Monitor one reading at a time

Calculate adjacent moving ranges and use supplied historical limits without losing time order or turning a signal into an equipment command.

The gap between neighbors matters

Fictional case: Juniper Batch records one width per batch. Supplied historical mean is 10.00 mm and MRbar is 0.1128 mm. Six subsequent illustrative readings are 10.00,10.12,10.04,9.94,10.08,10.01 mm. Analyst Owen checks the individuals and moving-range records. The core exhibit retains these exact values and historical parameters.

Your role and the reference condition

Process analyst and batch-record owner
Normal: Each reading retains its batch order and measurement context; moving ranges compare successive observations; baseline assumptions and the reaction rule are explicit.
Gap: A spreadsheet sorts readings before calculating ranges and derives a new baseline from the six-point illustration.

Work within these conditions

1. A single measurement per batch does not guarantee independence.

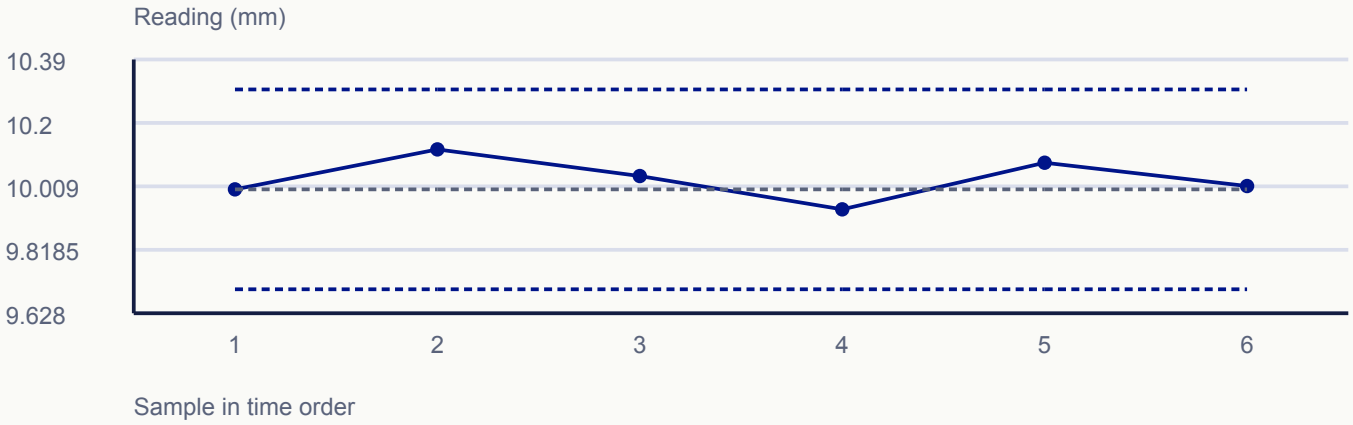
2. This calculation lesson does not establish a process capability study or prescribe a machine adjustment.

Fictional teaching case. Supplied observations support the exercise; proposed actions are not verified customer results.

See how the method works

When only one measurement is available at each observation time, an individuals chart may be appropriate. The moving range uses the absolute difference between adjacent readings in their original order. Sorting values before taking differences destroys the time structure and understates what the process experienced. In this example the historical moving-range average estimates a short-term standard deviation using the stated constant. The short plotted sequence is illustrative and is not used to estimate that baseline. Check dependence, measurement fitness and process context before adopting the method. A signal should trigger the defined investigation; it is not automatically a command to adjust equipment.

