Spectacles of Measurement

30702 characters in 4536 words on 875 lines

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1 Introduction

measure real-world for decision making, prediction

1.1 messfehler (p. profos)

what (material properties of existing objects by physical quantities)
why (to get quantitative & object information about point of interest)
what for (as a basis of decision making)
how (relate property to unit of same physical dimension)

1.2 criteria

if fulfilled result y = x + s + e
for x measurement, s systematic error, e random error,

objective
independent of person involved
both at operation & interpretation

reliable
consistent across context
repeated measurements yield equivalent results

valid
correspondence with goals
actual representation of property

1.3 representation

assigning numerals to (properties of) objects
ϕ : S (property) $\rightarrow$ X (numerals)
properties of objects like states, events
numerals like reals, rationals, integers

criteria
implies objectivity & reliability
but not validity or rules

example
object=person, property=height, mapping=cm
object=person, property=hair, mapping=color
mapping depending on required precision, reliability, scale
mapping may compare measurement (like $\geq$ 120cm giving predicate result)

china population 2 AC
"door" & "mouth" count
determines taxes & military service
allows to strictly enforce it

US constitution
representatives & tax relative to number of persons
#free persons + #military + 0.6(#indians + #slaves)
still done every 10 years

CH
continuous population counting depending on population register
quarterly integration of cantonal registers
completion based on 5% sample surveys

1.4 temperature (2nd century)

galen (2nd century)
medical condition determined by hot vs cold & moist vs dry
neutral = equal amounts of hottest & coldest (boiling & ice)
remained medical authority for over 1000 years

haslerus (1578)
distance from equator = expected body temperature
extension from galen theory

romer scale (1701)
0 = freezing point of brine (salted water; -21 °)
because colder than water, same under different pressures
60 = boiling point of water
because 60 divisible by much more, same as clock

thomasiums (1691)
measure personality
motives are hedonism, avarice, ambition, altruism
ratings 0, 5, ..., 60 by analyzing conversations, writings
claims objectivity as three persons came to same measurements
relates properties to each other

1.5 empirical structure

equivalence
some properties are same than those of others
body height, threshhold pass, hair color, personality

comparison
ordering properties
by height, pass/fail, character trait intensity

combination
properties are related to each other, merged
like average temperature, height

1.6 preserving structure

when ϕ : S $\rightarrow$ X is homomophism
each empirical relation (S) reflected in numerical relation
i ˜ j <=> ϕ(i) = ϕ(j)
if one-to-one (bijective) also called isomorphism

representation
(1) homomorphism ϕ : S $\rightarrow$ X
(2) for empirical (S; =, <, +, ...)
(3) to numerical (X; =, <, +, ...)
aigns numerals to properties while preserving laws
valid as a basis for decision making
can assign color to number

problems representation
existence (is it actually possible)
uniqueness (are mappings independent = contribute information)
meaningful (different mappings might create different results)
operationalization (is it implementable)
errors (how solid is it)

1.7 sealed envelopes

two sealed envelopes with x and 2x money
you are given one, then have choice to switch
do you take it?

trivial multiplication
assuming own envelope contains y
then other envelope contains either x/2 or 2x
E[amount swapping] = 0.5*x/2 + 0.5*2x = 5/4*x

reasoning mistake
reference point in "either x/2 or 2x" is changed
hence argument invalid

1.8 references

unit is given; counted for measurement
different units through historic reasons
definition by authority, agreement, cultural norms

scales
differnet base units
ratios might be preserved (big unit = 2 small unit or so)

1.9 length

foot & metric system

jakob köbel (1535)
16 men (because power of 2)
tall & small ones, left feet one behind the other
measure & divide by 16

metric system
1791 defined as 1/10'000 the distance north pole-equator
1889 reference created out of non-deforming metal alloy
now defined by 1/299'792'458s speed of light

1.10 topology

dufour map 1832 - 1865
measurement by triangulation
with baseline im "grossen moos"

extremely exact baseline measurement
placed metal rods one-after-the-other
aligned perfectly with stoppers in between
temperature tracking (to measure metal deformity)
adjusted for lag between temperature measurement & development over day

