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Logic Models: How to Represent Causality and Guide Development of Social Analytics Measures

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June 2018

HUSO

Venice, Italy

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Overview

- Introduction to Logic Modeling
- Specifying the Logic Model
- Measurement and Analysis
  - Special interest in measures from social analytics
- Reaching Evaluative Conclusions

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Logic Models

- Roots of program evaluation theory and methods can be traced to industrial psychology and "scientific" management methods from the 1920's and 1930's.
  - Concept of *intervention* to address a problem
  - Hawthorne effect
- "New Deal" programs in the 1930's, greatly expanded by the "Great Society" programs of the 1960's, were attempts by government to solve problems through interventions
- Logic Models identify interventions and intermediate, measurable outcomes to achieve long-term goals

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Example Interventions

- Problem: Local community is losing population and tax base is eroding as people and businesses move away
  - Intervention 1: Increase community activities such as cultural arts programs for youth
  - Intervention 2: Improve transportation infrastructure
  - Intervention 3: Improve public perception of local government

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Specifying the Logic Model

- Identify the desired long-term outcomes
- Identify the constructs involved in the model
  - Latent variables (cannot be directly observed)
  - Manifest variables (can be observed or measured)
- Specify the causal relationships among the constructs
  - Direct and indirect causes
- Specify factors that influence the causal relationships
  - Moderating and mediating variables

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Example Long-Term Outcomes

- Achieve and maintain strong economic viability for community businesses
- Achieve and maintain high public confidence in community institutions
- Achieve and maintain high levels of community satisfaction in residents

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Latent and Manifest

- Latent: Unobservable constructs that underlie observable phenomena (e.g., city satisfaction, standard of living, confidence in government)
- Manifest: Observable phenomena that can be measured (even if imperfectly), such as:
  - Annual funding for an activity
  - Number of events of a certain type
- *Manifest indicators of latent variables*

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Causal Relationships

- Changes in values of “A” are associated with changes in the probability of values of “B”
  - Invariant causal relationships are rare
- Causal relationships can be concurrent or predictive, but cannot work backward in time
- Direct cause: changes in A are associated with changes in B irrespective of other variables
- Indirect cause: changes in A are associated with one or more other variables which in turn are direct causes of B

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Moderating and Mediating

- Mediating: Changes in "A" cause some change in "X", but "X" has some other causes as well, and "X" is a cause of "B"
  - X *mediates* the effect of A on B
- Moderating: Changes in "A" cause some change in "B", but also cause some change in "Y" which in turn is also a cause of "B"
  - Y *moderates* the effect of A on B

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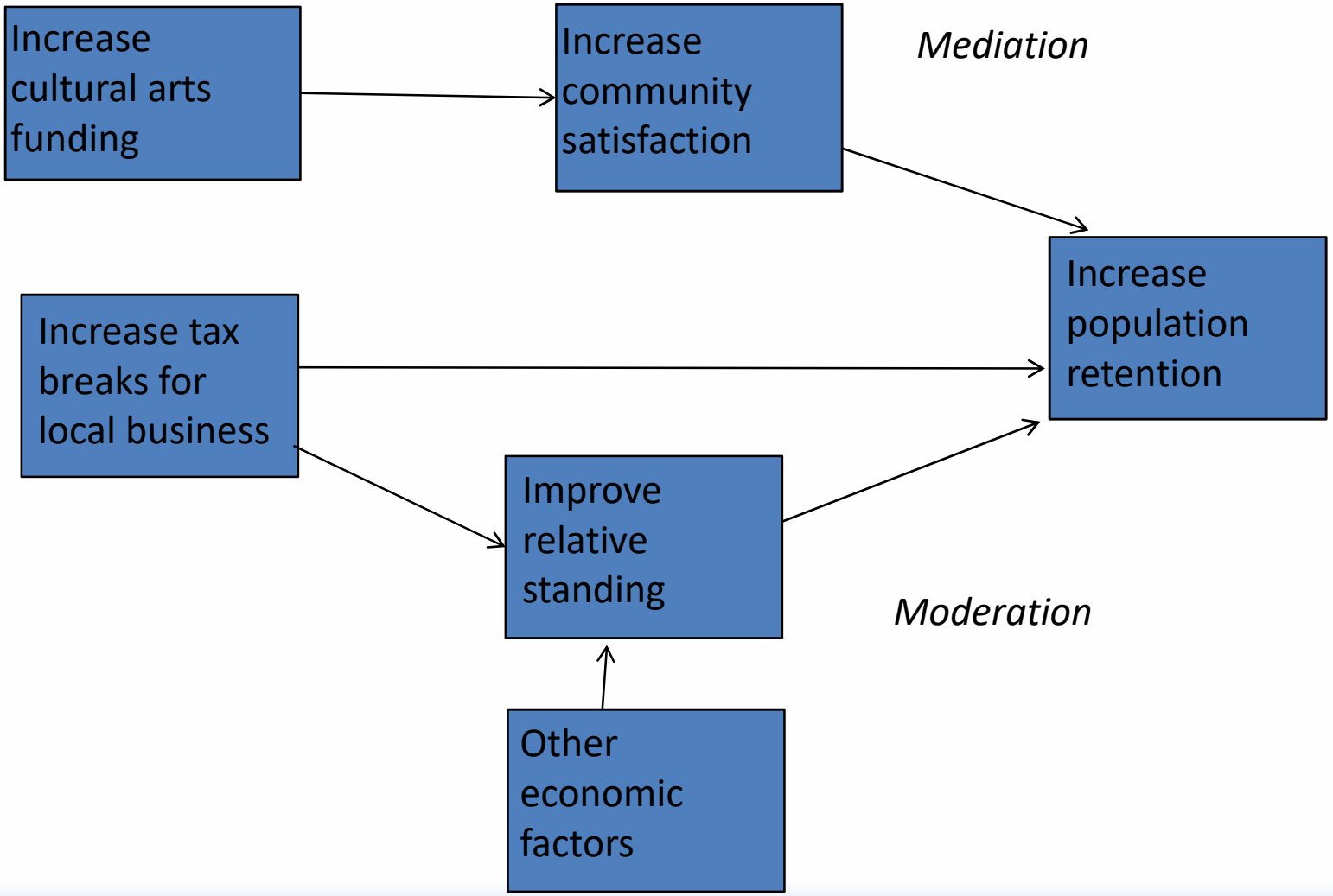
Graphical Representation



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Actions, Outputs, Outcomes

- Logic models specify actions (interventions) the performing organization takes
  - Internal causes of internal change
  - Outputs that cause external change
- External change is characterized by the temporal relationship between action and effect

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Effects and Outcomes

- Immediate effects – direct external effect of actions
- Intermediate outcomes – practical consequences of the immediate effects
- Long-term outcomes – stable, enduring outcomes that result from the intermediate outcomes