Individuals

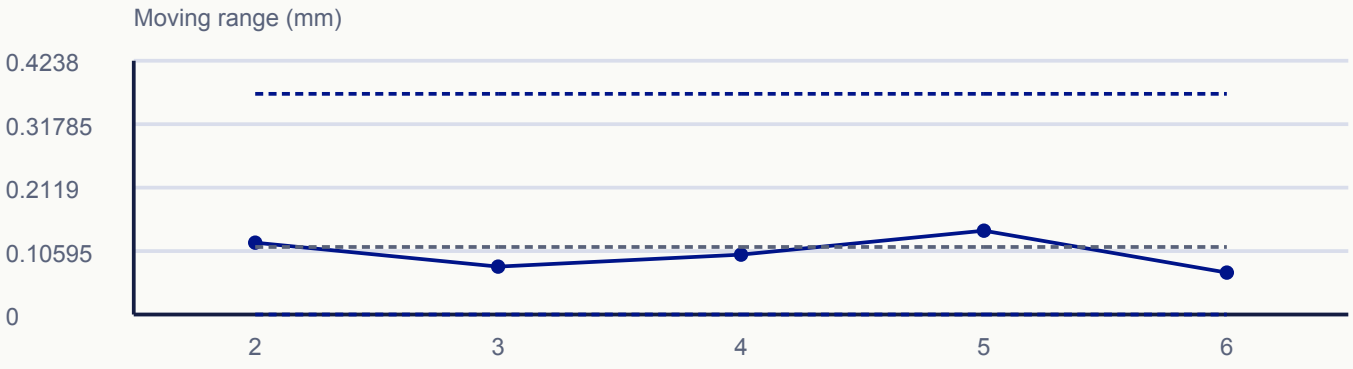


Center: 10

LCL: 9.7

UCL: 10.3

Adjacent moving ranges



Center: 0.1128

LCL: 0

UCL: 0.368518

sigma = 0.1128 / 1.128 = 0.1

I limits = 10 ± 3 x 0.1

MR UCL = 3.267 x 0.1128 = 0.3685176

Given historical mean 10 and MRbar 0.1128; plotted six readings do not estimate this baseline. Adjacent plotted moving ranges are exact absolute differences.

Given historical mean 10 and MRbar 0.1128; plotted six readings do not estimate this baseline. Adjacent plotted moving ranges are exact absolute differences.

Follow the evidence and decisions

Inspect the supplied case inputs

Input	Value
Historical mean	10.00 mm
Historical MRbar / d2	0.1128 mm /1.128
Individuals	10.00,10.12,10.04,9.94,10.08,10.01 mm
Adjacent moving ranges	0.12,0.08,0.10,0.14,0.07 mm
MR upper constant for pairs	3.267

01 / Protect observation order

Owen preserves batch identity and timestamps before calculating differences. The first plotted reading has no within-sequence previous observation, so this six-point sequence has five moving ranges.

Why: Sorting changes neighbors and therefore changes the statistic. A visually smoother range chart made from sorted values would no longer describe batch-to-batch behavior.

Evidence / check: Six ordered readings and five correctly aligned moving ranges.

02 / Recalculate the adjacent differences

He takes absolute differences:|10.12−10.00|=.12, then .08,.10,.14,.07 mm. Each moving range belongs to the later member of its pair.

Why: Absolute differences measure the size of the neighboring change; their sign is not plotted as spread. Keeping alignment helps trace a signal to both involved observations.

Evidence / check: The raw pair for every range is recoverable.

03 / Use the supplied historical estimate

Historical sigma estimate is .1128/1.128=.10 mm. Individuals limits are 10 ±3x.10, giving 9.70 and 10.30 mm. The MR upper limit is 3.267x.1128=.3685176 mm, with lower limit 0.

Why: The historical MRbar is an explicit input. The average of the five displayed ranges is .102 mm, which is not substituted for that baseline.

Evidence / check: Calculation record distinguishes historical parameters from later demonstration points.

04 / Interpret the displayed sequence narrowly

The six readings and five ranges have no beyond-limit point under the stated point rule. Owen checks dependence and operating context before making broader statements.

Why: Smooth autocorrelated data can yield misleading short-range estimates. Six quiet points do not demonstrate that all assumptions are adequate or that future behavior is stable.

Evidence / check: The report states the checked rule and the limits of the illustration.

05 / Prepare a traceable reaction

For any signal he records the batch pair, measurement condition, known changes and authorized response. He does not convert a positive error or large range into a knob-turning instruction.

Why: A chart detects evidence worth investigating; the process authority determines safe containment, correction and restart. Preserving the original result supports learning about causes.

Evidence / check: The response record contains observations and roles, with no invented operating command.