1.11 temperature

rømer scale
idea is divisibility (64 is power of two)
0 (brine freezing), 60 (water boiling)

fahrenheit
idea is tripling (32 + 64 + 128); real-world is close
0 (brine freezing), 32 water (fluid)
96 (human body temperature), 212 (water boiling)

celsius
for 100 change of scale is easy (as base 10 number system)
0 water freezing, 100 water boiling

kelvin
discovered absolute 0, uses celsious unit difference
273.15 as water boiling, 373.15 water boiling

1.12 transformations

which implications has changing the scale

nominal (=)
isomophism (x(i) = x(j) <=> y(i) = y(j))
like people

ordinal ($\leq$)
isotone (x(i) $\leq$ x(j) <=> y(i) $\leq$ y(j)
like "higher-than"

interval (+ $\leq$)
positive linear (x = $\beta * y + \alpha$; $\beta > 0$)
like bucketed measurement (eg days)

ratio (/ + $\leq$)
similarities (x = $\beta * y$; $\beta > 0$)
like m to cm

absolute (/, + $\leq$)
identity (y = x)
like counting

1.13 existance theorem

map emiprical structure to numerical ground ("assign numbers to properties")
want to nummerics to preserve homomophism / other properties
examples under which this is possible the following theorem

theorem (<)
empirial structure (S, <) with S finite
admits order-preserving representation ϕ : S $\rightarrow$ N
iff < is strict weak order (assymetric, negatively transitive)
negative transitivity avoids enforcing everything to be comparative

theorem ($\leq$)
empirial structure (S, $\leq$) with S finite
admits order-preserving representation ϕ : S $\rightarrow$ N
iff $\leq$ is weak order (reflexive, complete, transitive)

utility function ϕ
descriptive (define, then verify empirically)
normative (derive logically / rationally / by axiomatization)
ϕ might not exist for everything (like job preference)

theorem (<, +)
empirial structure (S, <, +)
admits order-preserving representation ϕ : S $\rightarrow$ N
iff < is strict weak order (assymetric, negatively transitive)
and associativity, order preserved if same element added, inflated (multiplied)

1.14 datafication

ϕ : S $\rightarrow$ X
S (scope, selection like course attendees, schools)
X (nested, labels like degrees, tracks)
relations (equality, equivalence)
analysis (counting, shares which requires knowledge about |S|)
exclusiveness (single or multiple labels; mapping)
exhaustiveness (completeness of domain S; total mapping)

measuring degrees of course attendees
scope is course attendees (but could be school, world, ..)
labels are degrees (but could include tracks, schools, ...)
relations (some degrees might be equal but different schools)

further examples
dress codes (orderable, not additive)
music genres (but labeling exhaustiveness, exclusiveness hard)
wind speed (relative measurement, beaufort is descriptive)

quotes
to measure is to know
if you cannot measure it, you cannot improve it
when you can measure you know something about it (kelvin)

1.15 free fall

odd numbers by galileo (1,3,5,7, ...)
natural numbers by fabri (1,2,3,4, ...)
doubling numbers by caze (1,2,4,8, ...)

scale invariance
necessary condition for any law to hold
if measured in different time unit, space should still hold
assume steps 2t, then galileo results in 4, 12, 20, ...
can rescale (divide by 4), results again in 1,3,5
$\Rightarrow$ galileo's proposal only one to fulfil this

1.16 temperature

compare °K, °C, °F, rankine °R (like °F starting at absolute 0)
comparison always works, but "5% more", "double" might be nonsensical

1.17 meaningful

if truth value invariant under admissible (homomophy-preserving) transformations
then statement about measured property is meaningful

change of scale
might affect truth value
hence meaningfulness relative to scale type
meaningful when statements only use preserved relations

scale types & their preserved relations
norminal preserve mode
ordinal preserve mode, median
interval preserve mode, median, arithmetic mean
ratio preserve mode, median, arithmetic mean, geometric mean

1.18 health of newborn children

check skin, heart, reflexes, muscle tone, breathing
each category 0,1,2 value depending on observable properties
then sum for assessent (critical until 3, low until 7, normal until 10)

analysis
for example bpm measure in none, <100 or >100
but when measured 0, 90 vs 110, same difference
$\Rightarrow$ interval criteria not satisfied

measure childrens health
all are proxys of childrens health

multiple measurements might increase accuracy
accuracy overall OK for quick assessment

