

Empower. Partner. Lead



Ohio Supercomputer Center

Modeling in Engineering using MATLAB

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Goals of the Session

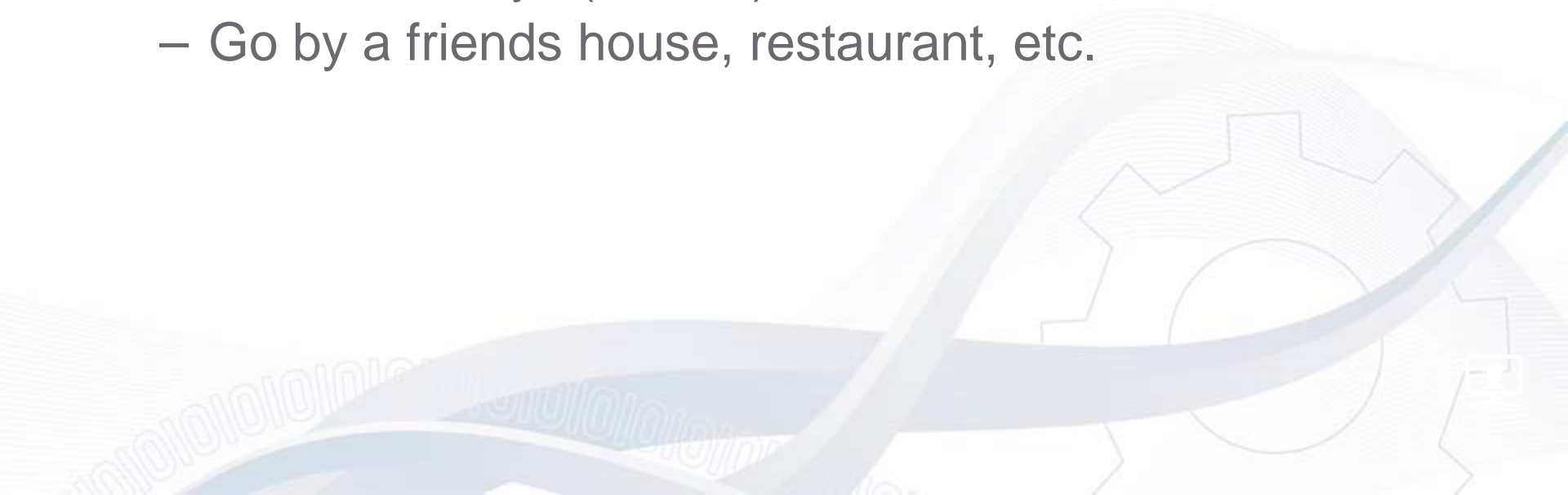
- Work through an example presentation and exercise that introduces many modeling concepts
 - Modeling terminology e.g. parameters, constants, validation
 - Conceptualization of the model framework and model assumptions
 - Mathematical form of the model structure
 - Linear vs. non-linear representations
 - Implications of the mathematical structure for model behavior
 - Using the model to provide evidence to draw conclusions about a real world practical problem

