

## → Head First DSP: Key-Maker Analogy for Convolution ←

You're a master craftsman in a busy workshop.

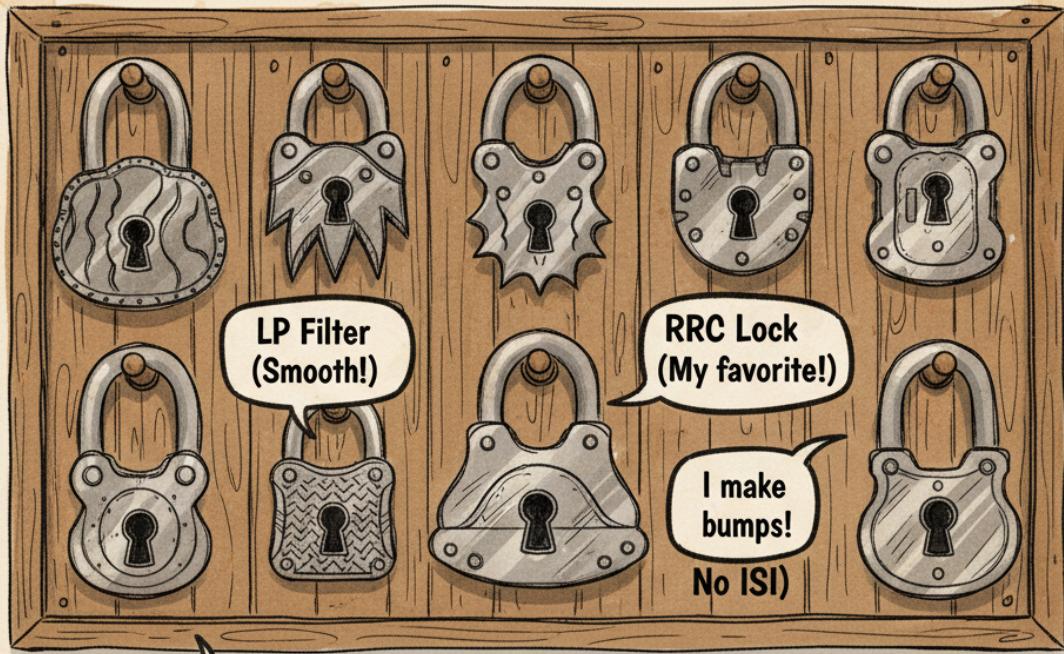
- On the table: little blobs of **raw clay** (these are your symbols:  $+1$ ,  $-1$ , or maybe even those  $N$ ,  $E$ ,  $S$ ,  $W$  points from before!).



- On the wall: a rack of intricate **locks of all kinds** (these are your filters: Low Pass, High Pass, Band Pass, or that trusty RRC from last time!).

# # Head First DSP: Key-Maker

## #4 Step 1: Know your lock



- Each filter = unique lock pattern. Lock pattern = filter coefficients.
- Example: RRC lock → smooth to prevent inter-symbol interference ISI.

You are the **Key Maker** (your secret identity: the convolution operator!). Your mission? Take those raw clay symbols and craft them into a final, perfectly shaped waveform that can travel over the air without a hitch. No guesswork, no surprises!