1.19 indirect measurement

unobservability
cost
physical size (too small or big)
accessibility in time / space
theoretical construct (like state of baby)

way around
instead of measuring property(object) (ϕ)
measure property'(object)
map to numerical space with ψ into proxy
then apply transformation f
$\phi = \psi * $ f (ideal case)

length
comparison meter stick, translation range scanner
sends light & registers reflection time
length = c/2 * t
corrects for non-vaccuum conditions

mass
comparison balance scale, translation spring scale
length = 1/k * F; translate length to weight

temperature
no direct comparison, translation thermometer
expansion of quicksilver as length

egg sizes
regulations define which sizes eggs can be labeled at
$\leq$ 53 S, $\leq$ 63 M, $\leq$ 73 L, else XL
weight taken as proxy of size
use springs which open hole if heavy enough

radiocarbon dating
C^{12} stable, C^{14} unstable; C^{12} to C^{14} in predictable ratio
C^{14} production by cosmic rays; ratio is kept in environment
organism has same ratio as environment due to exchange (like photosynthesis)
when organism dies, exchange is stopped and ratio deteriorates (as C^{14} decaying)
measure ratio of C^{12} / C^{14} in dead organism to determine time of death

big mac index
indication of purchasing power
expect that price ratio = currency ratio
adjust with gross domestic product per capita
https://www.economist.com/big-mac-index

world health
plot income vs lifespan
see log-linear relationship between income / life expectancy
https://www.gapminder.org/downloads/updated-gapminder-world-poster-2019/

2 conjoint measurement

2.1 archimedes (EUREKA)

measure if all gold used for gold crown
ensure weight & volumina match
volumina match by immersing into water, measure pegel change

2.2 multiplicative composition

density = mass (kg) / volume (m^3)
has inverse, hence order-reversing transformation
log(density) = log(mass) - log(volume)
alters neither equivalence nor ordering

2.3 conjoint measurement

conjoint representation
$\phi : S_1$ x ... x $S_n \rightarrow$ X
with $\phi(s_1, ..., s_n) \rightarrow$ f($\phi_{1(s_1)}, ..., \phi_{n(s_n)}$)
for ϕ_i: $S_i \rightarrow X_i$, aggregation f: X_1 x ... x $X_n \rightarrow$ X

additive conjoint representation
when f sums up representations
s $\leq$ t <=> ϕ(s) $\leq$ ϕ(t)
$(s_1, s_2) \leq \phi_{1(s_1)} + \phi_{2(s_2)} \leq \phi_{1(t_1)} + \phi_{2(t_2)}$

properties conjoint representation
$\leq$ is a weak ordering on S
solvability ($\exists$ s_2 for any condition $(s_1, ?) = (t_1, t_2)$)
double cancellation

double cancellation
when $(s_1, r_2) \leq (t_1, s_2)$
and $(r_1, s_2) \leq (s_1, t_2)$
then $(r_1, r_2) \leq (t_1, t_2)$
"double cancellation" because we remove (s_1, s_2)

independence
when $(s_1, s_2) \leq (t_1, s_2)$
then $(s_1, t_2) \leq (t_1, t_2)$

standard sequence
for sequence s_1, $s_{1'}$, $s_{1''}$, ...
it holds (s_1, s_2) ˜ $(s_{1'}, t_2)$
strictly bounded if some $s_{bottom} \leq s_1 \leq s_{top}$

additive representation
sufficient conditions for (S_1 x S_2, $\leq$)
a) $\leq$ is a weak order
b) solvability
c) double cancellation
d) every strictly bounded standard sequence is finite
(means scales cannot be infinitely small)
standard sequence if $s_{1(i)}$

conjoint additive representation
necessary conditions for (S_1 x S_2, $\leq$)
a) $\leq$ is complete
b) let standard sequences of length k and permutations π_1 π_2
if $(s_{1^i}, s_{2^i}) \leq (s_{1^j}, s_{2^j})$ for j permuted i
then $(s_{1^k}, s_{2^k}) \leq (s_{1^1}, s_{2^1})$ for k permuted 1
b condition summarizes theoretic conditions
but hard to test empirically