Introducing Modeling Skills

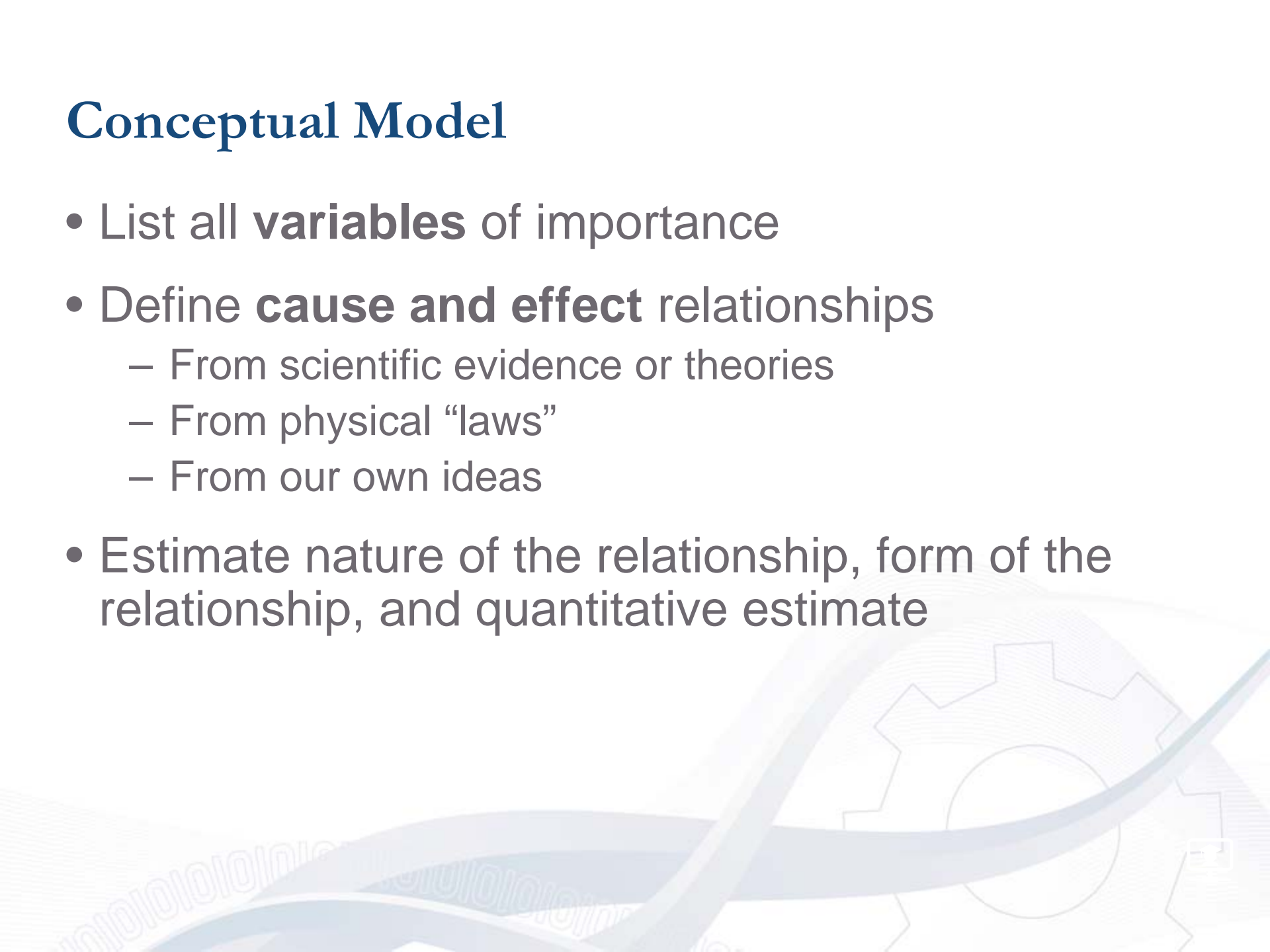
- Tied to a general course in modeling and simulation that is part of an undergraduate minor program
 - More information at <http://www.rscs.org/minor/index.shtml>
- Competency-based course
 - Focus on basic modeling skills
 - Understanding of modeling process
 - Accuracy and precision
 - Mathematical representations of physical phenomena

First Modeling Exercise

- Model of the time it takes to get from your house to a place of work using alternate routes
- Possible Objectives
 - Minimize the time it takes
 - Avoid traffic congestion
 - Avoid freeways (old car)
 - Go by a friends house, restaurant, etc.



Conceptual Model

- List all **variables** of importance
 - Define **cause and effect** relationships
 - From scientific evidence or theories
 - From physical “laws”
 - From our own ideas
 - Estimate nature of the relationship, form of the relationship, and quantitative estimate
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- The background of the slide features a decorative graphic. It includes several interlocking gears of varying sizes, rendered in a light blue and grey color scheme. A prominent, thick, blue wavy line curves across the lower half of the slide, overlapping the gears. The overall aesthetic is clean and technical, suggesting a focus on engineering or scientific concepts.

Weather and Traffic

Weather Condition	Impact on Traffic Flow
Clear skies, no wind	
Light rain	
Heavy rain	
Light snow	
Heavy snow	
Heavy snow and blowing, poor visibility	
Freezing rain	
Other?	