### Step 1: Know your lock

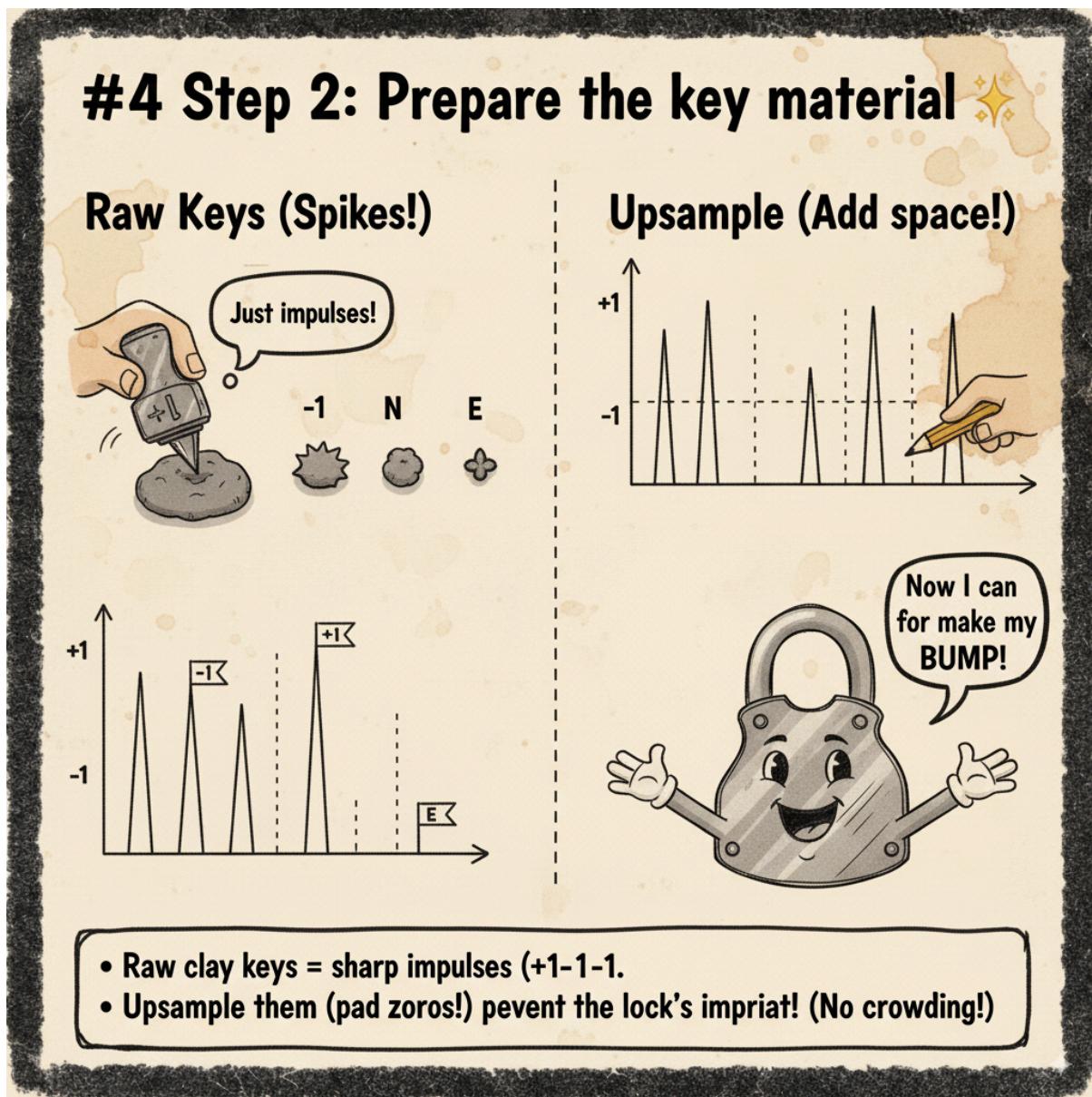
Before you do anything, you need to pick your lock!

- Each filter is like a unique, intricate **lock pattern**.
- This "lock pattern" is defined by its **filter coefficients**. Think of them as the tiny grooves and ridges inside the lock.
- **Example:** If you pick the **RRC lock**, you know it's going to produce that super-smooth "hill" pattern, specifically designed to prevent inter-symbol interference (ISI). My favorite!

## Step 2: Prepare the key material ✨

You can't just shove a lump of clay into a lock. You need to prepare your raw keys!

- Your raw clay keys are like sharp, momentary **impulses** (+1, -1, etc.).
- You **upsample them** (fancy talk for "add some space in between by padding zeros"). This gives you room to press the lock's pattern onto the timeline without the clay keys smashing into each other too early.