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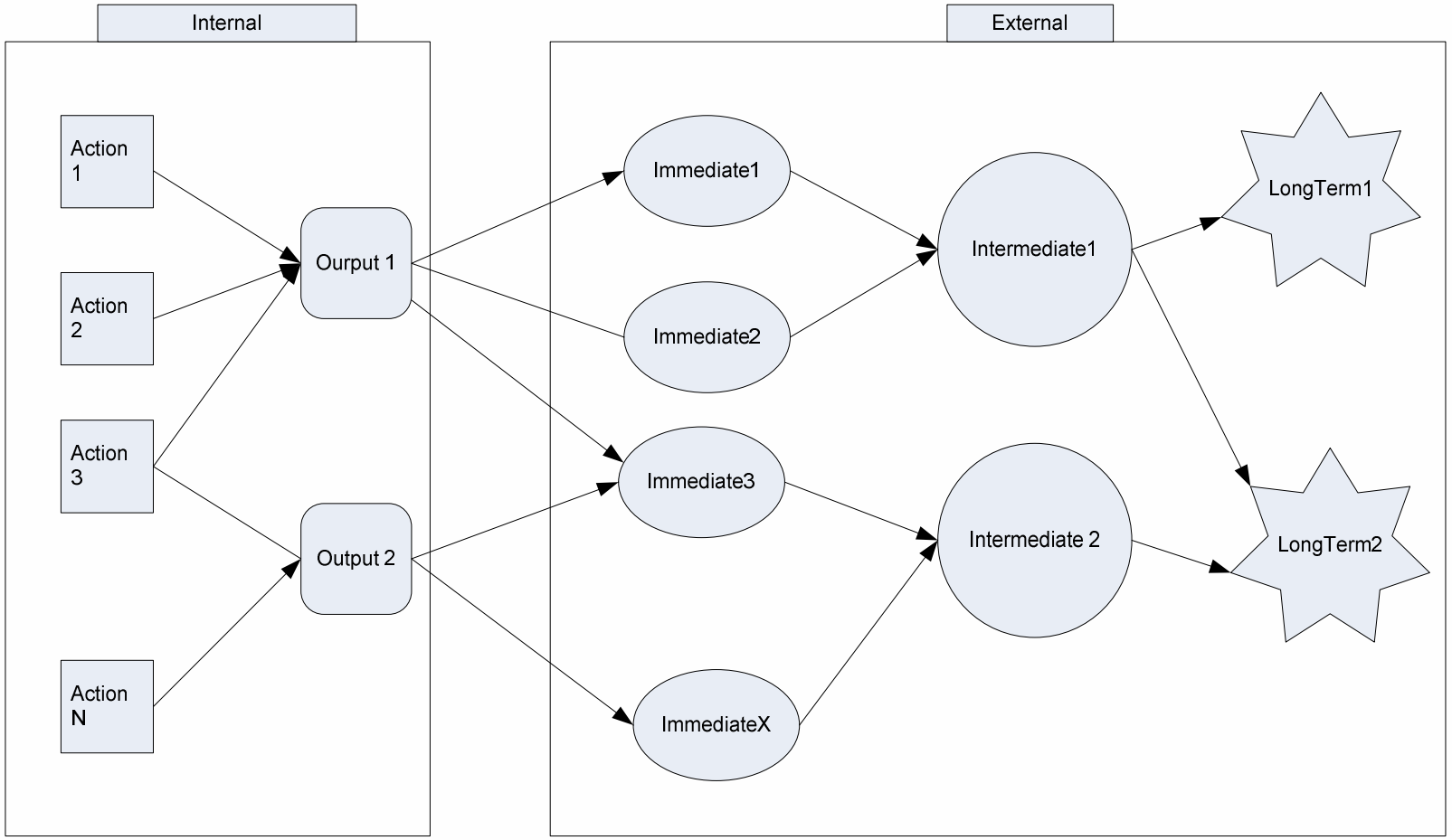
Graphical Depiction



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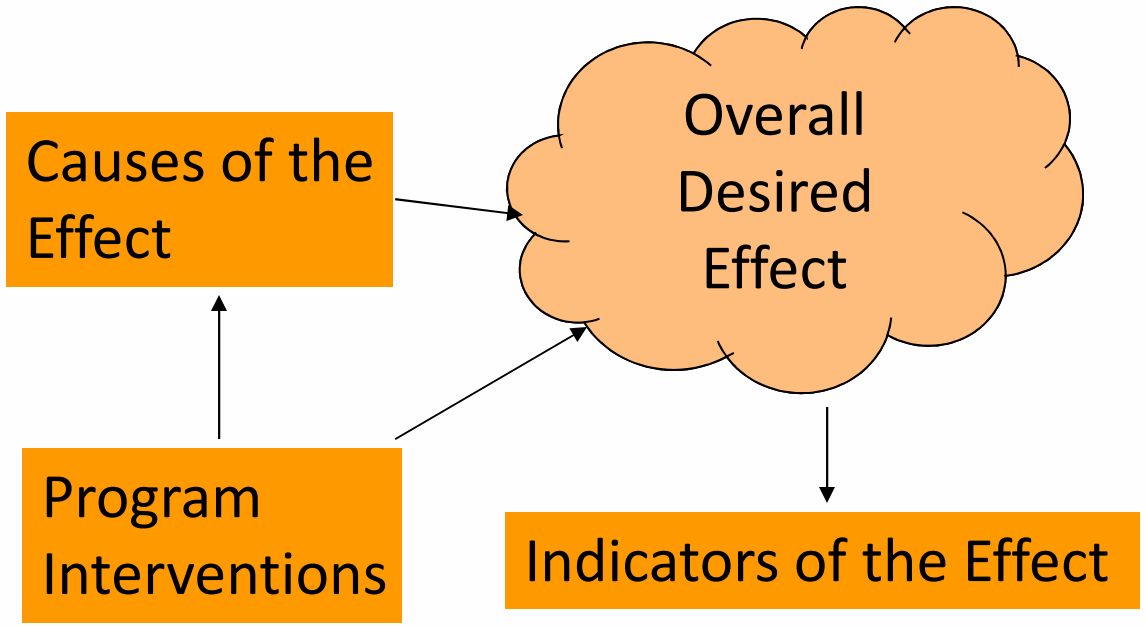
Desired Effect and Interventions



You might have to act on other causes (e.g. reduce barriers) in order to achieve the desired effect)

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Start at the End

- Logic models must address what outcomes (effects) are desired
- The desired outcomes are usually affected by factors beyond the interventions introduced by the program
- If you don't know where you want to go, you'll never know when you get there!

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Jump to the Beginning

- Describe the current situation
  - What factors contribute to the effect of interest?
  - What factors interfere with the effect of interest?
- Identify needs / gaps where there is opportunity to influence the effect
- Consider strengths, weaknesses, opportunities, threats (SWOT analysis)

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Fill in the Middle

- Given the desired effect, specify the interventions (program actions) that will be performed, and the rational for how those interventions will influence the desired effect
- The interventions can directly produce the desired effect, or can indirectly produce the effect by acting on other causes of the effect.