Completed time-order monitoring record

Record item	Result	Evidence boundary
Sigma from historical MRbar	.10 mm	Supplied baseline calculation
Individuals limits	9.70-10.30 mm	Not specification limits
MR limits	0-.3685176 mm	Adjacent-pair spread
Later illustration	Six readings; five ranges	Not a newly estimated baseline

A new reading jumps to 10.50 mm

After the last illustrative reading 10.01 mm, the next fictional observation is 10.50 mm.

Decision

Record both the individuals signal 10.50>10.30 and moving range .49>.3685176. Retain both batch identities and follow the approved abnormality response.

Reasoning

The moving range links the jump to its neighbor; it does not identify which physical cause produced it.

What would change the decision?

Two signals are recorded against the same unchanged baseline.

Practise with a changed case

A different baseline and sequence

New fictional process has historical mean 5.00 mm and MRbar .0564 mm. Later readings are 5.00,5.04,4.98,5.20 mm. Use d2=1.128 and MR constant 3.267.

Input	Value
Historical parameters	Mean 5.00; MRbar .0564 mm
Later sequence	5.00,5.04,4.98,5.20 mm
Constants	1.128 and 3.267

Your task

1. Compute individuals and MR limits.
2. Calculate the three adjacent ranges and identify signals.
3. Explain why sorting the readings would corrupt the result.

Use the next page to record your reasoning before reading the answer.

Your practice worksheet

A different baseline and sequence

Ordered pairs

Absolute differences

Historical limit calculation

Signals

Authorized next evidence

Complete your reasoning before turning to the answer. Use the separate learner workbook for group practice.

Check your reasoning and transfer it

1. Sigma=.0564/1.128=.05 mm; individuals limits 4.85-5.15 mm. MR upper limit 3.267x.0564=.1842588 mm.

2. Adjacent ranges are .04,.06,.22 mm. The final 5.20 reading exceeds 5.15; its .22 moving range exceeds .1842588. Sorting would change the batch neighbors and their differences.

Suggested completed record

Statistic	Values or limits	Signal
Individuals	4.85-5.15 mm	5.20 above UCL
Moving range	.04,.06,.22 mm; UCL .1842588	.22 above UCL

Plausible wrong turns

1. Moving ranges must remain adjacent in original order.

2. A control signal does not specify a safe adjustment.

Evidence of a sound answer

1. Use the supplied historical baseline.

2. Align ranges to their pairs.

3. Record both signals without inventing cause.

Take the learning back to work

Commitment	Agreed follow-through
Owner	SPC analyst and batch-process owner
Record	Ordered measurements, baseline revision and pair-linked response log
Review	At each defined observation and during baseline review
Verification evidence	Correct pair alignment, measurement fitness and verified response
If unresolved	Investigate dependence or process changes; do not conceal signals through sorting or automatic rebaselining.

Help someone else apply the method

Prepare

1. Ordered batch cards
2. Calculator
3. Blank pair-to-range table

Minutes	Activity and coaching prompt
5	Identify neighbors Why are there five ranges for six displayed readings?
8	Compare historical and plotted averages Which baseline is this exercise using?
10	Complete the 5 mm sequence Which records belong in the investigation?
5	Debrief How would dependence affect confidence in the method?

Debrief

1. Ask learners to calculate one range aloud from its two readings.
2. Do not let a correct limit calculation imply adequate sampling design.

Individual or remote practice

Preserve the written observation order and annotate each difference between adjacent rows.

Connect the method and check its boundaries

Before application

1. Original time order
2. A suitable baseline and independence assessment

Outside this lesson

1. Autocorrelated time-series modelling
2. Sorted-data moving ranges

NIST: Individuals charts

NIST: Individuals charts

An individuals chart can estimate dispersion from successive moving ranges using d2=1.128 for pairs.

Public primary-source summary; underlying paid standards/forms are not reproduced.

NIST: X-bar, R and S charts

NIST: X-bar, R and S charts

Mean and dispersion charts answer different questions; subgroup size determines constants. Range charts suit relatively small subgroups.

Public primary-source summary; underlying paid standards/forms are not reproduced.

Open this lesson and its visual aids