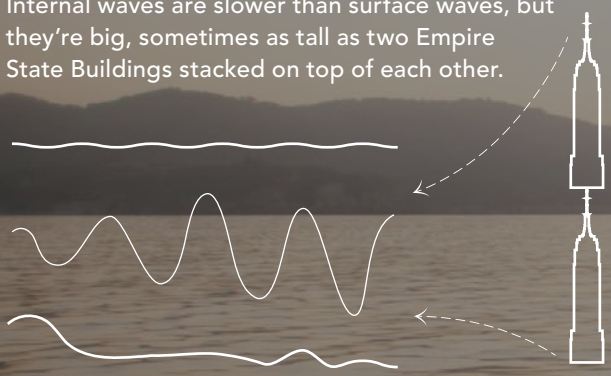
Algorithms and Wave Aqua-tions

You might have thought the bottom of the ocean was as calm as a pond, but actually, there are waves down there that we never see. They're called internal waves.

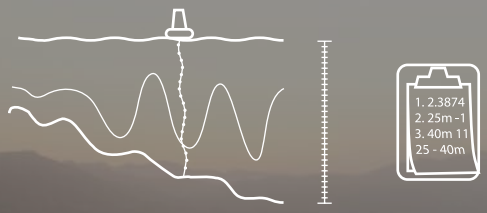
Internal waves are slower than surface waves, but they're big, sometimes as tall as two Empire State Buildings stacked on top of each other.



And we know much less about them than about the waves we can see.

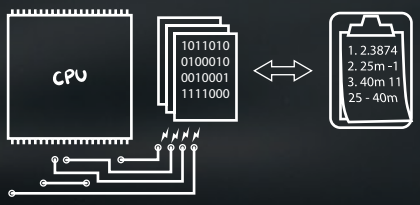
But they might affect our lives in important ways. Do the phytoplankton that produce half the world's oxygen depend on these waves to move nutrients from deep in the ocean up to the level where the phytoplankton live? How do internal waves affect ocean acidification and oxygen levels? Do they move wastewater discharges back to shore?

Physics Professor Ryan Walter wanted to find the answers to these questions. He collected a whole lot of data about the density and velocity of water in internal waves when they break near shore.

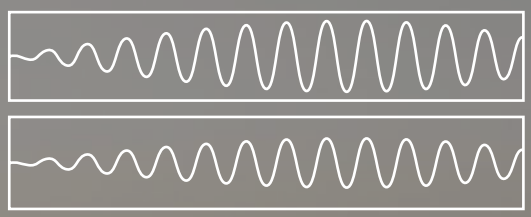


Then he met math professors Paul Choboter and Joyce Lin and graduate student Caleb Miller, who likes waves and was looking for a thesis project.

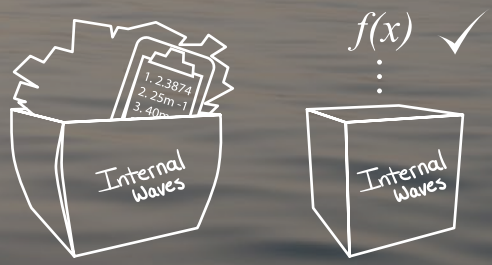
Together, they thought they could test out some computer models to see whether they could make a model that matched the data.



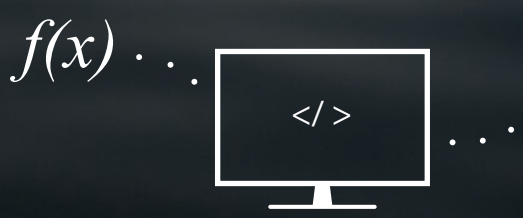
When Miller graphed the data, he found that the changes in the density of water and in its velocity along shore were related. So he chose these two variables to plug into the model.



But there were still a whole lot of data points, more than could fit in a model. Being a mathematics student, Miller thought, "Hey, if I can find a formula that describes the pattern of the data, I can plug that into the model instead."



He started with the Dubreil-Jacotin-Long (DJL) equation, which describes internal waves generally. He also found a computer program called the DJL Equation Solver.



Then he got to work modifying the equation solver to account for the actual data. He made it run calculations based on different times of day or different potential energy. Every time he needed to consider something new, his answer was, "I can write a computer script for that."

And it worked! Plugging the data into the models turned up some patterns. When the speed of the water changes, the wave narrows or gets broader. The water's density determines the shape of the wave.

These are just the first few steps toward answering those questions about the health of the ocean. The underwater adventure continues…

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