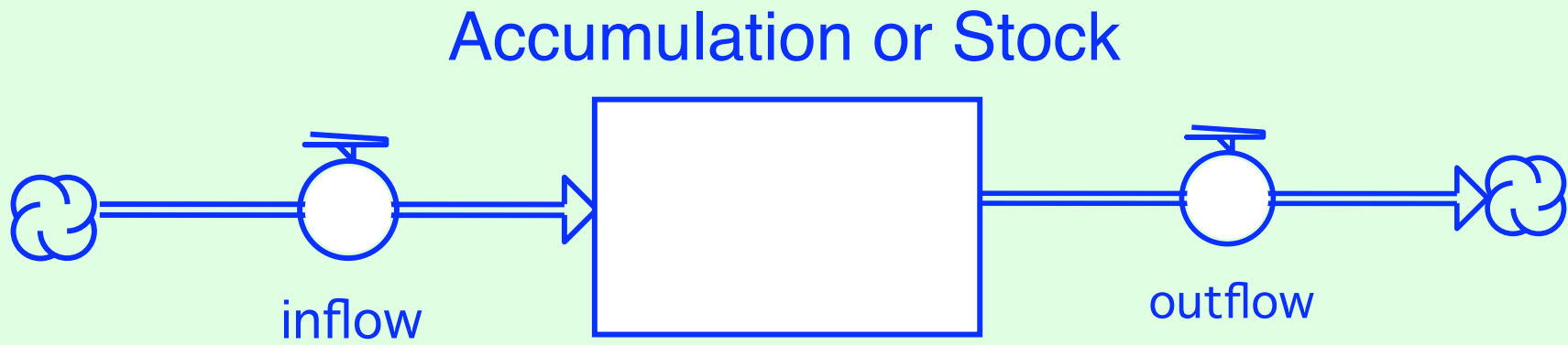


Introduction to Accumulations and Stock/Flow Representations



Accumulations are everywhere!

Level of happiness



Library of Congress Prints and Photographs Division, Photoprint by Donald Roberts, Detroit, MI, Public Domain

Water in a lake



FreeStockPhotos.com

FreestockPhoto.com

People in a city



NARA, Records of Public Health Service, Public Domain

Animals in a population



FreeStockPhotos.com

FreestockPhoto.com

Money in the bank



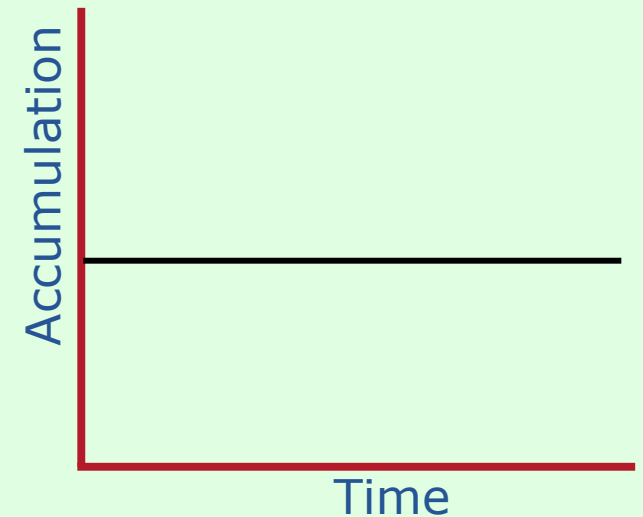
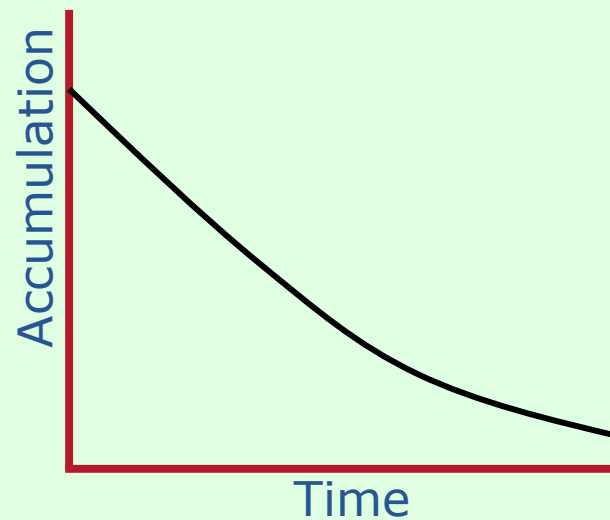
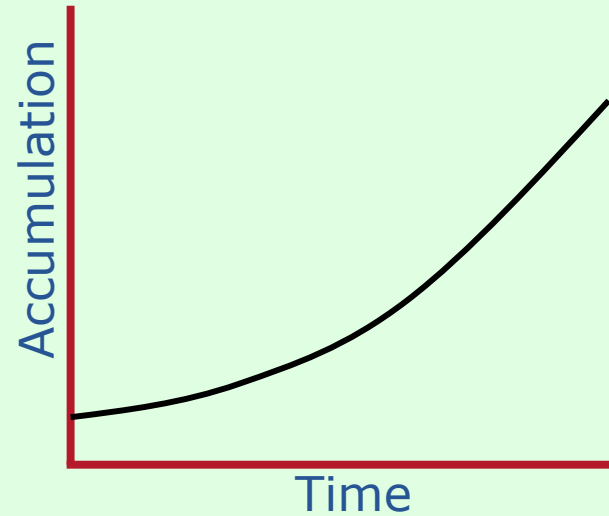
Wikimedia Commons, Public Domain