More Modeling Ideas

- Assess the **accuracy** of our model
 - How close does it come to the real answer?
 - How would we measure this?
- Simplify the model – eliminate some variables from consideration
 - Decide which conditions represent the “majority” of cases
 - Leave out other conditions to be modeled at a later time

Still More Ideas

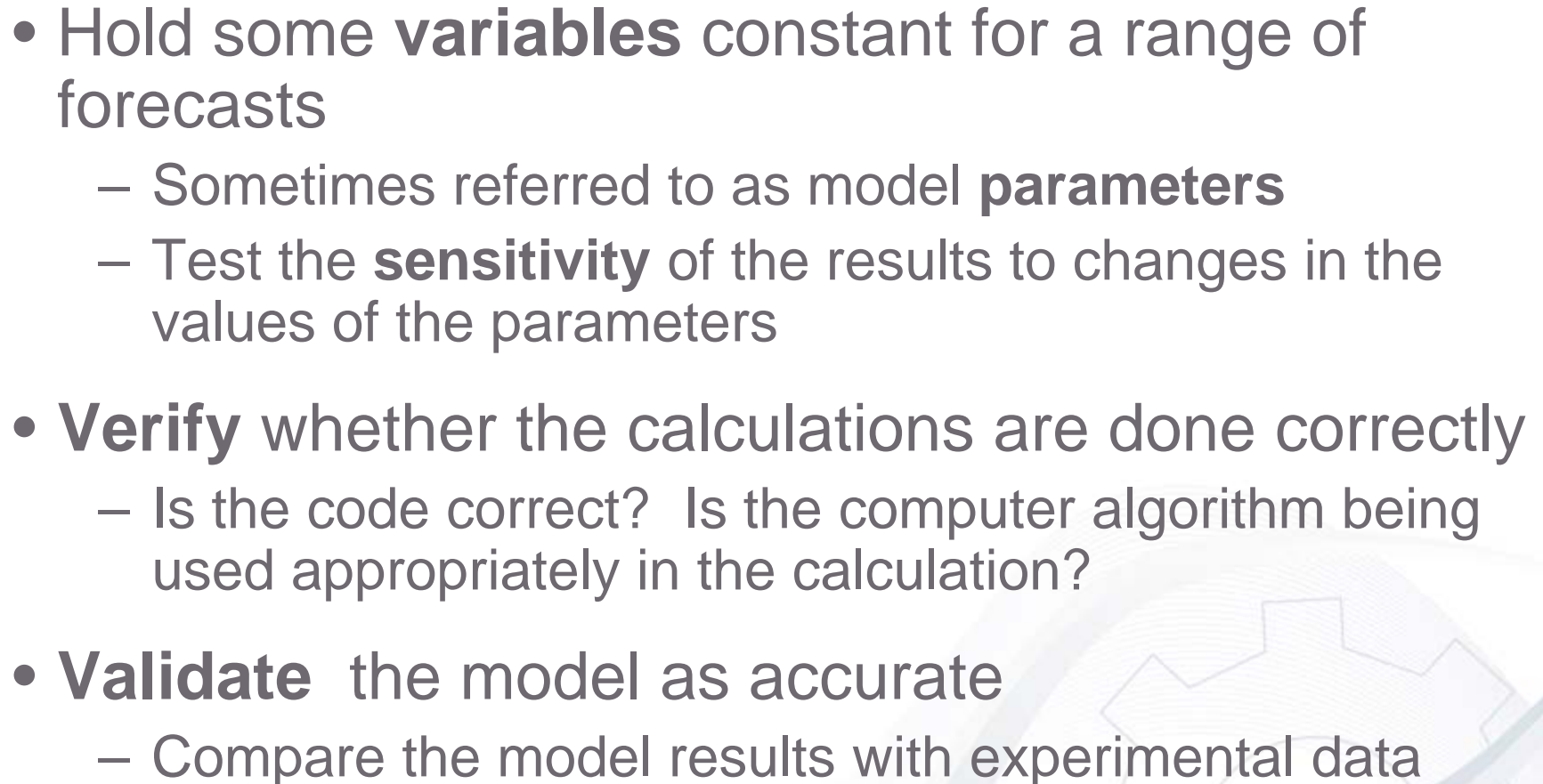
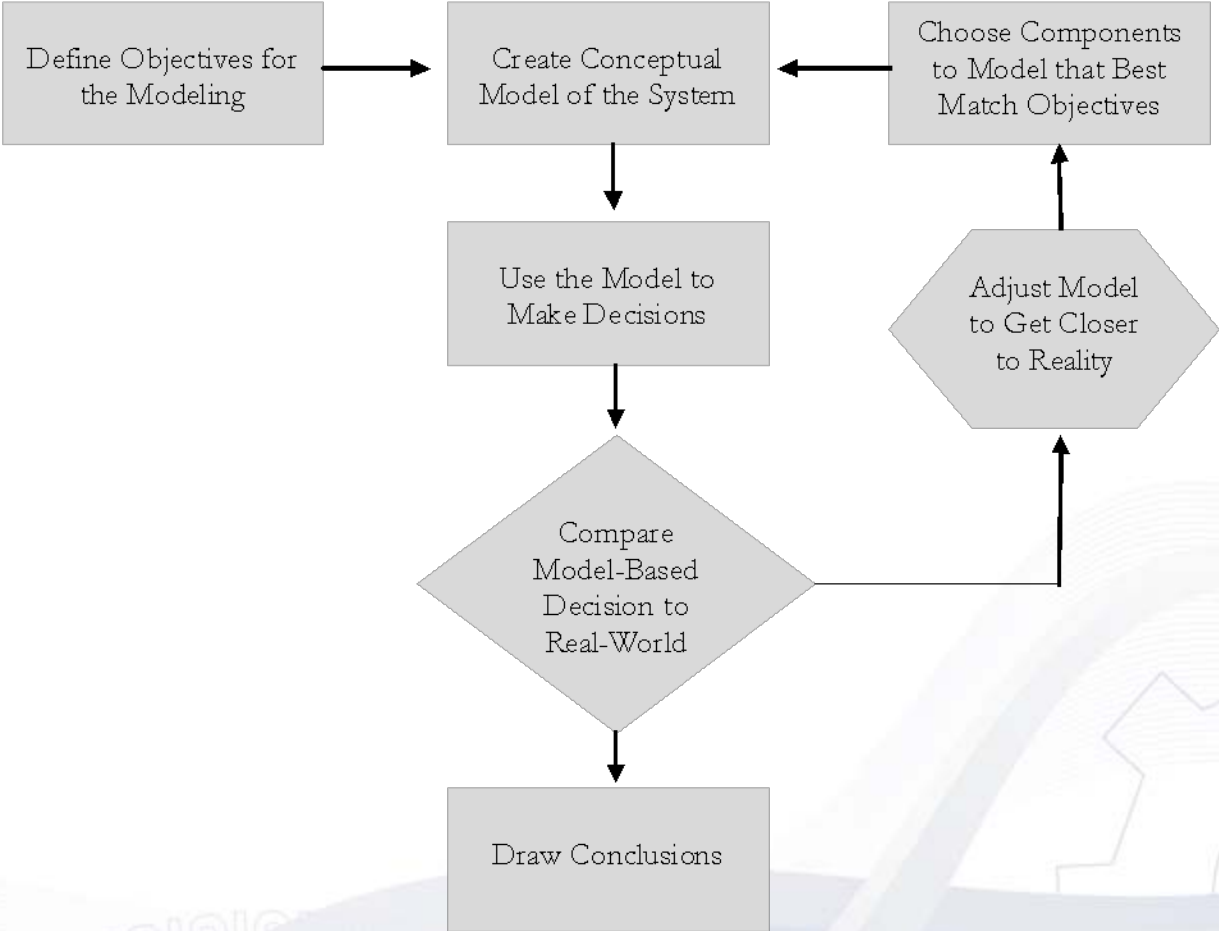
- Hold some **variables** constant for a range of forecasts
 - Sometimes referred to as model **parameters**
 - Test the **sensitivity** of the results to changes in the values of the parameters
 - **Verify** whether the calculations are done correctly