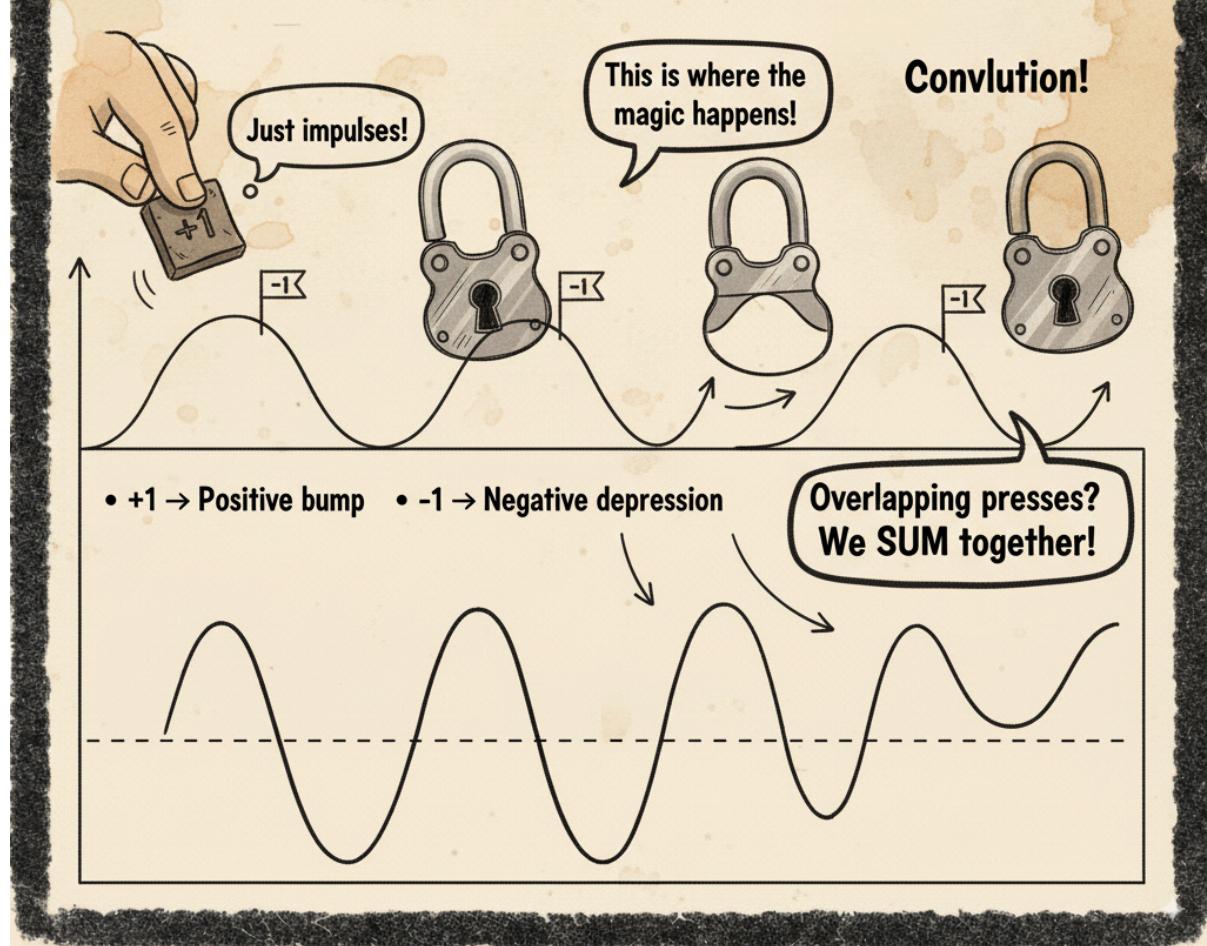
## Step 3: Press key into lock! ↪

This is where the magic happens! The core operation here is **convolution**.

- Imagine taking each prepared clay spike and **pressing it firmly into the chosen lock's pattern** along your timeline.

## #4 Head First DSP: Key-Maker

### ##8 Step 3: Press key into lock!



- A **+1** symbol? It presses out a positive bump!
  - A **-1** symbol? It presses out a negative depression (an inverted bump)!
- What happens if the "presses" from different symbols overlap? No problem! The system just **sums them together** to create the final, combined shape.