Accumulations
may grow,

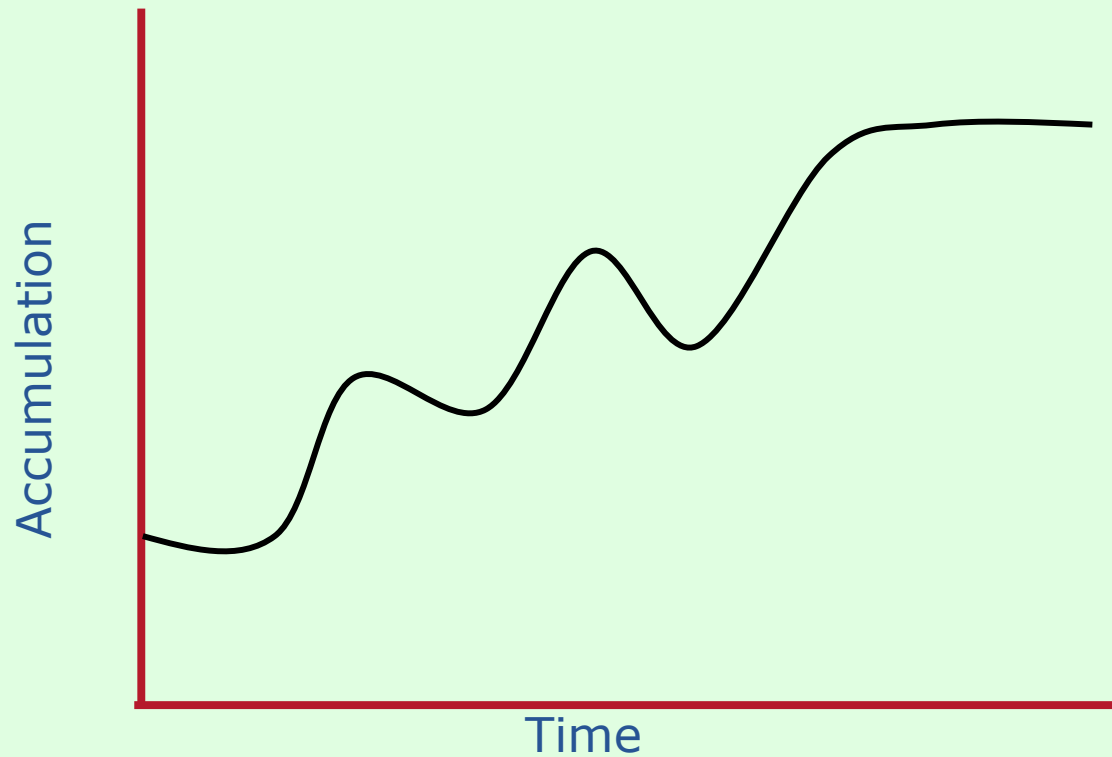
remain
stable,

decline,

...