 - Is the code correct? Is the computer algorithm being used appropriately in the calculation?
 - **Validate** the model as accurate
 - Compare the model results with experimental data
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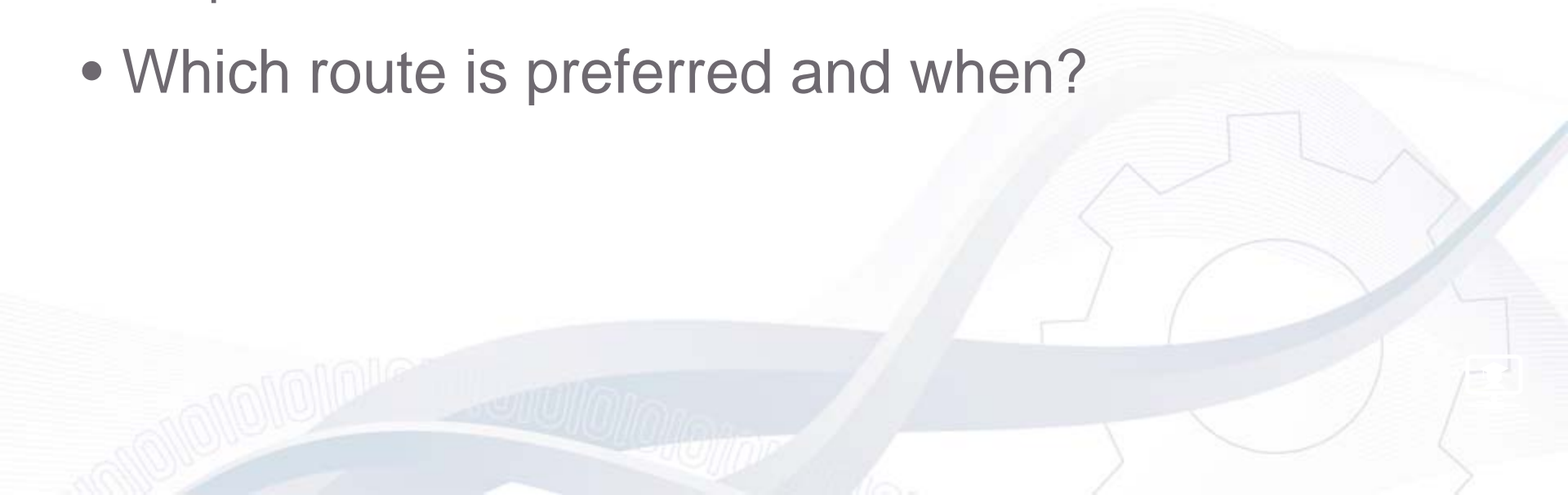
Figure 2: The Modeling and Inquiry Process



