Using a theorectical example to illustrate the concept, imagine trying to output data out of a Serial object in MPIDE. You connect the TX (data output) pin to an opamp to boost the signal (your trying to transmit over a reasonable distance so you need a larger voltage than normal). We used Serial.begin(9600) in our sketch code, so we are transmitting at 9600 bytes/sec, i.e. a frequency of 9.6 kHrtz. At this frequency data transmission is fine, the voltage output of the opamp is what we expect. So now, we try increasing the data transmission rate

Without going into great detail, say you were to transmit a sine wave audio signal through an opamp circuit designed to just to pass the signal from input to output (basically doing no amplification). At low frequencies this circuit performs fine, and you hear the low hum of the sine wave (the signal input is the same strength as the signal output). As you increase the pitch of the wave (i.e. increasing frequency), you will start to notice that the output signal is diminishing (the signal sounds dimmer). Now if you were to increase the pitch drastically (still within the range of hearing), you would probably see the output cut out entirely. This is because to input frequency is exceeding the response of the opamp, and it is attenuating the signal.

While most opamps normally have no issues with audio frequencies (the cutoff is usally in the Megahertz, or Gigahertz range), increasing “open loop gain” extends the range of the component.

One key advantage of the output signal taking its voltage from the rails rather than the input signal is that it acts as way of isolating a circuit. You have probably seen that if you have two resistors in parallel, the equivalent resistance is much less than either resistor. If you were to add another resistor, it would again change the equivalent resistance value of the circuit (you would have three resistors in parallel as opposed to two). The point being, the more components you add to a circuit the more it changes the overall properties of the circuit, whether you want it to or not. Isolation allows you to create sub-circuits that are modular, and can be interconnected without affecting any other portion of the circuit.

“Open loop gain” is set incredibly high on purpose. This is done so because increasing gain increases the performance of the opamp, particularly the frequency range of the device (by something called the “gain bandwidth product”).

An explanation of frequency response could reasonably encompass its own tutorial, and starts to stray out of the scope of this tutorial. For simplicity sake frequency response can be thought of as how well a device responds to a signal at a given frequency. (Frequency is measured in hertz, were 1 Hrtz represents one repetition of the signal per second).

You might not be familiar with negative voltage sources, but they are simply a voltage source were the potential energy is lower than that of ground (thus causing the difference in potential energy, i.e. voltage, to be negative). Most of the time you can create a negative voltage source by simply reversing the connections on a standard voltage source (connect the positive terminal to ground, instead of the negative one).

Abstract Opamp Model: