (a heart rate 0.18 spreads above her usual). Her HRV weighs 0.8, a share of 0.444, at −0.595. They agree closely, so the limit does not apply:

$$-0.177 + 0.444 \times (-0.595 - (-0.177)) = -0.36$$

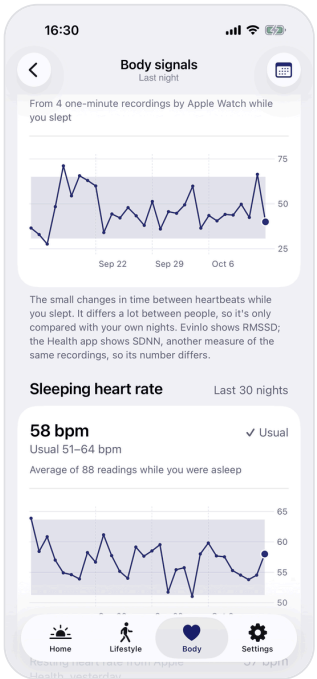
with full confidence (1). Readiness turns this one number into 57 points for her heart part. On the same night with an illness-like episode, her heart signal is −3.37.

What you see in the app

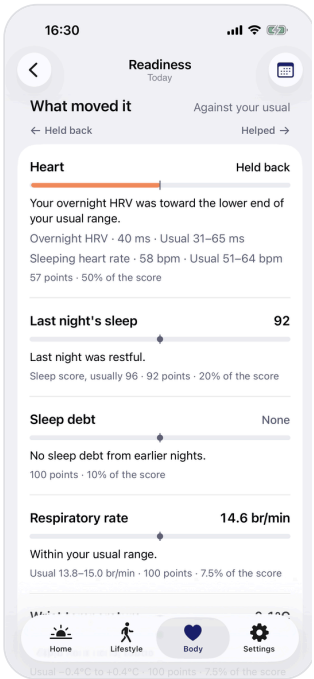
The layer has no page of its own; its numbers show up wherever a body value does. These are Maya's screens at 16:30 on that Tuesday, in the app's synthetic data mode, then a new person and Maya with the episode.



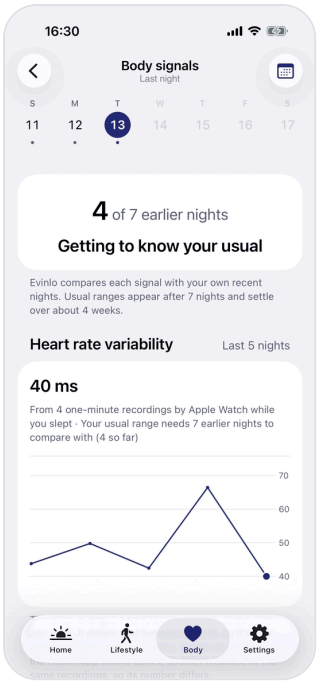
Body signals: the values on one shared scale.



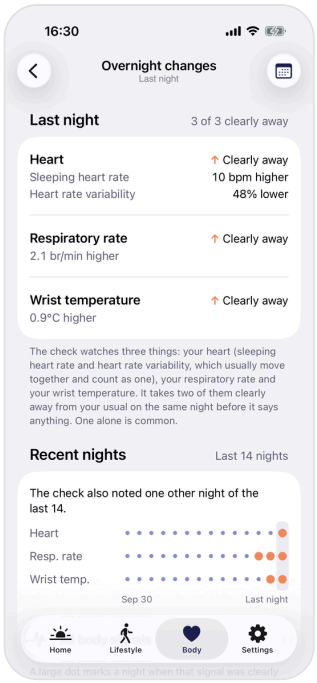
Each value, its usual range and what it rests on.



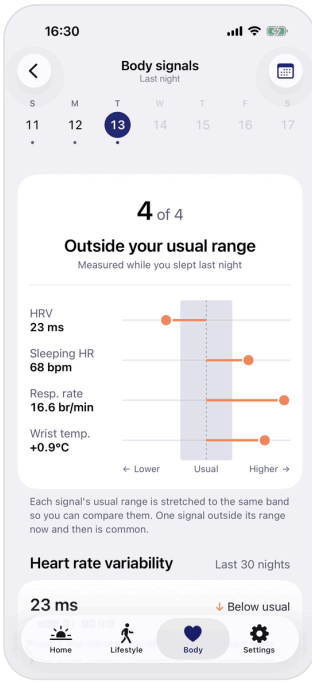
Readiness: the same values, turned into points.



A new person: “4 of 7 earlier nights”.



The episode, as differences: “10 bpm higher”.



The episode: “4 of 4” outside the range.

Honest limits

- **A handful of recordings.** A night’s HRV often rests on four or five one-minute recordings, and where they fall is up to the watch. That is why HRV is weighed by its recordings and why the sleeping heart rate leads the heart signal.
- **A watch estimates.** Optical heart rate depends on fit, movement, cold skin and tattoos. Wrist temperature is skin temperature, moved by the room and the bedding.
- **The hour pattern covers the heart only.** The respiratory rate can also change over the night, and no allowance corrects it, so after a short night it can sit away from your usual for that reason alone.
- **Many things move these values:** alcohol, caffeine, a late meal, heat, altitude, travel, medication, the menstrual cycle and illness. The layer measures *that* a value moved, not *why*.
- **Your usual follows you.** A slow, lasting change becomes the new usual over weeks. A cycle widens your range rather than standing out every month.
- **A method takeover rests on little evidence.** Apple’s own RMSSD readings taking over from the beat-to-beat recordings has been replayed on synthetic people only. The rule stays as it is and is looked at again with the first real takeover.
- **Maya is generated.** Her nights are calmer than a real person’s, and her watch never slips. Your own values will scatter more.

For the experts

Version and scope

`OvernightAlgorithm.version` is **1.0.0**. It covers the payload of a night, the nightly values, the hour pattern, the baselines and regimes (the groups of nights that share a usual: one per watch for wrist temperature, one per HRV method), and the heart signal; it is also the version of the `overnight` feature kind, so a new version drops every cached night. The pages built on the layer have their own versions: `BodySignalsAlgorithm.version` and `IllnessAlgorithm.version`, both 1.0.0.

Parameters (`OvernightParameters.v1`)

Parameter	Value	What it does
`usableMinimumAsleepMinutes`	180	A night needs 3 hours asleep to have body signals
`beatSeriesDurationSeconds`, `beatIntervalMilliseconds`	30…150 s, 300…2000 ms	A usable recording's length; intervals a heart can produce
`artefactRelativeDifference`, `artefactMaximumShare`	0.20, 0.20	A difference beyond 20% of its two intervals' mean is left out; at most a fifth may be
`beatSeriesMinimumDifferences`, `minimumRMSSD`	20, 1.0 ms	What a recording needs to count
`beatSeriesMinimum`, `…Good`; `appleRMSSDMinimum`, `…Good`; `sdnnMinimum`	2, 3; 6, 12; 3	Recordings or readings for an HRV value, and for "good" (SDNN is always "limited")
`sdnnShortWindowMaximumSeconds`	90	SDNN of longer recordings is a regime of its own
`sleepingHeartRateMinimumReadings`, `…Bins`; `respiratoryMinimumSamples`; `oxygenMinimumSamples`	20 in 3 hours; 10; 3	Readings for the other nightly values
`temperatureMinimumOverlapMinutes`, `…ReadMarginBeforeHours`, `…AfterHours`	120, 2, 6	Apple's nightly sample must overlap the night 2 hours; it is read from 2 h before sleep onset to 6 h after the final wake
`correction`, `profileBins`	`hourProfile`, 9	The hour pattern, in nine hours after sleep onset, the last holding everything from 8 hours on (`ramp` and `none` are evaluation variants)
`profileMinimumNights`, `profileMinimumAsleepMinutes`	20, 360	Teaching nights needed, of at least 6 hours; else no allowance
`profileMinimumHeartRateBins`, `…ReadingsPerBin`, `profileMinimumRecordings`	5, 3, 3	A night teaches heart rate with 5 hours of 3 readings, HRV with 3 recordings
`profileMinimumBinCount`	10	Contributions an hour needs; else the nearest hour that has them
`allowanceNoteScales`	0.5	From this allowance, in spreads, the row says "Usual for the hours measured"
`rampHours`, `rampShrinkage`, `rampSlopeRange…`	6, 50, −2…0 bpm and 0… 0.10 ln ms per hour	The ramp variant only

Parameter	Value	What it does
`baselineWindowDays`, `baselineMinimumNights`, `baselineEstablishedNights`	60, 7, 28	The window of every usual; early range; settled range
`provisionalFloorFactor`, `usualRangeScales`	1.5, 2.0	The floor while a range is early; median ± 2 spreads
`floorLnHRV`, `floorHeartRate`, `floorRespiratoryRate`, `floorWristTemperature`, `floorBloodOxygen`	0.10 ln ms, 1.5 bpm, 0.25 breaths/min, 0.15 °C, 0.6 points	The smallest spread per signal
`methodTakeoverNights`, `methodChangeNoteNights`	28, 14	A method takes over once its own usual has 28 nights; the page names a change to Apple's readings for 14 nights
`heartZMinimum`, `heartZMaximum`, `heartAgreementLimit`, `heartConfidenceFull`	−4, 3, 1.5, 1.5	The limits of each input, the most the other input may move the anchor (times its share), the weight of full confidence
`sdnnWeightFactor`, `restingHeartRateWeight`, `appleRMSSDCountCap`	0.5, 0.5, 8	SDNN's weight against an RMSSD of the same count; Apple's resting heart rate as a stand-in; Apple's readings count as at most 8
`lateSampleMarginHours`, `notInYetHours`, `recentDataDays`	4, 4, 30	A night is settled 4 hours past the final wake; "Not in yet" for 4 hours; "No … found" (for example "No wrist temperature found") looks back 30 nights
`statusChainDays`, `waitingForSignalsMinutes`	16, 120	Used by Overnight changes (nights its status reaches back) and Readiness (minutes it waits for last night's values)

The minimum spreads, the 60 days, the 7 and 28 nights, the factor 1.5, the width of 2 spreads, every minimum count, the 20% artefact rule, the hour pattern with its 20 nights, and the weights and the 1.5-spread limit of the heart signal are design choices. Comparing each person with their own baseline with robust statistics, RMSSD for short recordings, and that these values depend on the time of night are supported by the literature.

Formulas

A night's HRV by one method, from the RMSSD of its *k* recordings:

$$\mathrm{HRV}_{\mathrm{night}} = \frac{1}{k}\sum_{j=1}^{k} \ln \mathrm{RMSSD}_j \qquad \text{shown as } e^{\mathrm{HRV}_{\mathrm{night}}} \text{ ms}$$

The usual of one signal, from the values x of the nights before (adjusted by their allowance), with f its floor and n their number:

$$m = \mathrm{median}(x), \qquad s = \max\left(1.4826 \cdot \mathrm{median}|x - m|,\ cf\right)$$

with $c = 1.5$ while $n < 28$ and $c = 1$ from then on, and no usual at all below 7 nights.

The hour pattern p and a night's allowance, with c_b the night's readings in hour b and c all of them:

$$a = \sum_{b=0}^{8} \frac{c_b}{c}\, p_b, \qquad z = \frac{x - a - m}{s}, \qquad \text{range} = [\, m + a - 2s,\ m + a + 2s \,]$$

The heart signal, with g_A and g_O the favourable distances of the anchor and the other input (each limited to −4…3) and w their weights:

$$g = g_A + \frac{w_O}{w_A + w_O} \cdot \mathrm{clamp}\left(g_O - g_A,\ -1.5,\ 1.5\right), \qquad \text{confidence} = \min\left(1,\ \frac{w_A + w_O}{1.5}\right)$$

with w = 1 for the sleeping heart rate, 0.5 for Apple's resting heart rate, $k/(k+1)$ for HRV from k recordings (Apple's readings: k at most 8; SDNN: half of that).

The order of operations

1. **The night.** The sleep section hands over the night's window: onset, final wake, the asleep stretches, the source, whether it is complete.
2. **Extraction** (`OvernightExtractor.payload`), pure in the night's own samples: is it a usable Apple Watch night; which watch; the samples of the asleep time; heart-rate sums and counts per hour after onset; every HRV recording of every method (beat-to-beat recordings analysed one by one); respiratory and blood-oxygen sums; Apple's wrist-temperature sample. The result, the night's **payload**, is cached on the iPhone once 48 hours have passed since the night ended; it holds no pattern, usual, distance or score.
3. **Stage C0** of the day pipeline shows the plain values of the night and the 7 nights before, while the usual ranges are worked out.
4. **Evaluation** (`OvernightEngine.signals(for:)`) from the payloads of [day − 60, day] only: the nightly values of every night (with their minimums); for each signal, the hour pattern from the nights before, their adjusted values, the baseline, then the night's reading; the HRV method; Apple's resting heart rate of the day before; why a missing signal is missing; the heart signal; whether the night is settled.
5. **Stage C1** hands this one evaluated night to Body signals, Overnight changes and Readiness.

Edge cases

- **"Not in yet"**: until 4 hours after waking, a missing value that the 7 nights before had is expected to arrive. After that, the row says "Too few readings last night for a value", "Not recorded last night", or, with nothing in the 30 nights before either, what Evinlo did not find ("No wrist temperature found"). Apple Health does not tell an app whether access was turned off, so the app never says that a watch cannot measure something.
- **Two HRV regimes of one method in a night** (two versions of Apple's algorithm, short and long SDNN recordings): the one with more recordings is the night's.
- **A new watch** restarts the usual of wrist temperature, not that of any other signal. A new version of Apple's algorithm on the same watch does not restart it.
- **Older days.** Body signals are worked out for the last 365 days; older days show sleep and movement only.

Where it lives in the code

What	Where
Parameters, version, the payload and `OvernightSignals`	`Packages/EvinloKit/Sources/EvinloAlgorithms/Contract/OvernightContract.swift`
Extraction: which nights, which watch, asleep time	`EvinloAlgorithms/Overnight/OvernightExtraction.swift`, `NightDevice.swift`, `AsleepTime.swift`

What	Where
RMSSD of one recording	`EvinloAlgorithms/Overnight/BeatSeriesAnalysis.swift`
Nightly values and their minimums	`EvinloAlgorithms/Overnight/OvernightNightValues.swift`
The hour pattern and the allowance	`EvinloAlgorithms/Overnight/OnsetProfile.swift`
Baselines and the HRV method	`EvinloAlgorithms/Overnight/SignalBaselines.swift`, `EvinloAlgorithms/Statistics/RobustStatistics.swift`
One day's evaluation	`EvinloAlgorithms/Overnight/OvernightTimeline.swift`, `OvernightEngine+Days.swift`
The heart signal	`EvinloAlgorithms/Overnight/HeartMerging.swift`
How a value is shown (ms, a difference in °C)	`EvinloAlgorithms/BodySignals/SignalDisplay.swift`
The tests	`Packages/EvinloKit/Tests/EvinloAlgorithmsTests/Overnight/`

What the validation checks

The evaluation tool (`Tools/EvinloEval`) replays every night through the same day pipeline as the app, without look-ahead, and reports aggregates only. Its hard guardrails fail on any data: two evaluations are identical; a day's result does not change when later nights are taken away; no value is not a number; no usual range mixes watches (wrist temperature) or HRV methods; no range comes from fewer than 7 nights; every range is in order. On synthetic people it also checks that a new watch restarts wrist temperature for exactly 7 nights, that a new person has no range before the eighth night, that Apple's RMSSD takes over exactly when its own usual is full, and that nights cut short with an unchanged body read like full nights with the allowance and not without it. On such a person, a night cut to four to five and a half hours read about a third of a spread worse than a full night without a correction, and like a full night with it. Unit tests cover each rule on its own, from a hand-computed recording to the heart signal's limit.

References

- Leys C. et al., "Detecting outliers: do not use standard deviation around the mean, use absolute deviation around the median", *Journal of Experimental Social Psychology* 49(4), 2013.
- Munoz M. L. et al., "Validity of (ultra-)short recordings for heart rate variability measurements", *PLoS ONE* 10(9), 2015.
- Shaffer F., Ginsberg J. P., "An overview of heart rate variability metrics and norms", *Frontiers in Public Health* 5:258, 2017.
- Apple's support articles on overnight vitals and on nightly wrist temperature, which describe what the watch records and that wrist temperature needs a new baseline after a change of watch.
- The complete rules: docs/scoring.md, "Body signals".

Spotted something unclear or wrong, or want to improve a rule? Evinlo is open source, and every rule can be changed through a proposal and a replay. Start at **evinlo.com/contribute**.