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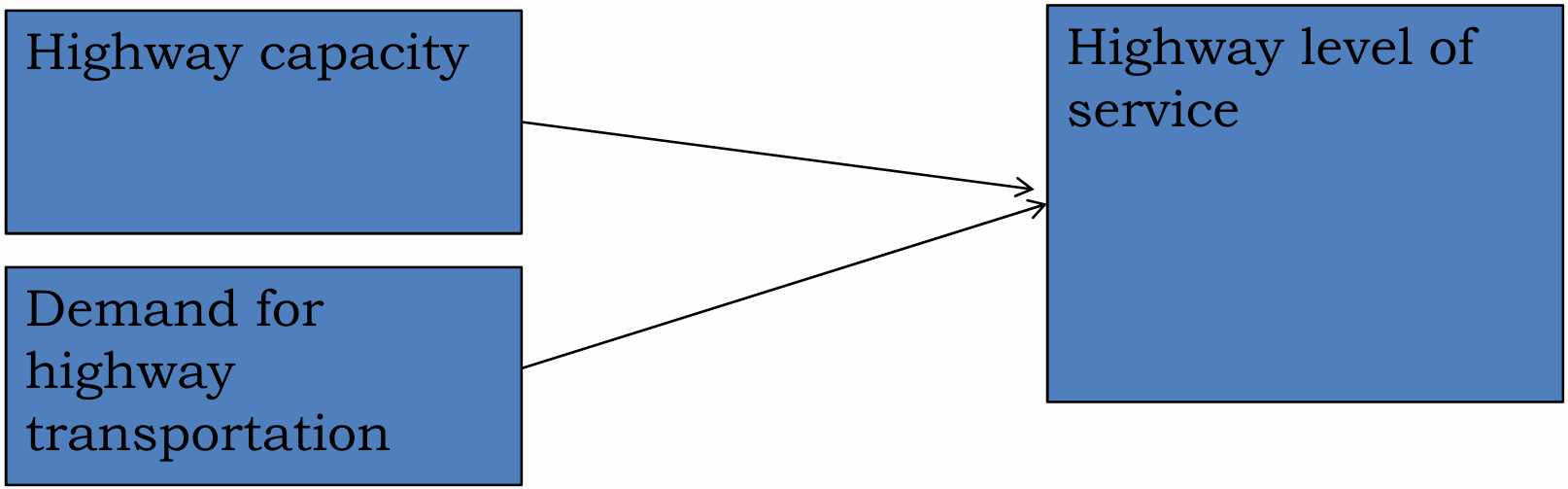
A Working Example



Level of service A: Free flow speed, freely change lanes. Spacing > 25 car lengths.
B: Free flow speed, lane changes slightly restricted. Spacing ~ 15 car lengths
C: Free flow speed, lane changes noticeably restricted. Spacing ~ 10 car lengths
D: Decreased speed & maneuverability. Any incident creates delay. Spacing ~ 8 car lengths.
E: At capacity. Speeds restricted. Maneuvers difficult and may create shock waves. Minor incidents create major delays. Spacing ~ 6 car lengths
F: Forced flow ("traffic jam"). Spacing < 5 car lengths.

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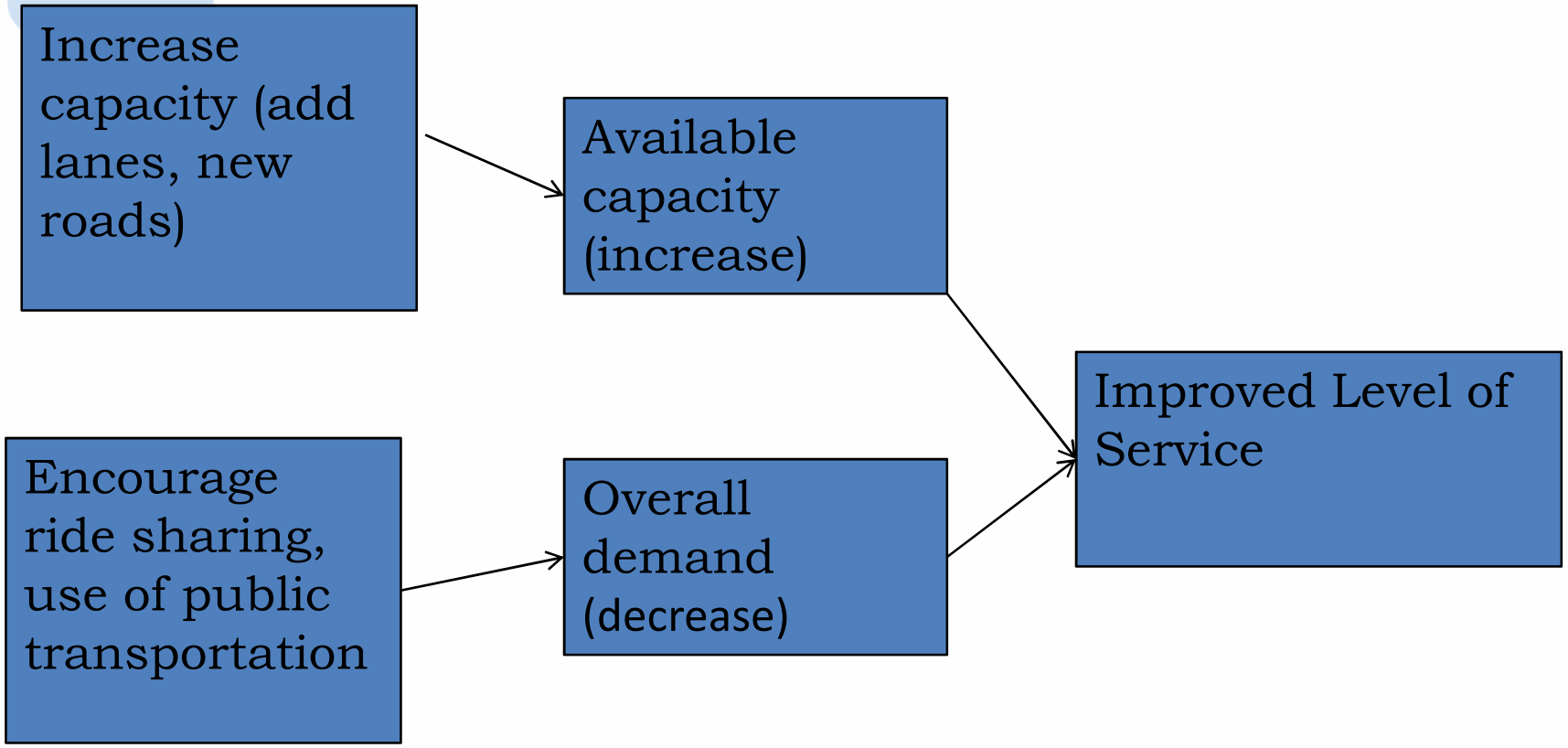
Interventions!