...or exhibit a combination of these patterns.



Look at each of the pictures below and imagine them in motion. What accumulations can you identify?



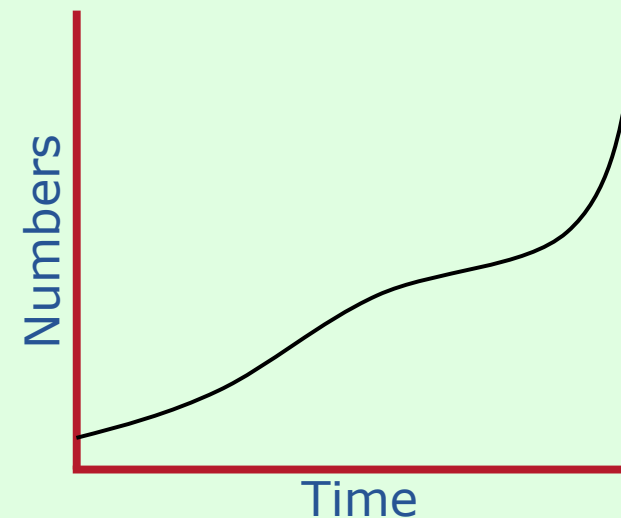
5	3			7	8			
6			1	9	5			8
	9	8		4		5	6	
8				6				3
4		6	8		3	7		1
7		3		2		8		6
	6					2	8	
	8		4	1	9			5
				8			7	9

Let's look at the accumulation of numbers on the Sudoku game over time.

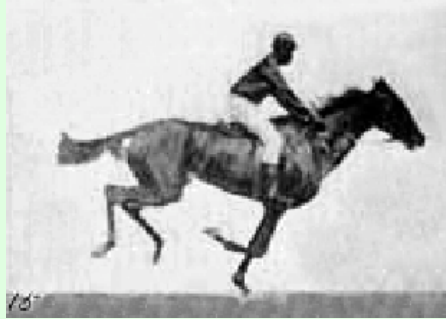
As long as someone continues to analyze the game board, more numbers can potentially be added.

The numbers may be added more or less quickly over time, depending on the difficulty of the puzzle and the skill of individual. Generally, as more numbers are filled in, the easier it may be to fill in the final spaces.

5	3			7	8			
6			1	9	5			8
	9	8		4		5	6	
8				6				3
4		6	8		3	7		1
7		3		2		8		6
	6					2	8	
	8		4	1	9			5
				8			7	9