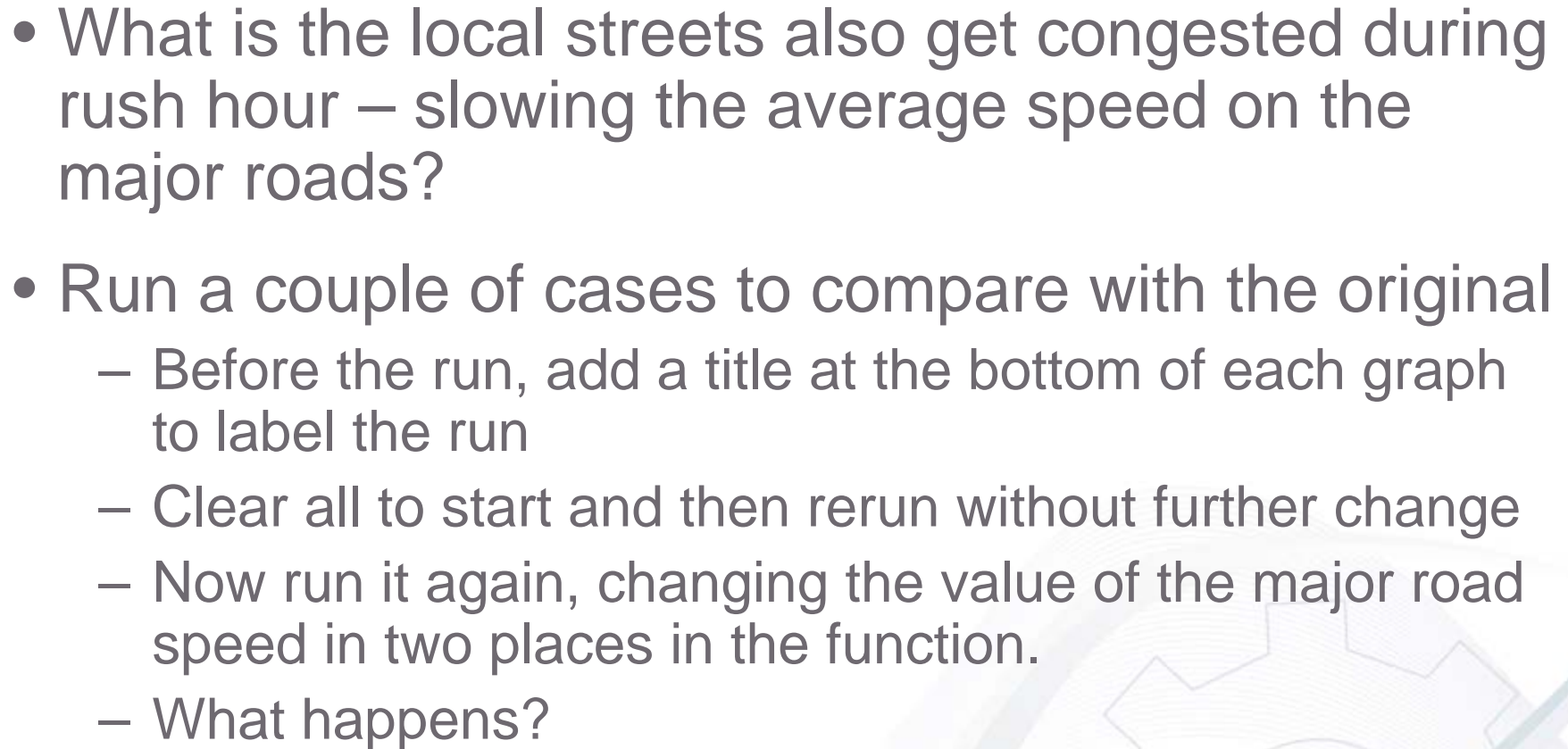
Conceptual Traffic Model

- Assuming we want to minimize the time it takes us to go from home to work, what should be the conceptual components of our traffic model?
- Open file trafficmodel.doc to see the assignment
- Open MATLAB and open trafficmodel1 to see the simple traffic model
 - Examine the model assumptions and setup
 - Change the red light probability as instructed for one of the cases to see what happens to the results

Expanding the Exercise and Program

- Open traffic1b and run_traffic
 - Run_traffic is a function called from traffic1b
 - Allows consideration of multiple changes in a parameter and plots the results in two ways to show the impacts of the multiple runs
 - Setup to run all the changes in the red light time parameter
 - Which route is preferred and when?
- 
- The background of the slide features a decorative graphic. It includes several interlocking gears of different sizes and colors (light blue and grey) overlaid on a background of binary code (0s and 1s) in a light blue color. The overall aesthetic is technical and modern.

Changing Other Parameters

- What is the local streets also get congested during rush hour – slowing the average speed on the major roads?
 - Run a couple of cases to compare with the original
 - Before the run, add a title at the bottom of each graph to label the run
 - Clear all to start and then rerun without further change
 - Now run it again, changing the value of the major road speed in two places in the function.
 - What happens?
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Optional Extension

- Focus on the nature of the traffic flow versus congestion relationship
 - Relationship is not linear as congestion increases
 - Potential differences in results if highly congested conditions exist
- Opportunity to discuss the model limitations
 - Forecasting with assumptions that are violated by the conditions
 - Forecasting beyond experimental data
 - Passing a critical point where physical conditions or behaviors change significantly