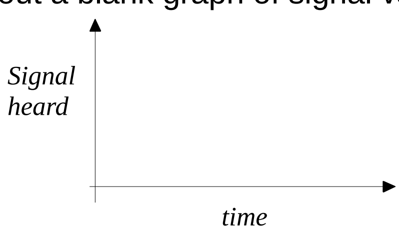
Fourier Transform Activity

- Construct graphs of data using the ***FourierTransform_ActivityGraph.ods*** file.
  - Each graph should have data that appears random but has data points at one or more regular time intervals.
  - Time axis from 0 s to 60 s
  - Each graph contains two signals at the periods indicated below, with noise included in the signal. These are created in the *FourierTransform_ActivityGraph.ods* file.
    1. (3, 7)
    2. (4, 7)
    3. (3, 8)
    4. (4, 9)
    5. (4, 6)
    6. (3, 5)
    7. (5, 9)
    8. (5, 7)
    9. (6, 9)
    10. (5, 8)

  50 s on time-axis = 7.50” → 1 s = 0.15”

- Intro
  - Hand out a blank graph of signal vs. time to each student.



  - Demonstrate gnuradio sound of single, clean periodic pulses at 1.0 s intervals. Ask students to sketch what they think the pulse would like like on the graph.
  - Have students discuss their graph with another student; then discuss as class:
    - Have a volunteer sketch their graph on the board
    - Why does your graph represent what you heard?
    - How is the *period* of a wave represented in your graph?
    - This is an example of a periodic signal.

        - Signals that are not noise usually have some sort of pattern that is repetitious - periodic.
        - Review the *period*, *amplitude*, and *frequency* of this signal, and how each is represented in a signal.
    - Then demonstrate gnuradio pulses with noise added. Ask students to sketch what they think the signal would look like in this case.
    - Students compare with a neighbor.
    - Then discuss as class:
        - What's different?
        - What's the same?
        - Noise is usually not periodic. Recall from yesterday: Signals carry information. When processing signals, it is necessary to distinguish the signal from the noise.
        - Recall Tad's presentation with the photo filtiering. This is filtering of amplitude.
        - Another method scientists use is filtering by frequency. Scientists have methods to filter signals by frequency (or period).
- Signal Processing Activity
    - Demonstrate process with the teacher graph
        - explain masks.
        - demonstrate sliding process to identify periods.
        - explain that a periodic signal must fill at each period translation.
        - explain how noise shows up – signals less than 1.0 (usually), and not periodic.
        - Explain offset.
    - Group students into pairs.
    - Handout signal sheets and masks. Explain that they are to determine the periods in each signal graph; then replot the data showing only those periodic signals, without noise.
    - Have students sketch the Signal vs. Frequency graph that corresponds to their
- Post Activity Discussion
    - What challenges are there determining the periodic signals in the total signal?
    - For the 3 s and 4 s signals, harmonics show up. How do you think we can distinguish whether the actual signal is the 3 s, 6 s, or 9 s?
    - Many siganls are a mixing of multiple frequencies – next activity with Howard.
    - Scavenger hunt clue.

- Motivation: Explain/remind students that waves are repetitious, e.g. water waves oscillate periodically. Information can be carried in the pattern, e.g. the morse code activity done previously.
- Show sample graphs:
  - Example showing sum of sinusoidal signals. What periodic waves are in this?
  - Example with periodic pulse signal in noise.
    - What repetitious (periodic) waves in this signal?
    - Demonstrate masking method for determining the periodic waves in this.
      - Lay the mask over the graph and slide the mask until each opening aligns with the data at one second intervals.
      - By sliding the mask to match up with the data at each one second interval the period of the signal can be determined.
- Pair students up. Hand out graphs and masks to each group.
  - Students are to use the mask method to determine the period of any waves in their graph.
  - Have each group sketch what the graph would look like if there were no noise.
  - Extension: On a signal vs. frequency graph, have each group plot signal vs. frequency.
- Scavenger hunt:
  - column (0 – 9) determined by amplitude of stronger signal
  - row (X – R) determined by frequency of weaker signal; use a table to convert frequency to a letter.