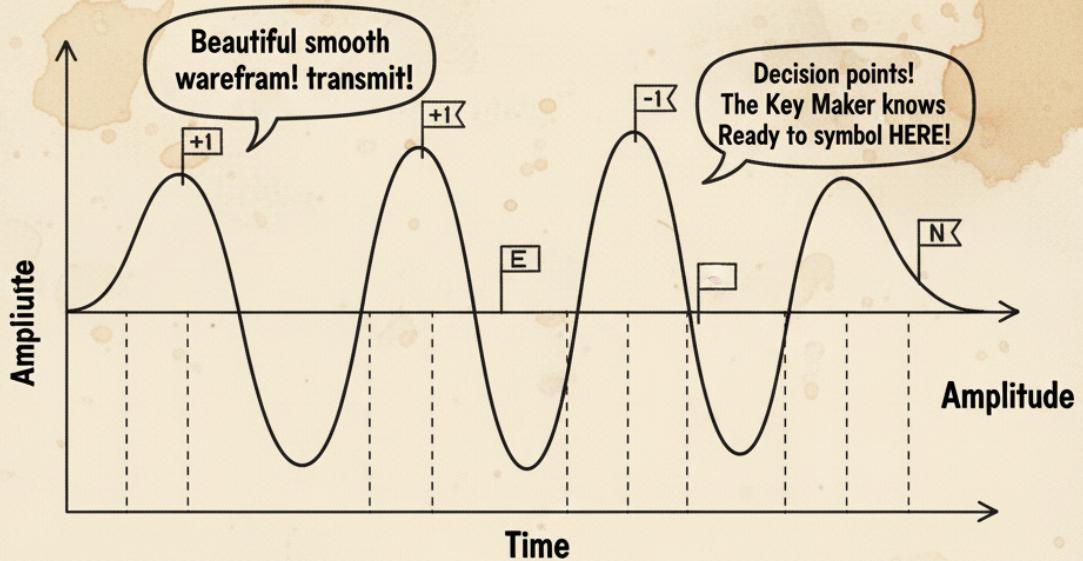
### Step 4: Inspect your final key ☺

After all your clay spikes have been pressed into the lock, what do you have?

- A beautiful, **smooth waveform** emerges! No more sharp spikes.
- This is your brand-new, perfectly shaped signal, ready to transmit!
- The "**decision points**" on this waveform are exactly where the Key Maker knows which symbol each bump *really* corresponds to. Like those RRC hill peaks!

# #4 Head First DSP: Key-Maker

## #8 Step 4: Inspect your final key ☺☺



- Smooth warefram emerges!
- Ready to transsist = where is that truth of the symbol!
- No more spikes, just gentle hills!



## Step 5: Optional - Try a new lock! 🔒

Want to see something cool?

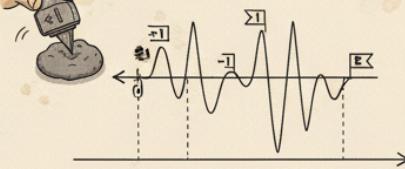
- Grab the **same raw clay keys**, but pick a different lock (e.g., an HP filter, or a simple LP filter).
- Press them in again, and BAM! You'll get a completely **different shaped waveform**.
- Same raw data, different filter = entirely different signal! How neat is that?

## #4 Head First DSP: Try a New Lock!

Same Raw Keys...



Our same data!



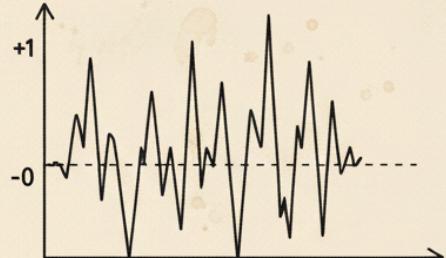
RRC Filter

Smooth! No ISI

...Different Lock!



Spiky! ZIG-ZAGS!



HP Filter

! Spiky! Lots of ISI

**K Takvulation** > "pressing your rour raw key (symbol) into the known locks to get the final shaped key (filter) for ikaped for warforam) for clean transnision." Change the signal!

Big picture takeaway> Convolution = "pressing your raw key (symbols) into the known lock (filter) to get a final shaped key (waveform) for clean transmission." It's how you turn abstract data into a tangible, transmittable signal!