2.4 measuring loundness

loundness = (amplitude, frequency)

weak order
every pair of sound comparable, transitive

solvability
for given sound (a, f) and frequency (f')
come up with a' such equally lound

double cancellation
empirical tests hard (as many combinations)
instead show conjoint commutativity

sound compression
average DB & peak points plotted
in old song, average db lower & different peaks
in newer song, higher average db & peaks all on line
$\Rightarrow$ improved mastering likely increases sales

2.5 examples

BMI
weight / m^2
18.5 - 25 is OK

h-index
plot #citations for each paper
fit largest square in there
45 means $\Rightarrow$ 45 papers with each at least 45 citations
does not capture few high-valued, many low-valued

3 units & scales

3.1 scale types

nominal (labels are all distinct)
ordinal (order of label preserved relative to empirical observation)
interval (distance between labels always same)
ratio (fixed reference point; like absolute 0)
absolute (fixed unit; like counting people)

analysis
interval enables reasoning about differences
ratio enables multiples & fractions

3.2 example

(mechanical) horsepower
lifting 550 lbs up 1 feet in 1 second (=745.7 watt)
used as a unit for "rate of work"

other horsepowers
hydraulic/air (rate of flow times pressure)
boiler (rate of heating)
electrical (directly defined in watt)
tax (power of cars)

3.3 historic developments

want measurements to depend on environment (not authorities)
1795 decimal meter system (france)
1799 meter & kilogram (archives de la republique)
1875 May 20th agreement signed between 17 countries
introduced buro for administration (BIPM)
governed by conference of member states (CGPM)
adviced by scientific committee (CIPM)
1889 prototypes sanctioned (officially recognised)
1954 kelvin, ampere & candela as base units
1960 systeme international d'unites (SI units)
1971 mole introduced as seventh base unit
2018 new definitions for kilogram, ampere, kelvin, mole
(allowed to remove the need for prototypes)
2019 new SI base units in effect

3.4 SI base units

since 2019, one natural constant per unit

time (t)
in seconds (s)
duration of ca 9 billion caesium radiation periods
9 192 631 770 Hz

length (l)
in meter (m)
length of path traveled by light in 1/299 792 458s
c / 299 792 458 for c speed of light

mass (m)
in kilogram (kg)
the mass of the international prototype of kilogram (until 2019)
h / ($6.626 * 10^{34}$) for h planck constant

thermodynamic temperature (T)
in kelvin (K)
the change of thermodynamic temperature
to result in energy kT = $1.38 * 10^{-23}$ J

luminous intensity (I_v)
in candela (cd)
from source to given direction
with frequency $540 * 10^{12}$
with radiant intensity of 1/683 watt per steradian

electric current (I)
in ampere (A)
flow of $1/(1.6 * 10^{19})$ elementary charges e per second

amount of substance (n)
in mole (mol)
$6.02 * 10^{23}$ specified elementary entities

3.5 derived units

SI base units are fixed
all other units can be derived from this
might have other name / symbol defined

examples
square meter as area
metre pre second as velocity
kilogram per cubic meter as density

special examples
weight (which is actually a force)
richter scale (log_{10} (measurement / f(distance)))
frequencies (hertz for periodic processes, becquerel for random)
angular velocity (actually a ratio; has no unit)

3.6 unit of information

information to be measured in bit
log(n) bits necessary for n items

3.7 constants

planck constant (very hard to measure)
half-life (randomized)
day, moon cycle, year (varies)
π (infinite)
UNIX-time (1.1.1970)

3.8 legal & scientific

want scientific input & legal backing
for meterology alone, 9 different institutions

3.9 financing BIPM

the burea international des poids et mesures

capacity to pay
GNI (gross national income)
PPP (purchasing power parity)
scaled to capita

BIPM donation
fixed budget, payed in percentage by capacity to pay
upper limit (US at 22.000)
lower limit (small, poor countries 0.001)
adjustments (like "welcome discount")

3.10 thresholds

poverty line
60% of median household income of population
median guards against outlines
household includes "economies of scale", non-earners

process deviation
manufacturing process might has some uncontrolled factors
want to reach 6 σ of correctness (management strategy)

basel accords
formulated recommendation of how much money banks have to actually have
members of committee adapt recommendations into law