Some possible interventions to promote change

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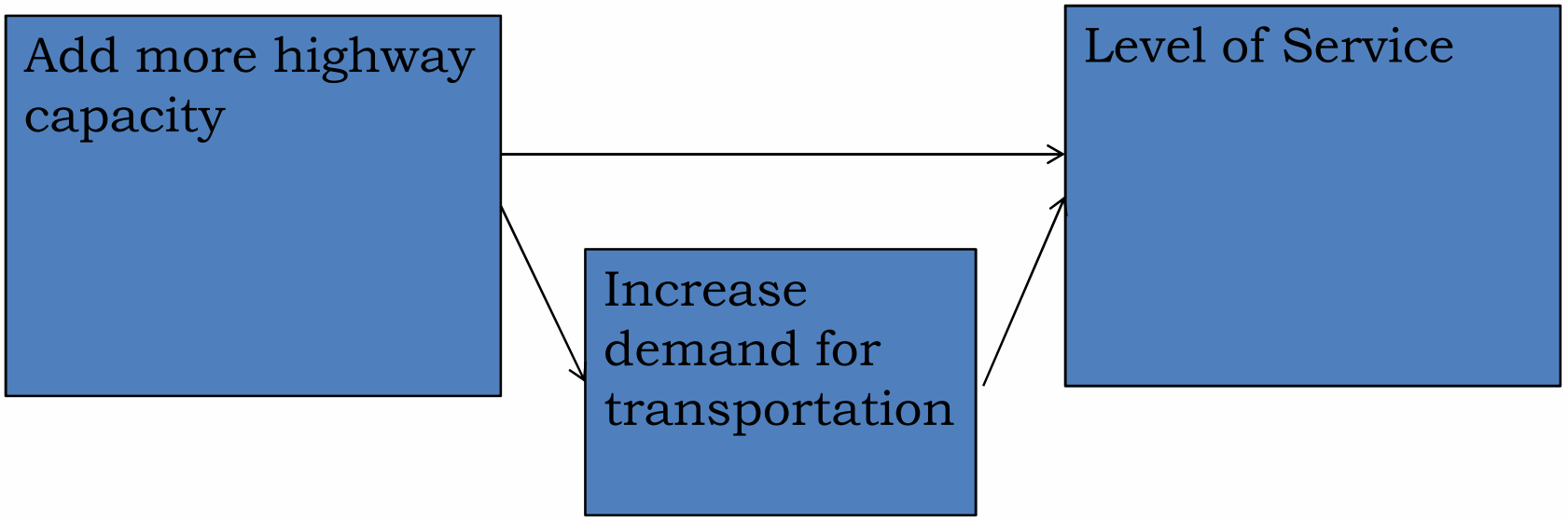
A Moderating Variable



This acknowledges that increasing supply also affects demand, which moderates the impact on LOS.

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Measurement

- Identifying the indicators for each construct in the model
- Develop methods of obtaining data for each indicator
- Collect that data

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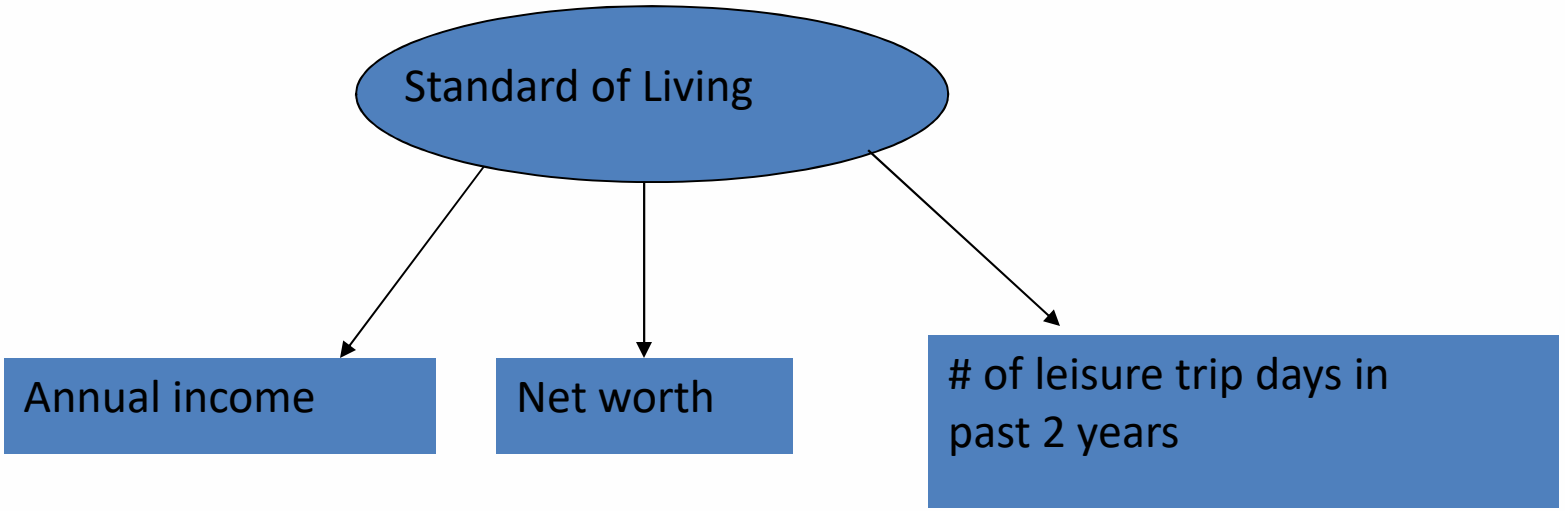
Examples of Indicators for a Construct



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Outcomes vs. Outputs

- An "outcome measure" assesses the actual results, effects, or impact of a program activity compared to its intended purpose. Outcome measurement cannot be done until a program or project reaches maturity
- An "output measure" records the actual level of activity or effort that was realized, and can be expressed in a quantitative or qualitative manner. Output measures are often intermediate, in that they assess how well a program or operation is being carried out during a particular time period

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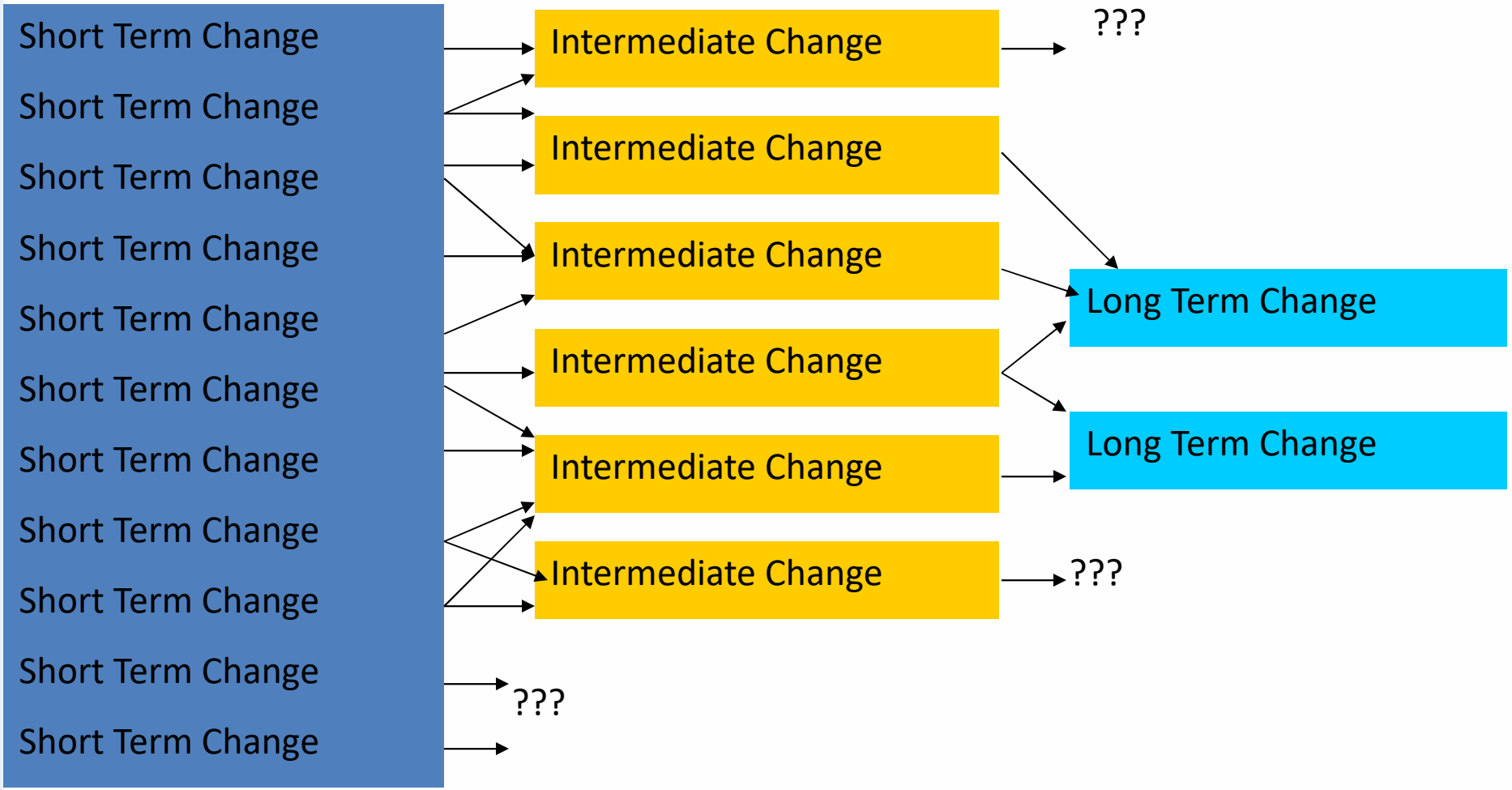
Outcomes – Causal Chains



