# Measurement Accuracy Realism

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# Traditional measurement accuracy realism

- Presupposition: There is in nature the quantity, Q, with value q in units, u, for object or type of object, O.
- Then q', a measurement outcome of Q in units u on O, counts as
- a) Perfectly accurate: q' = q
- b) Accurate (enough): the outcome, q', is close enough to q for present purposes
- c) Outcome q' is more accurate than outcome q'': q' is closer to q than is q''.

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# Failure of TMAR: General statement

- ‘The temparture of the water in this glass’ fails to refer
- No deep metaphysics here
- The world is too complicated

# Reference failure source points

- 1) Dimensional quantities: Mass, length, time, velocity…
- 2) Units: Kilograms, meters, seconds….
- 3) Working quantities:
  - Type: Speed of sound in air, in water (kind of substance)
  - Token: Speed of sound in the air in the Sydney Opera House at…. (concrete instance)
  - Concretizations of the abstract dimensional quantities

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# Difficulties for working quantities: Token cases

- The temperature of the water in this glass
  - Temperature gradients in the water
  - What do we include as the water in the glass

# Difficulties for working quantities: Type cases

- Speed of sound in air
  - At what temperature, pressure….?
  - When these are specified, how understood?
    - An interval?  Then no speed is picked out
    - With complete precision?  No such things for air…
      - No sample uniformly the same value
      - And precise values are idealizations.

# Difficulties for units

- The international prototype kilogram
  - Air contaminants?
  - Scratches?
  - Sublimation?
  - Relative motion?
- This both problems for specification at a time, and what the mass is over time

# Difficulties for units

- Other units are defined theoretically, e.g., the second
  - The second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom… This definition refers to a cesium atom at rest at a temperature of 0ºK.

# Difficulties for units

- The second: Difficulties
  - Band width (time-energy uncertainty)?
  - 0ºK ?
- At best, characterization of the second in some possible world
  - (And what would a world with no quantum effects be like??)
- GTR and QFT are idealized theories

# Difficulties for dimensional quantities

- Individuated by the theories in which variables for these quantities occur
- …theories that are all idealized
- So such quantities, if anywhere, in non-actual “possible worlds”
- E.g., mass
- E.g., velocity

# Repair by appeal to intervals?

- Here understood as completely determinate collections of #s
- Understood as an interval in which the REAL value occurs?? X!
- Working quantities: A supervaluationist interpretation??
  - E.g., speed of sound in air
    - Instantaneous velocity: Still an idealization for each precissification
  - Average velocity?
    Which, and for each precissification?
    Problems with distance and time…

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  - How understand a relevant interval
  - Range of de-idealizations?
  - Only constraint on de-idealization is that past successes be preserve.
- Dimensional quantities, similarly
  - Interval of “distance” of an idealization from some “finally correct” definition of the quantity?

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What, then to make of attributions of accuracy?

# Robustness accuracy

- Examination for units
- Need for physical realization of theoretical definitions, and making copies
  - Physical realization is deidealization
  - Promiscuous appeal to theory to minimize difference of the realization and the theoretical definition or prototype.
  - Shortfall from complete deidizlization summarized in "UNCERTAINTY BUDGETS"
  - These not uncertainty of departure from a value in nature, but from the idealization of fundamental theory.

## Robustness accuracy

- We model clocks deidealized as best we can
- Then we compare clocks
- We require that we get the agreement we expect in light of these models, up to ascribed uncertainty budget.
- When we say that our standard for the second is accurate to within 5 parts in $10^{16}$ we mean that this is the spread allowed by the uncertainty budget.
- All this relative to current theory

# Robustness accuracy for measuring instruments

- Essentially the same story
  - Model an instrument and measurement process according to current best theories
  - Accuracy characterized in terms of estimated uncertainties for the instrument, together with that for units

# Robustness accuracy for measuring instruments

- Tal's summary:
  - Given multiple, sufficiently diverse processes that are used to measure the same quantity, the uncertainties ascribed to their outcomes are adequate if and only if
    - (i) discrepancies among measurement outcomes fall within their ascribed uncertainties; and
    - (ii) the ascribed uncertainties are derived from appropriate [as described above] models of each measurement process.
- Our best accuracy estimates based on these estimates of uncertainties

## But why should modeled uncertainties count as measures of (in)accuracy?

- The uncertainties aren't spread of departure from actually existing values
- But of departures from values one would have were the world as idealized in our theories
- So we can RETAIN measurement accuracy realism as a further IDEALIZATION
- The robustness condition insures that so doing won't get us into trouble.

# Recast the issue in terms of vagueness?

- No such things as THE temperature of the water in this glass
- So “The temperature of the water in this glass” counts as vague
- So no general issue here, over and above general issues about vagueness

# Recast the issue in terms of vagueness?

- Above we saw that we can adopt measurement accuracy realism as an idealization

- In practice we can use any of a (not exactly specified) range of values

- Can think of this equally as the idealized value OR as a precisification of the vague expression

# Recast the issue in terms of vagueness?

- There is no determinate collection of values that qualify
- There are only the practical questions of what numbers will serve, and how well, for practical issues.
- And practical questions do not always have sharp, clear-cut answers

# Recast the issue in terms of vagueness?

- So instead of recasting issue about measurement accuracy as question of vagueness we have recast questions about vagueness as issues about application of idealization
- Analogize the open-endedness of vague language to the open-endedness of the use of a tool.
- Makes sense of the (rejection of) higher order vagueness.

# The morals are extremely general

- Vagueness and failure of determinate reference are ubiquitous
- Very generally we can see trading in determinate reference in terms of idealization
- Vagueness is just the flip side
  - The range of cases in which the idealization can be depended on in practice
  - Is just the range of cases in which the vague “semantic alter-ego” counts as true.