4 sensors & intruments

y = x + s + ϵ
for y result, x measurement, s structural error, ϵ random error

4.1 intrument

sensor
transformation
display
read out

errors
gross errors, blunders (inappropriate setup / operator)
conditions (heat, stability, ...)
range (measure room length vs distance to moon)
transmission, conversion (quicksilver)
feedback (
drift (changes in error with repeated measurements)

prevent errors
conversion (change scale to normalize)
correction (remove predicted error)
calibration (reset to known measure)

4.2 length

ruler, measurement band, roller
vernier (measure fraction of milimeter)
laser
angles (sextant, triangle ruler)

4.3 mass

balance scale

spring scales (force ⇒ length)
strain gauge (force ⇒ resistance)

4.4 temperatue

thermometer
bimetal (different metals bend differently)
thermocouple (current)
pyrometer (radiation)

4.5 weather

temperature
humidity
precipitation
wind direction / speed
atmospheric pressure

4.6 height of trees

given (laser) range finder & and angle measurement
tan measure length until tree middle
but high variation (small errors ∗ angle has large effect)
sin measures length until tip of tree
but systematic error (underestimation of height of tree)

5 measure effort

5.1 classical test theory

y = x + ϵ (target observation is the value we observe)
$\epsilon = 0$ (no systematic error)
corr(x, ϵ) = 0 (no correlation between value / error)
uncorrelated errors between items, repondents

averaging
no systematic error ⇒ many measurements lead to good average
assumption is measurement on interval scale

5.2 likert scale

to address single, one-dimensional concept
bipolar (+ and -), discrete levels (1, 2, ...) & centered (0 exists)
both positives & negative orientations
score is average (or total) level (aligned orientations)

example
environmental consciousness, knowledge, behaviour
for each dimension measure likert scale
"we should doing more" (+), "we are doing enough" (-)

constructing scale
create items pool (variation, coverage, refinement)
pretest (difficulty, selectivity, correlation)
selection (single dimension, variying difficulties, high selecitivity)
finalization (instruct terms, reduce order effects)
aftwards, report on observed properties

measurement criteria
objectivity (usually granted if administred same way)
reliability (test-retest, parallel tests, split-half test)

validity
content (theory, personal expertise)
criterion (correlation to other observable variable)
construct (consistency of associations)

5.3 guttman scale

single, one-dimensional concept
items of increasing difficulty with binary answers
score is number of items checked
personal answered most correctly ⇒ best one

formally
subjects S, items I, checkings $Y \subseteq S \times I$
can define consistency of guttman scale
(higher ratings only answered by better persons
reproducability = 1 - errors

5.4 thurstone scale

single, one-dimensional concept
weighted items, binary answers
score is sum of weights of items checked
weights by expert assessment / pairwise comparison

example neighborhood
feel like a stranger (-2)
no secrets (+3)
know everyone (+1)
no one notices if I'm gone (-3)

pairwise comparison
dominance matrix ("prefer X over Y?")
normalized matrix (replaced counts by percentages)
with (observation - average) / standard diviation
get z-score (preference to other items in standard deviations)
use minimal z-score as 0-point (shift scale upwards)

5.5 item response theory

latent trait (invisible) manifests observation probabilistically

plot & parameters
ability plotted against probability of correct answer
guessing chance c_i (if too diffcult)
difficulty b_i (before random guess, after always correct)
discrimination a_i (how exact difficulty separates)

6 indices

6.1 indices

item response theory
latent variables (invisible)
result probabilistically in manifest variables

reflective indicators (descriptive)
latent variables (invisible)
assumed to effect in manifest variables
like prices of products reflect inflation (consumer price index)

formative indicators (normative)
latent variables (invisble)
declared to be cause of manifest variables
like IQ defines intelligence (IQ test)

6.2 index construction

C-OAR-SE model
Construction definition (object, attributes, ...)
Object representation (concrete through open-ended interviews)
Attribute classification (concrete through open-ended interviews)
Rater identification (experts)
Scale formation (combine items, pretest)
Enumeration (derive total score)

common composition methods
index additive or multiplicative, unweighted or weigthed
like consumer price index is additive, weighted score
like swiss market index resuting is additive, unweighted score
like human development index is multiplicative, unweighted score
like water quality index is multiplicative, weighted score

consumer price index
tries to measure inflation to guide monetary policy
how much products the money is actually worth
1000 fairly common items (milk, cars, rent, ...)
collected at 5400 locations in 11 regions
for each product, geometric weight taken
for each region/distribution channel, weighted sum
for each product category / consumption share, weighted sum