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Major Issues

- Developing indicators for constructs in the logic model
- Assessing reliability and validity of the indicators
- Measuring the hard-to-measure
- Aggregate vs. individual data
- Statistical analysis (especially advanced techniques)

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Heuristic for Developing Indicators

- For each construct in the logic model, you either need:
  - 3 or more manifest indicators, or
  - A perfect indicator, or
  - An accepted, validated measurement instrument
- Manifest indicators (other than perfect indicators) are partial measures of the construct, so multiple complementary measures are better

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Initial Steps

- Don't re-invent the wheel – have others already developed methods to measure this construct?
- Elaborate and refine your understanding and definition of the construct
- Identify observable attributes that have some association with the construct
  - New possibilities come from social analytics sources, such as social media

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Miscellaneous Types of Indicators

- Objective facts or attributes that are related to the construct
- Scores or subscale scores on tests, questionnaires, etc. that have already been developed and are in use
- Self-report in response to items on a questionnaire or interview
- Response from third parties (e.g., technical experts, managers) to items on a questionnaire or interview
- Sentiment expressed in social media or other communications

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Difficulties

- How will you get access to desired data (e.g., income, system performance measures, incident reports, Facebook posts)
  - Permissions required for access to social media
  - Privacy issues
- Will it be possible for you to develop and validate a new measurement instrument in the context of your effort?
  - Some are easier to collect, but harder to validate (e.g., comments left on a website or social media page set up explicitly for this purpose)

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Options for Social Media

- Automated analysis: gain access to social media platform(s) content and use computational methods to identify topics of discussion and sentiment expressed
- Manual analysis: Retrieve content, screen for topic appropriateness, then perform content analysis
- Hybrid: Use computational methods for preliminary screening and scoring, followed by human final scoring

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General Method for Developing Questionnaires

- Identify your measurement objectives
  - What do you need to know (not: what questions would I like to ask)?
- Develop a draft instrument that attempts to meet those measurement objectives
- **Pre-test the instrument**
  - Refine in accordance with pre-test results

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Measurement Objectives

- Start with the end in mind – what information do you need out of this measurement to perform your evaluation
- Adopt a time-budget goal for respondents (how long should they expect it to take to complete the process)
- Add questions of convenience or secondary interest only if they can fit in the time budget

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Draft Questions

- Initially, try to phrase the question as you would in conversation, even if it is a bit wordy. Use common, informal style.
- Attempt to improve the question by making it more direct
- Identify need to supply definitions or clarifications, especially for unfamiliar terms or terms with other meanings in common usage

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Design the Answer

- How will the respondent answer your question?
  - Yes/No
  - Yes/No plus elaboration/explanation
  - Short open-ended answer
  - Long open-ended answer
  - Select from multiple choice (you supply the choices)
  - Rate using scale you specify

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Scales

- Proper use of rating scales can be one of the most important aspects of your study
- Scales and scale anchors have been studied extensively. Use scales and anchors that have been validated – don't invent your own!
- Be consistent across questions in the type of scale and the *polarity* of the scale you use

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Likert-type Scales

- Scale with verbal anchors for each end and possible some (or all) intermediate points
- Even-number vs. Odd-number of scale points
  - Use odd numbered scale ONLY if the mid-point is truly of interest, otherwise use an even numbered scale
- Consider the virtues of a 4-point scale

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4-Point Likert-Type Scale

- Allows respondent to indicate satisfaction or dissatisfaction clearly, with one shade of gray on each side, for example:
  - 1 = Completely unsatisfactory
  - 2 = Somewhat unsatisfactory
  - 3 = Somewhat satisfactory
  - 4 = Completely satisfactory
- When you analyze the data, you can often combine the 1's and 2's, and the 3's and 4's
- Solicit comments on reasons for dissatisfaction

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Wording of the Question

- It really matters how you word the question
- Sometime the results you get are solely determined by how you worded the question – not by the construct you are trying to measure

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Which Do You Prefer (V.1)

- Would you prefer that airport security screeners be:
  - (a) highly trained federal officers, or
  - (b) employees of the low-bid contractor?

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Which Do You Prefer (V.2)

- Would you prefer that airport security screeners be:
  - (a) unionized government employees, or
  - (b) experienced private-sector personnel whose jobs depend on performance and cost-effectiveness?

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Demographics

- Collect the demographics you need to:
  - Characterize the respondents for documentation of the extent to which they are representative of the population of interest
    - Generally includes such factors as gender, age, race/ethnicity
    - Use standard categories unless you have a rationale for doing otherwise!
  - Analyze results by subgroups of interest (e.g., gender, age, geographic area)

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Direct Questions

- Don't fool yourself into depending on some circuitous logic to infer something that you are interested in – if you need to know it, ask it!
- Give every question the "so what?" test – what difference will their specific answer (or the pattern of answers across people) make on how you interpret your overall findings
  - "So what if they think the training takes too long?" – are you going to recommend training be shortened?

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Don't ask "Why?"