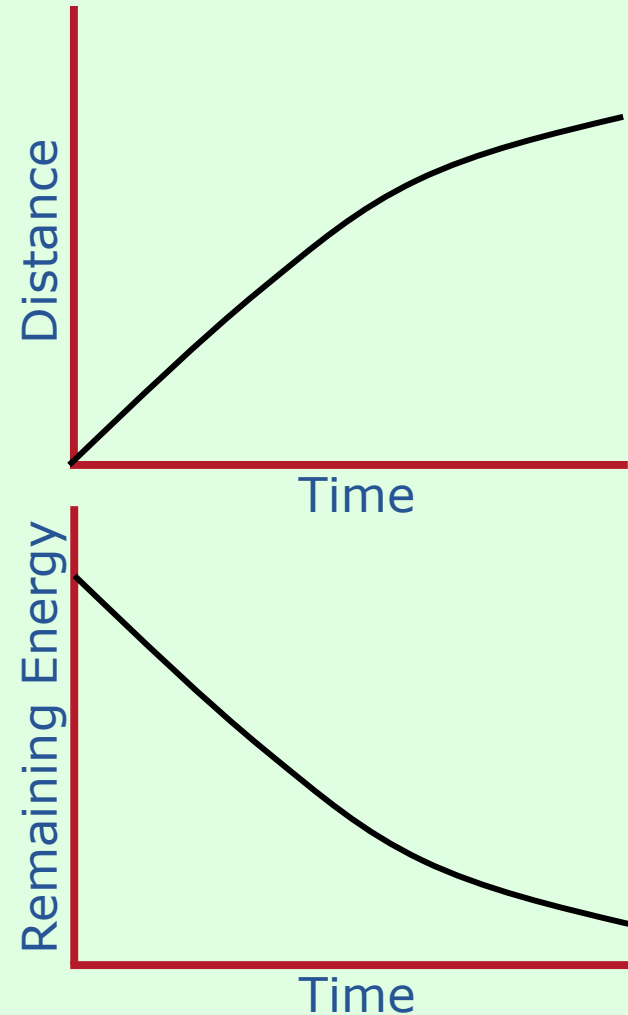


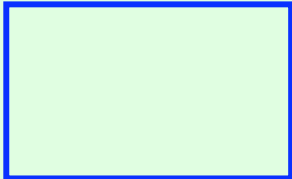
Let's look at the horse running over time.

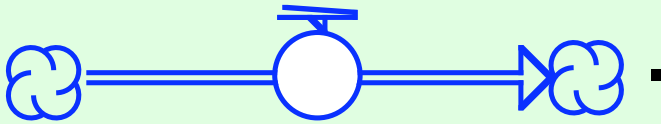


As the horse runs, the more distance is covered. Also, the more the horse runs, the less energy the horse would have. The graphs show both of these trends.

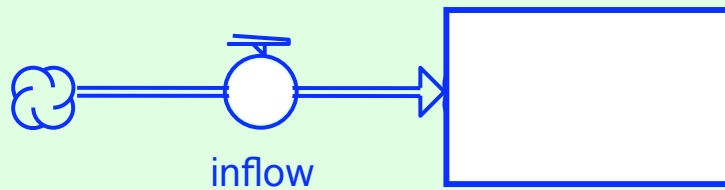
Notice that the distance is drawn as a curved line. The assumption is that as the horse tires, he would run more slowly.



An accumulation may also be called a stock and be represented as  .

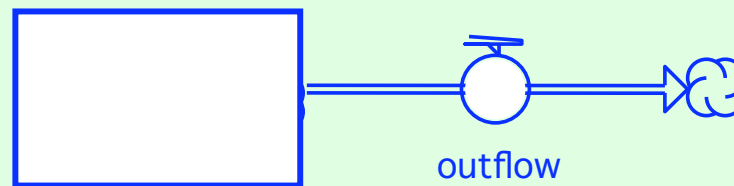
The rate at which the stock changes may be called a flow that can be represented as  .
flow

These parts connect to look like...



to show
how a stock
increases.

or



to show
how a stock
decreases.

or

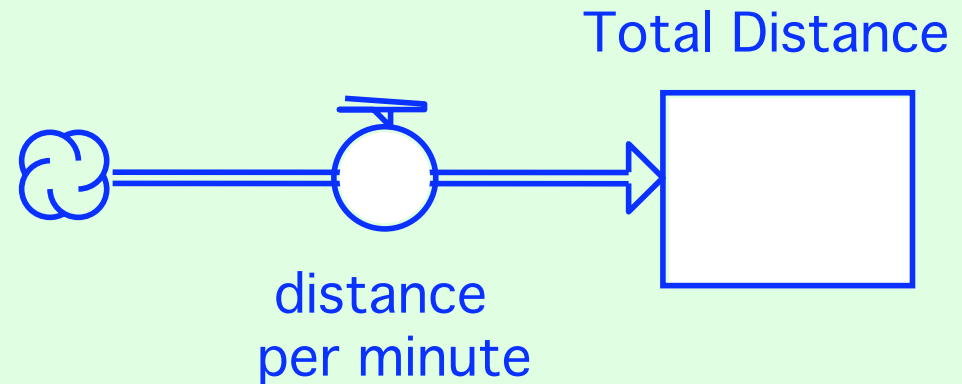


to show how a
stock
increases and
decreases.