6.3 conjoint analysis

latent preference (willingness to pay) for multi-featured product
features are package design, brand name, price, ...

study design
give each participant exhaustive list
but too large, likely ranking takes too long
give each participant different sublist covering range
faster to do, can then run regression

regression
rank defined as sum of weighted components
regression calculates weight
then can infer utility for each value of property

like price (low-middle-high), brand (name1-name2-name3)

6.4 event horizon telescope

measurements of telescopes over the world
then combined into image of black hole
april 2019 first measurement, update april 2021
confirms that simulations were / are on the right track

6.5 big data

3V (2013)
Volume (how much data there is)
Velocity (rate at which data arrives)
Variety (heterogeneity of data)

6V definition
Veracity (correctness)
Variability (change over time)
Value (usefulness of data)

the end of theory
enough data makes extrapolation unnecessary
models are not needed anymore
but disagreeable as observations likely biased

6.6 measurement vs datafication

measurement part of datafication

measurement
assignment of numerals
to represent properties
while preserving laws (homomophy)

measurement process
many empirical testing to ensure representation makes sense
issues with existence, scales, meaningfulness, operationalization, bias

datafication
assignment of values (not numerals anymore)
to represent properties (or values are used directly)

datafication critique
on much less empirical grounds
much less reliable, systematic
but still used as basis for decisions as it were a measurement

7 measurement politics

measurement to understand phenomena better & predict future behaviour
helps us organize social structure & societies
but once number is accepted, then arising does no longer matter
numbers are compared "the same" with different validities

7.1 objectivity

negotiation/agreement from same basis
required for coordination (trade, division of labor)
required for ethics (like impersonal trade due to objective price discrimination)
might be relative to specific group (required understanding of topic)
expert judgements where objectivity cannot be archived

7.2 usage

engineering & science (natural)
bureaucracy & technocracy (social)
technocracy powered by objective expert opinions

further examples
taxation (contribute according to principles, fairness)
insurance (pooling of risks)
risk & cost-benefit analysis
environmental policy

administrating goods 3000 BCE
mesopotamia had warehouses & needed to keep track of inventory
objects with different indents (1, 10, 60, 120; bisexagesimal system)
clay table documents sign of product & quantity
may includes signature of authority
clay balls storing quantities exist too

rosetta stone (300 BCE)
three different translations of same text
divine pharao (clear leader makes god-given rule)
decentralized government (local rulers decided by pharao)
taxes to central government depending on population, land, state
governance-organised central storage of supplies

french engineering school (1794)
also motivated founding of ETH (1855)
introduced quantification to steer social structures
like fair price of rail travel (cost of operation / passengers)
like building canal (break even point after high investment)
factor in societal benefits (less traffic) and user behaviour (canal slower)

amalgamal
argues that averaging cost/usage not fair due to different gains/efficiency
writes 600 pages about how to calculate price more faily
but concludes that it is likely still not enough

population-level averages
crime rates (>1830)
for elite/rich people, police budget
unemployment rates (>1900)
for poor people, only relevant if social services exist

life insurance (>19th century GB)
no longer government, but private companies offering product
insure "law of nature" (sudden death, murder, ...) but not sickness
administrative basis uses general vital statistics
selective admission only for applicants passing medical tests

7.3 tools

bushels of grain (GB middle ages)
way to measure grain (volumnia)
local reference at town hall ("more appropriate", local power demonstration)
price is fixed, but measurement can be influenced (wet, quality, ...)

declaration of grievances (french revolution)
demands (besides other) measurements should be democratized
leaded into meter / kilogram development, but unfamiliar for peasants

weather predictions nature
off measurement (1993) in strasbourg yielded cyclone (which was never there)
lothar (1999) forecasting wrong due to wrong measurement on island
lead to damages of around 6 billion
weather derivatives traded on stock markets