- If you are inclined to ask "why", think of some possible answers you are interested in. See if you can formulate the questions to ask about those answers of interest directly. Alternately, provide a list of possible answers you are interested in, and let the respondent "check all that apply"

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Reliability and Validity

- Reliability is the extent to which a measure is stable and free from random error
  - If the construct is unstable, measures will be unreliable
  - If the measurement instrument is poorly constructed (ambiguous questions, unfamiliar terms, wrong scales, etc.), the measures will be unreliable
- Validity is the extent to which the instrument measures what it is intended to measure

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Types of Validity

- Criterion-referenced validity (the best kind)
  - Concurrent
  - Predictive
- Construct validity (agreement with other measures of the construct)
- Content validity (adequate sampling of the domain)
- Face validity (appears to be valid on inspection)

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Relationship

- Reliability is a pre-requisite for validity
  - Sets the upper bound of validity – can't be more valid than it is reliable
- An instrument has a single reliability, but has multiple validities
- Possible for an instrument to be highly reliable but have virtually zero-validity for your purpose

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Assessing Reliability

- Various statistical techniques can be used for a multi-item test
- Repeated application (but there can be problems with memory effects)
- Alternate forms (of the same test) administered at different times
- Split-half technique
- Issue of stability (over time) versus reliability (of the instrument at any given time)

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Assessing Validity

- Statistical methods (basically, r^2)
  - Requires independent measure of the criterion (for criterion-referenced validity) or of other measures of the construct (for construct validity)
- Synthetic validity – relying on a validation procedure performed elsewhere
- Logical methods (weaker) – quantify sampling of the domain, or obtain qualitative assessment of adequacy of questions

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Correlation

- Generally refers to the Pearson Product-Moment Coefficient of Correlation (PPMC), usually presented simply as *r*
- Other forms are appropriate for other types of data (such as categorical data or ordinal data)
- Indicates the *linear relationship* between 2 variables

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Usefulness of Correlation

- Tends to reflect strength of relationship, even if the relationship is non-linear (which is often the case)
- Quite robust and useful across many types of data
- Relatively easy to understand
  - Ranges from -1.0 to +1.0
  - Zero means no correlation
  - Magnitude indicates strength of relationship
  - Sign indicates direction of relationship

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Limitation on Correlation

- A relationship between two variables that follows an inverted-U function will show a zero correlation
- This relationship is found in some behavioral measures, such as the relationship between arousal level and performance

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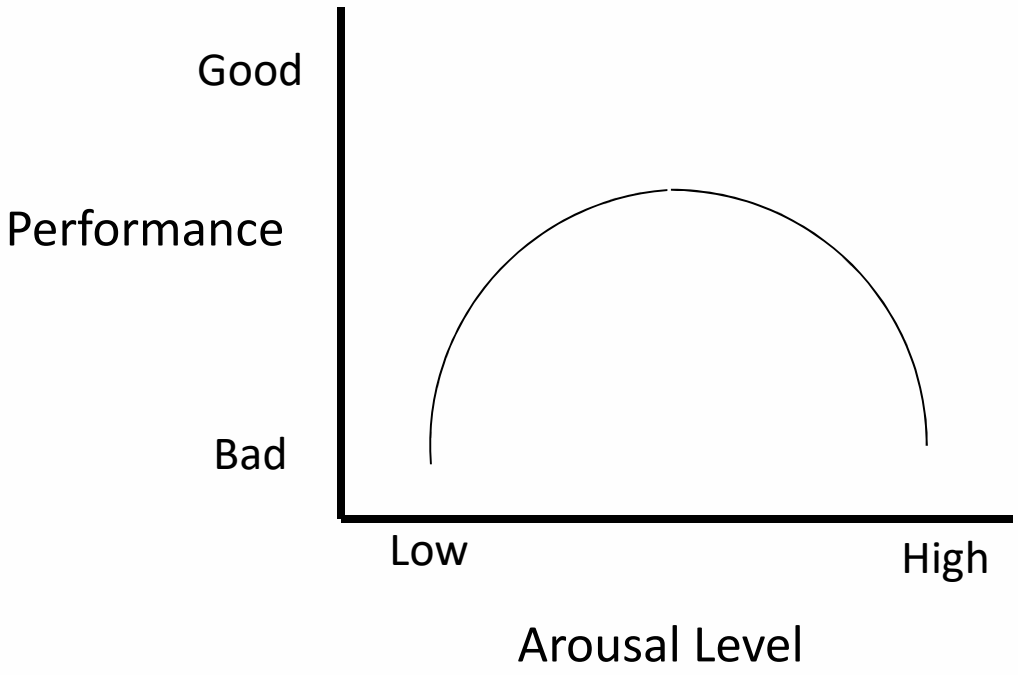
The Inverted U



Some aspects of behavior follow this pattern. The correlation is 0.0, even though the relationship is real.

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Content Analysis

- Answers to open-ended questions or social media posts are generally unstructured comments that have to be analyzed by the technique known as *content analysis*
- Basic approach is to use at least 2 independent analysts
- Develop a list of themes of interest
  - Some a priori, some based on the answers
- Each analyst scores against the list
- Resolve differences (may use a 3rd analyst to referee)

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Content Analysis

- List of themes generally starts quite specific, then proceeds to become more general as themes get combined or broadened in interpretation
- Results of interest are the frequency (or proportion of respondents) with which the various themes are mentioned
- Themes mentioned by only one person may be noted, but those mentioned by at least 2 are of greater interest

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Some Practical Tidbits

- Collecting data by phone interview is quite different than by a written questionnaire
  - Need to give verbal preview of the answer before asking the question, unless the question is very brief and direct
- Emailed questionnaires often return blank (respondent doesn't save the electronic file or doesn't return the correct file)

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Evaluating the Logic Model

- Combination of descriptive statistics, inferential statistics, and logical interpretation of qualitative data

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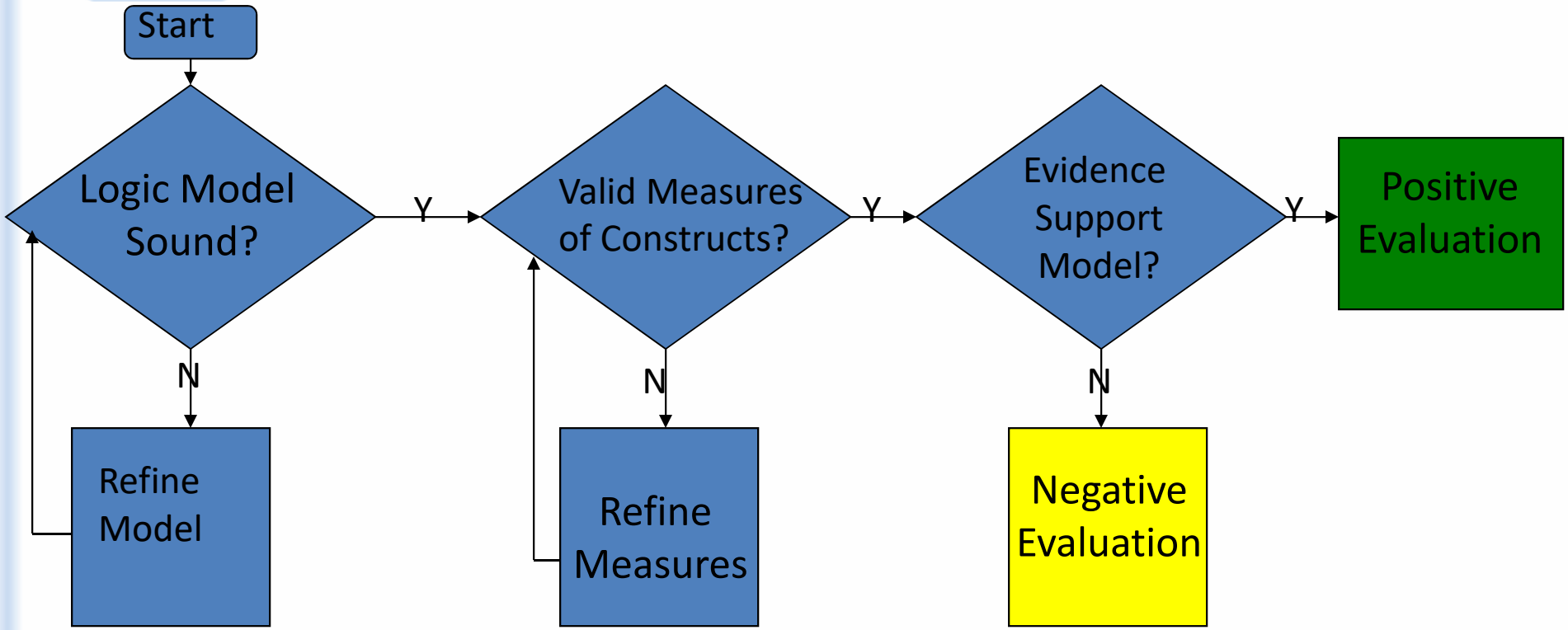
Basic Decision Tree