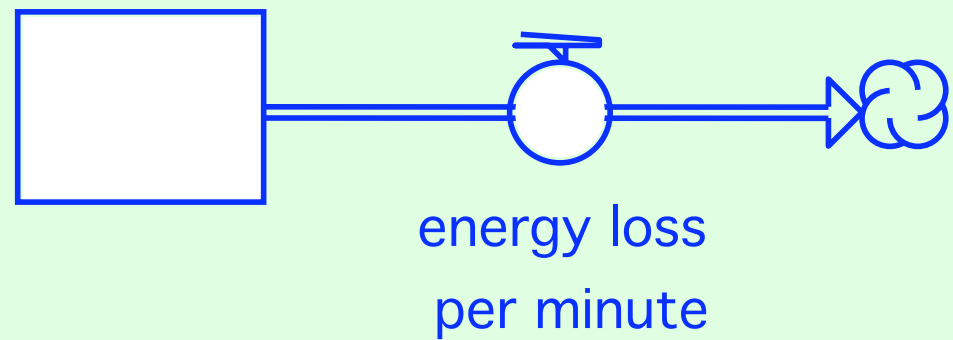
Let's consider the distance example.

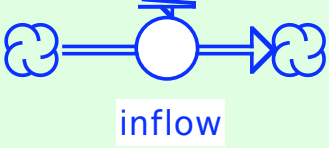
The stocks represent the total distance run and the level of energy left.

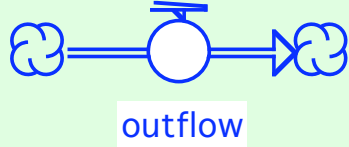
The flows show how the stocks either increase or decrease.