7.4 measurement in social systems

standardization
precision, reliability not enough for validity, accuracy
want define variables (probability distributions that make sense to measure)
with units & standards, sensing & analysis
add legal framework & regulation

implications
power (regulation, convincing laws)
scalability (able to master over many peasents)
universal competence (illusion of management pure by the numbers)
like impact management of scientifics with seemingly objective measurements
delegation of responsibility (as responsibility now delegated to numbers)
like (unknowingly) wrong/delayed numbers decision problem
behavioural adaptation (gaming the system)
like beginner PhDs writing survey articles (instead of seasoned researchers)

8 discrimination and behavior

8.1 reactions to measurements

system is modified
do what is desired (which might not be a good thing)
do something that looks good in measurement system
they lie (create untrue measurements)
find ways to avoid being measured

example reading tests
modified (easier tests in some schools)
do what desired (school focuses on reading)
something that looks good (training to pass tests)
lies (cheating scandals in many states)

avoidance (parents/teachers avoid tests)

8.2 university ranking

indicators
outcome (graduation/retention rate, income higher than parents)
student excellence (SAT scores, top 10%)
faculty (class size, salary, student/faculty ratio)
financial resources
alumni giving rate
expert opinion

northeast university (boston)
from place 162 to place 99 in 10 years, to place 40 into 25 years
building dorms to improve retention rate
hiring faculty (student/factory, hiring starts, high salary)
caps of 19 to classes (as extra points <20)
admission recruiting (finding good students)
many international students, only high-SAT- scores-domestic
incentives for worse students to enroll in spring

8.3 online advertising

100 billion industry (2018), exponential growth

seach engine
around 50% of market share
incremental ad clicks (total clicks - unpaid clicks) at 89%

controlled experiment
for branded search, no effect
for new customers has positive return
for existing customers ROI negative

micro-targeting
direct marketing (recency, frequency, monetary, customer churn)
political campaigns (agenda setting, tailored arguments)
commercial, political databases (cambridge analytica)

8.4 modeled data

measurement/datafication
direct observation
indirect
empirical regularity (statistics, machine learning)

assumed regularities
prejudice, stereotypes
market segmentations

8.5 regularities

city/country divide
democrats/republicans
cheap housing initiative

cultural divide
french part of switzerland for fair-food initiative

relation outcomes
homophily (similar people attract each other)
social selection (similar attributes attract each other)
social influence (related people adapt to each other)

8.6 social circles

individuals characterized by interactions in different social circles
multiple overlapping social circles might create stronger relationships
stronger relationships constrain decisions

estimate relationships
count triangles (joint friends)
count quads (joint friends that do not know each others)
then count among top neighbours how many are common

evaluation
can use the estimation to remove irrelevant edges
can deduce common attributes of groups if other members leak

cambridge analytica
around 100k users used app, then could also access their facebook friends profiles
facebook shut down API capability, but too late
used to influence populistic elections

9 smart living

9.1 definitions

by technology
electronic (some technological device)
connected (to some network)
information processing (some actual data processed)
simplified human-computer interaction
context-aware

by behaviour
reactive (behaviour reacts to environment)
adaptive (behaviour changes over time)
autonomous (no reliance on others)

9.2 smart homes

comfort
ease interaction with devices
for heating, lighting, watering, cleaning
like vacuum cleaner, lawn mower

monitoring
use for surveillance
for security, occupancy, movement
like cameras, sensors

control
use to control industrial applicances
for control, saving
like sensors

access
to enter secured area
for entering house, authentication
like doors, locks, windows

9.3 quantified self

indentification (DNA / biometrics)
status (weight, fitness)
activity (status time series)

9.4 nudging

permanent
"typical customers use.."
"in your neighbourhood typical consumption is..."
opt-in / opt-out
organ donation default

situated
"your speed is (smilie/frauny)"
"you balance this month ..."
apps of amusement parks

9.5 model

indirect measurement of behaviour to understand type
requires surveilled interaction forming a trace
then classifying / regressing over the trace

personalization/discrimination
new / loyal / special / rich customers
driving history motivates car insurance
browser history hint online shopping desires
...

9.6 health insurance

pooling risks

escalation levels
nudging (brochures, health risks)
incentivizing (check-ups, benefits)
controlling (behaviour monitoring)

9.7 data access

opendata.swiss
bitaboutme (analyse data of large services like spotify)
mitdata cooperative (controlled access to medical data for research)
GDPR & california laws