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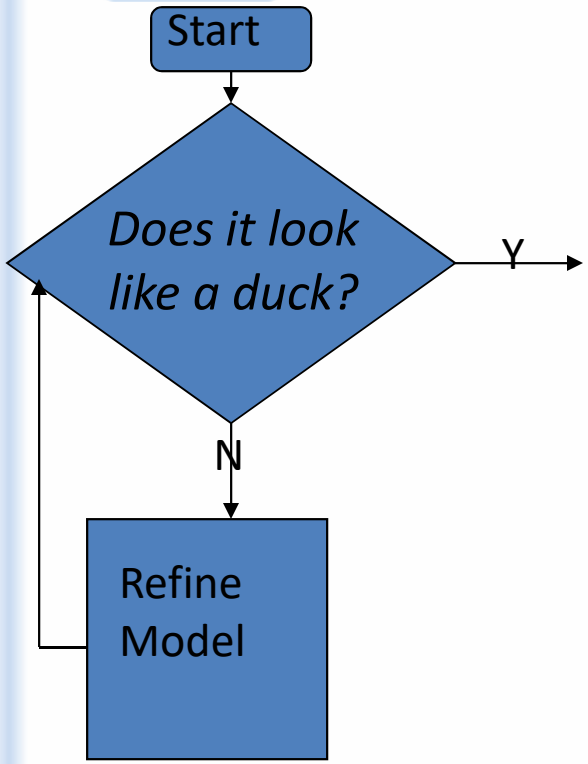

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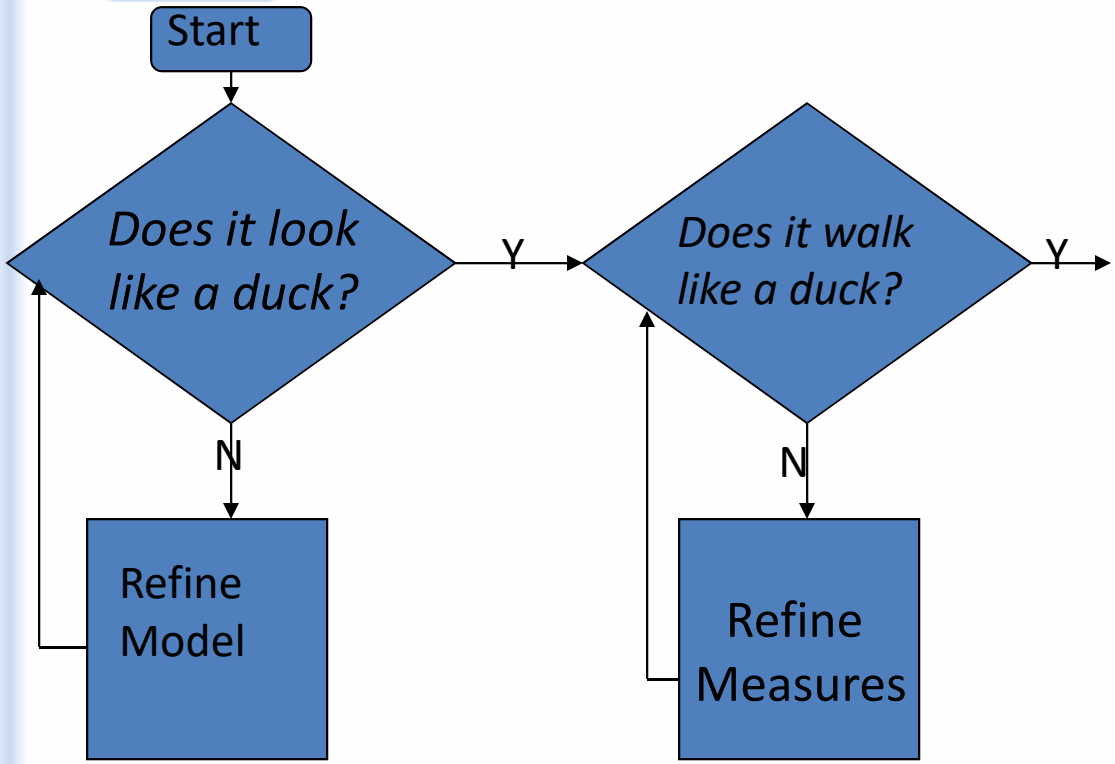