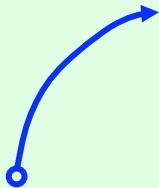
Energy Level



In addition, we can consider what might affect the rate(s) of  inflow

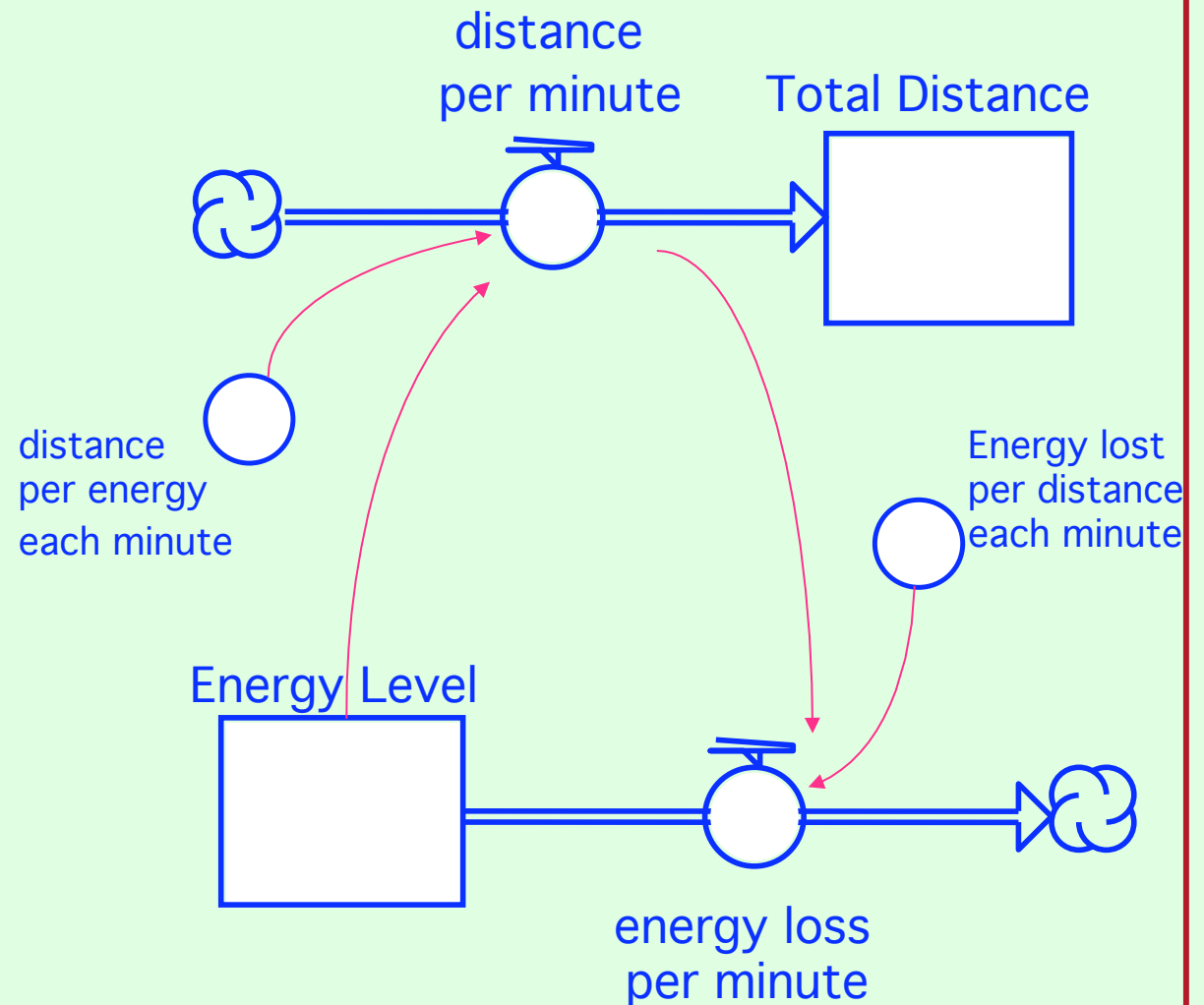
or  outflow by adding other parts

called converters  and

connectors  .

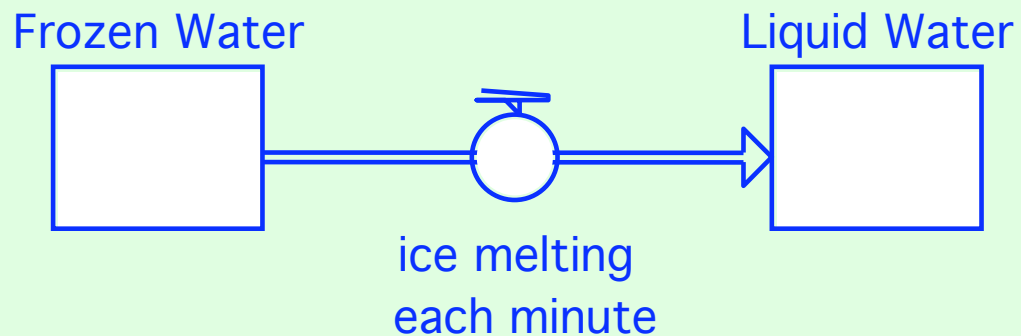
Let's return to the distance example.

We can add elements and show how they might affect one another. We can consider that it takes energy for the horse to run and that running decreases the horse's energy.



Here's another example. Remember the glass filled with ice?

In some situations, one accumulation can flow into another. With the glass, the water in the form of ice melts and forms liquid water.



Note that stocks can only flow into one another if they represent the same "material," in this case, water.

Additional Credits:

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Note that this presentation is intended as a basic introduction to representing accumulations with stock/flow diagrams. See the Waters Foundation website at

www.watersfoundation.org for more information.

Stock/Flow diagrams created with STELLA software, iSee Systems™, www.iseesystems.com

Additional Resources to consider when introducing accumulations and stock/flow language:

WebEd - Systems Thinking in Schools, Module 4-Stocks and Flows,

www.watersfoundation.org/webed/index.html

Schlumberger Simulations (SEED),

www.seed.slb.com/en/scictr/watch/climate_change/stock.htm