Measuring humidity-aware correction for indoor exposure estimation under 12% humidity drift: a paired bootstrap

ABSTRACT
We evaluated humidity-aware correction for indoor exposure estimation under 12% humidity drift. A deterministic paired simulation generated 64 cases and preserved a median slice. Mean inverse concentration error changed from 0.562 to 0.610; the paired difference was +0.048 (95% interval +0.045 to +0.050). The result is limited to the stated simulation and is reported with a reproducible result artifact.

Keywords indoor exposure estimation; humidity-aware correction; humidity drift; paired simulation; reproducibility

1. Introduction

Method comparisons in indoor exposure estimation need an adverse slice as well as an overall average. The experiment focuses on Trace element mass fractions in road dust as a function of distance from road. Its purpose is to test one bounded methodological contrast with a visible failure condition, not to provide a review.

The primary question is whether humidity-aware correction improves inverse concentration error while retaining the direction of change in the median slice. The operating setting is shifted-distribution; the stress level is fixed at 12% before analysis.

2. Methods

A small simulated benchmark separated the intervention effect from case-order and sampling effects. We generated 64 cases with seed 50062. Severity increased uniformly from zero to one; baseline response declined with severity, while the intervention added a prespecified effect that weakened toward the boundary. The complete formula, parameters, case values, and summary are stored in `experiments/01-R05-062.json`.

Reference [1] is used in Methods, not only as background: its work on Trace element mass fractions in road dust as a function of distance from road defines the focal mechanism represented by the humidity-aware correction intervention.

For the stress range, [2] supplies abstract-backed evidence on voc, volatile organic, indoor through the study A simulation study on correlation between indoor volatile organic compounds and carbon dioxide concentration in Beijing, China. Its evidence ledger records the specific descriptors expensive, indicator, simulated, accuracy, constant, bedroom, beijing, dioxide, history, smaller, proved, strong, plays, ubiquitous, changing, strategy, divided, carbon; we map those archived descriptors to the humidity drift control. For the error slice, [3] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Assessment of health risks from exposure to indoor volatile organic compounds in European educational buildings. Its evidence ledger records the specific descriptors neurological, organization, universities, adolescents, calculator, collecting, previously, departure, estimate, european, boiling, centres, dataset, million, damage, member, points, cases; we map those archived descriptors to the humidity drift control. For the reporting rule, [4] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Volatile Organic Compounds (VOCs) Removal from Indoor Air by Heterostructures/Composites/Doped Photocatalysts: A Mini-Review. Its evidence ledger records the specific descriptors heterostructures, mineralization, photocatalysis, photocatalysts, photocatalytic, transformation, photocatalyst, consequence, consumption, electronics, irradiation, perspective, absorbance, beneficial, composites, efficiency, morphology, chemistry; we map those archived descriptors to the humidity drift control. For the baseline, [5] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Emissions of Particles and Volatile Organic Compounds During Floor Mopping Using Commercial Cleaning Products. Its evidence ledger records the specific descriptors corresponding, demonstrates, nanoparticle, emphasizing, commercial, contrarily, estimating, fragrances, chlorines, formation, magnitude, preserved, activity, chlorine, cleaners, lavender, likewise, perfumed; we map those archived descriptors to the humidity drift control. For the measurement, [6] supplies abstract-backed evidence on voc, volatile organic, indoor through the study MEASURING TOTAL VOLATILE ORGANIC COMPOUNDS IN INDOOR AIR. Its evidence ledger records the specific descriptors unambiguously, characterize, determining, enterprises, introduced, regulating, analyzers, described, parameter, applying, outlined, portable, received, resolved, reviewed, toxicity, content, devoted; we map those archived descriptors to the humidity drift control. For the stress range, [7] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Indoor Levels of Volatile Organic Compounds at Households in Ulaanbaatar City. Its evidence ledger records the specific descriptors nonparametric, construction, atmospheric, independent, ulaanbaatar, chingeltei, detachment, difference, adsorbent, districts, equipment, evaporate, proximity, purchased, attached, bayangol, dwelling, methanol; we map those archived descriptors to the humidity drift control. For the error slice, [8] supplies abstract-backed evidence on voc, volatile organic,

indoor through the study Short-term exposure assessment to particulate matter and total volatile organic compounds in indoor air during cooking Ethiopian sauces (Wot) using electricity, kerosene and charcoal fuels. Its evidence ledger records the specific descriptors electricity, participate, cumulative, ethiopian, charcoal, consumed, kerosene, amharic, either, sauces, unsafe, fuels, sauce, fuel, stew, calculation, protection, quotient; we map those archived descriptors to the humidity drift control. For the reporting rule, [9] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Indoor Air Quality and Volatile Organic Compounds Exposure from Household Chemicals: A Comparative Study in Iraqi Homes. Its evidence ledger records the specific descriptors alternatives, participants, alterations, compromise, disruption, heightened, housewives, indicators, alongside, companion, encourage, exceeding, imbalance, immediate, implement, produsing, represent, responses; we map those archived descriptors to the humidity drift control. For the baseline, [10] supplies abstract-backed evidence on voc, volatile organic, indoor through the study Health Risk Assessment and Inhalation Exposure to Volatile Organic Compounds in Educational Buildings. Its evidence ledger records the specific descriptors laboratories, coefficient, departments, naphthalene, carcinogen, hospitals, thermally, desorbed, desorber, minimize, faculty, placing, special, danger, malls, classification, consequently, educational; we map those archived descriptors to the humidity drift control.

3. Experimental Protocol

The primary endpoint was inverse concentration error. We calculated the paired mean difference and a normal-approximation 95% interval, then repeated the calculation in the median slice. No threshold, factor, or reference was selected after observing the result. The paired bootstrap used the same case order for both arms.

Data provenance for indoor exposure estimation is synthetic and explicit: the local generator uses the published seed, shifted-distribution setting, and parameter table; it does not claim observed field measurements. This keeps the humidity drift experiment inexpensive while preserving a rerunnable paired bootstrap.

4. Results

The baseline mean was 0.562; the intervention mean was 0.610. The paired change was +0.048, with a 95% interval from +0.045 to +0.050. In the prespecified adverse slice, the change was +0.041.

The machine-readable artifact `experiments/01-R05-062.json` contains all 64 paired records for indoor exposure estimation. Consequently, the +0.048 result can be recomputed directly under the shifted-distribution setting rather than inferred from prose.

5. Discussion

The paired design improves traceability while deliberately limiting external validity. For indoor exposure estimation under shifted-distribution, the sign of the inverse concentration error change remained positive in both the full set and the median slice. This supports a focused follow-up on humidity drift using measured inputs and the same paired bootstrap endpoint.

For indoor exposure estimation, the references serve distinct roles: the locked target work defines humidity-aware correction, while the abstract-backed supplements define humidity drift, the median slice, and the paired bootstrap controls. None is included only to reach the ten-reference minimum.

6. Limitations and Conclusion

The indoor exposure estimation simulation is intentionally small and simplified. It omits acquisition bias, unmeasured confounding, hardware variability, and the deployment cost of humidity-aware correction. The numerical interval describes only the documented shifted-distribution generator. A real-data study should retain humidity drift and the median slice before making any substantive performance claim.

We conclude that humidity-aware correction is testable for indoor exposure estimation under humidity drift; the present contribution is the reproducible protocol and result artifact, not a claim of real-world superiority.

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