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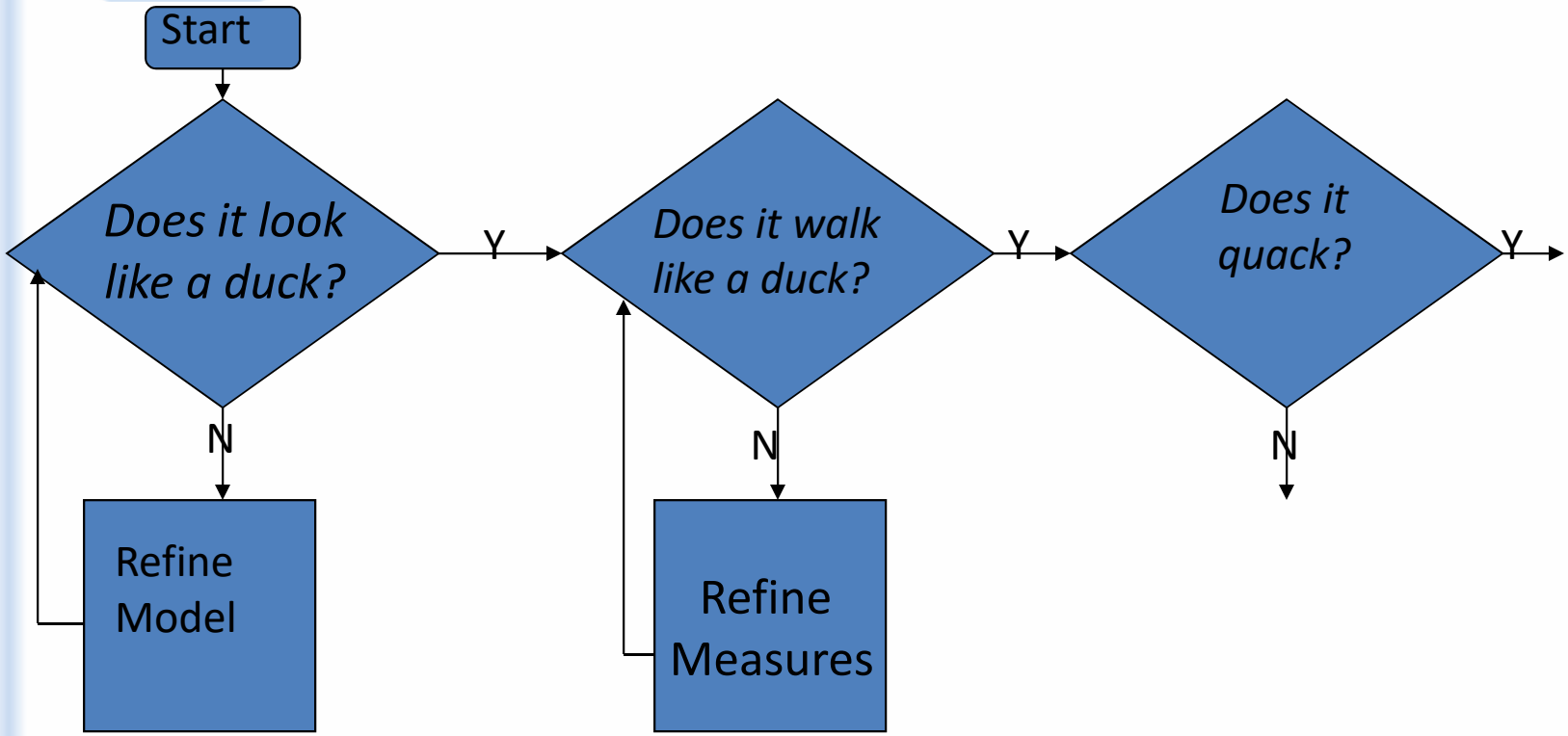

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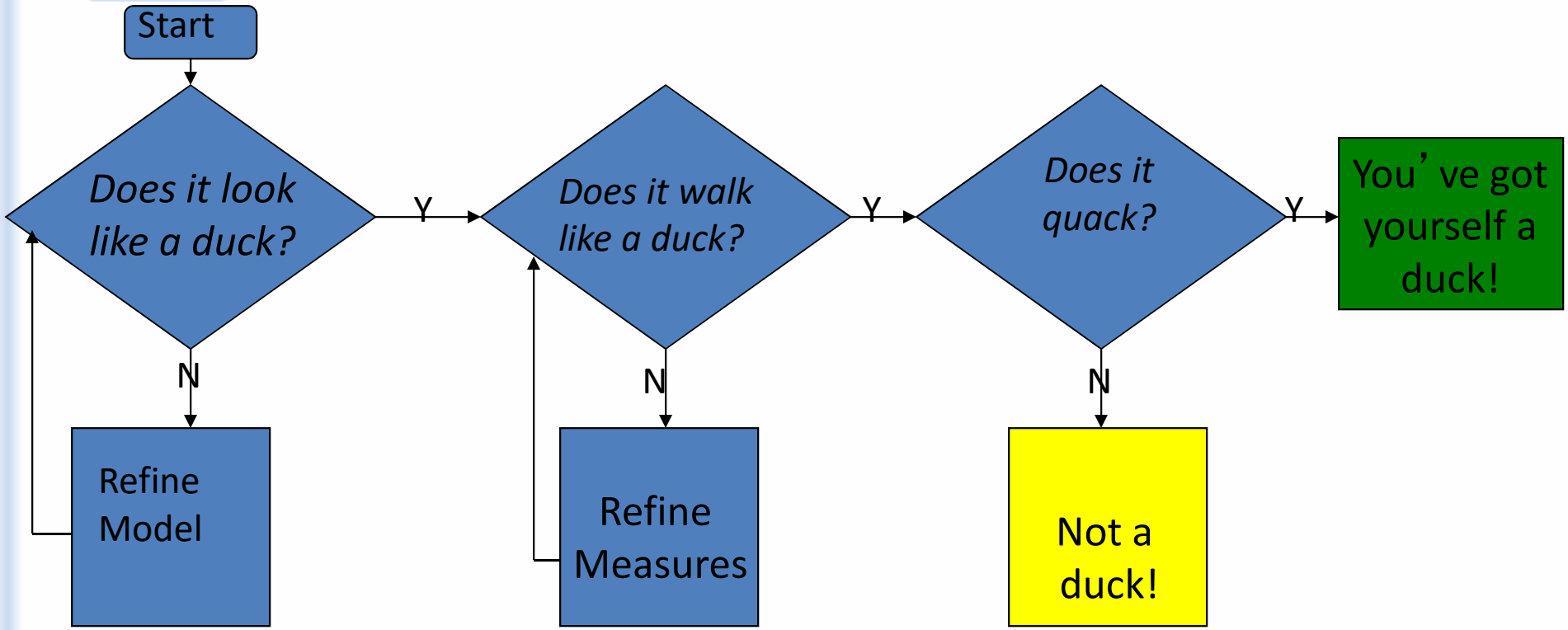

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Descriptive Level

- Are the constructs related in the way expected?
  - Generally assessed by correlation coefficients and/or by changes in proportions or frequencies in categories

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Inferential Level

- The proper technique depends on the type of model being tested – best to get qualified help if you are not properly trained
  - Structural equations modeling (SEM)
  - Confirmatory factor analysis (CFA)
- Basically, this step involves testing the relationships in the model to see if the probability of getting these results is different that what would be expected by chance

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Logical Level

- Statistics are a tool that are used by the evaluator – not the other way around
- Determine whether the pattern of results makes sense – irrespective of whether they point to a positive or negative outcome
- Test for the "average man" fallacy

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Average Man Fallacy

- Averages may be an artifact of aggregating data from multiple individuals, and may not represent the experience of any individual
  - No family has 2.4 children
- If the data are collected from a mixture of people, some who benefited and some who didn't, the average effect may be a mild benefit. The magnitude of the benefit reflects the proportion in each category.

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Examine Individuals

- In assessing the possibility of the average man fallacy, find specific cases that show the desired change versus those that do not.
- It may be useful to try to develop logic models that can differentiate between the two groups
- Use “case tracing” to identify specific individuals that show changes in the patterns of interest, and tally those cases

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Exploratory Data Analysis

- Look for unintended effects and unexpected relationships
- Let your imagination and curiosity run wild

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Draw Conclusions Based on Evidence

- Insist that the logic model make sense
- Insist on having good, reliable, valid measures of the constructs
- Insist on having understandable descriptive statistics of the results
- Insist on having proper inferential analysis of the data
- Insist on having firm evidence at the individual level

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Summary

- Logic models, in the context of program evaluation, provide a rigorous method for assessing interventions of interest in social analytics
- Social media platforms and data are a new source of manifest indicators
  - New computational tools can facilitate collection of these data
- These methods can lead to improved outcomes for communities attempting interventions

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