Pulse compression and a simple sonar with R

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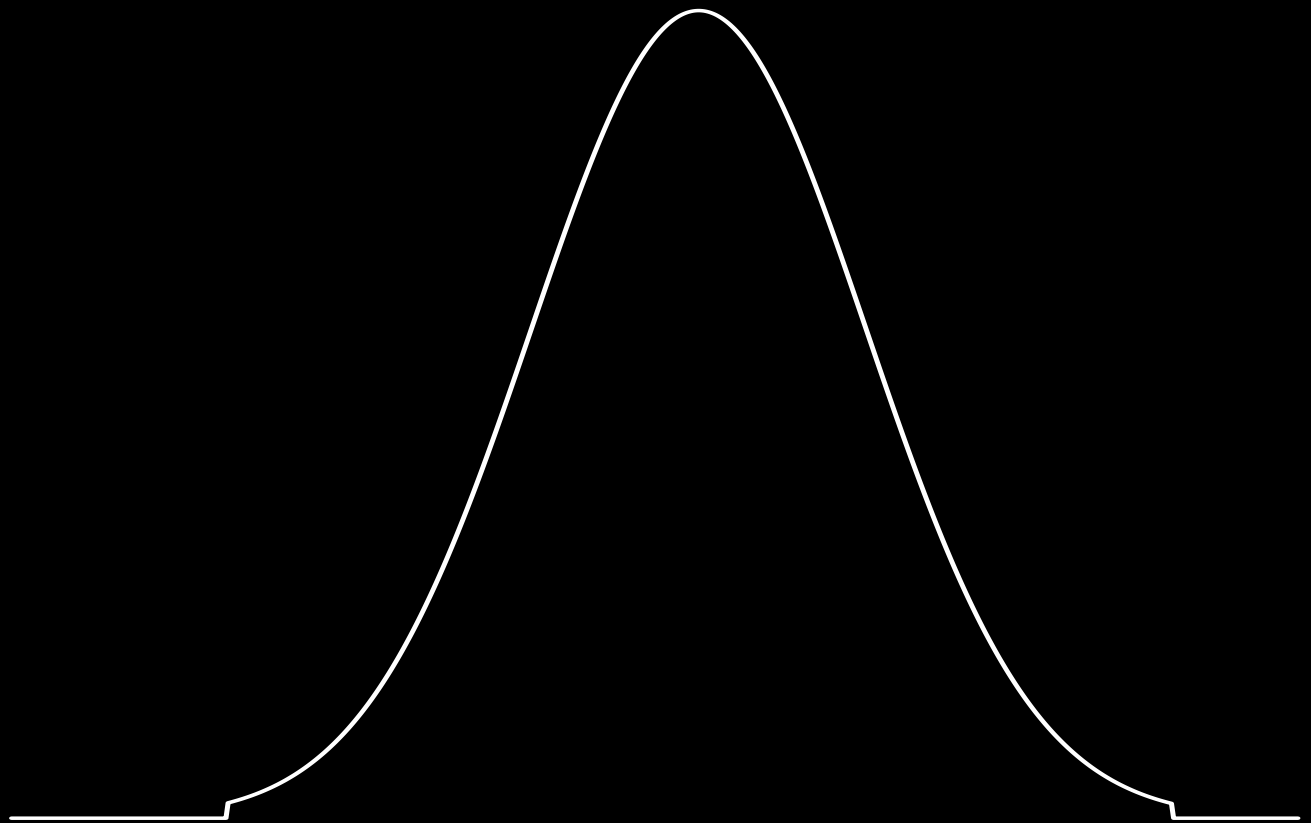
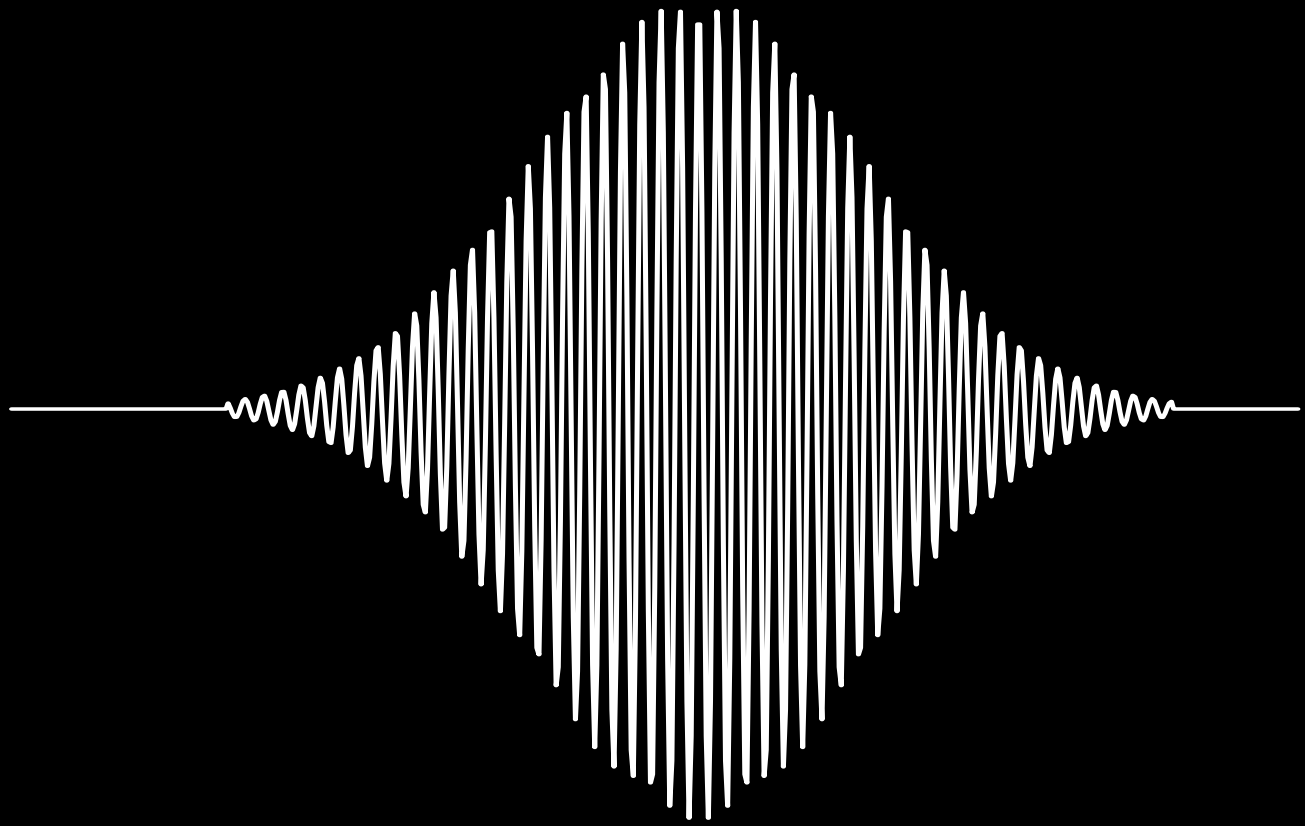
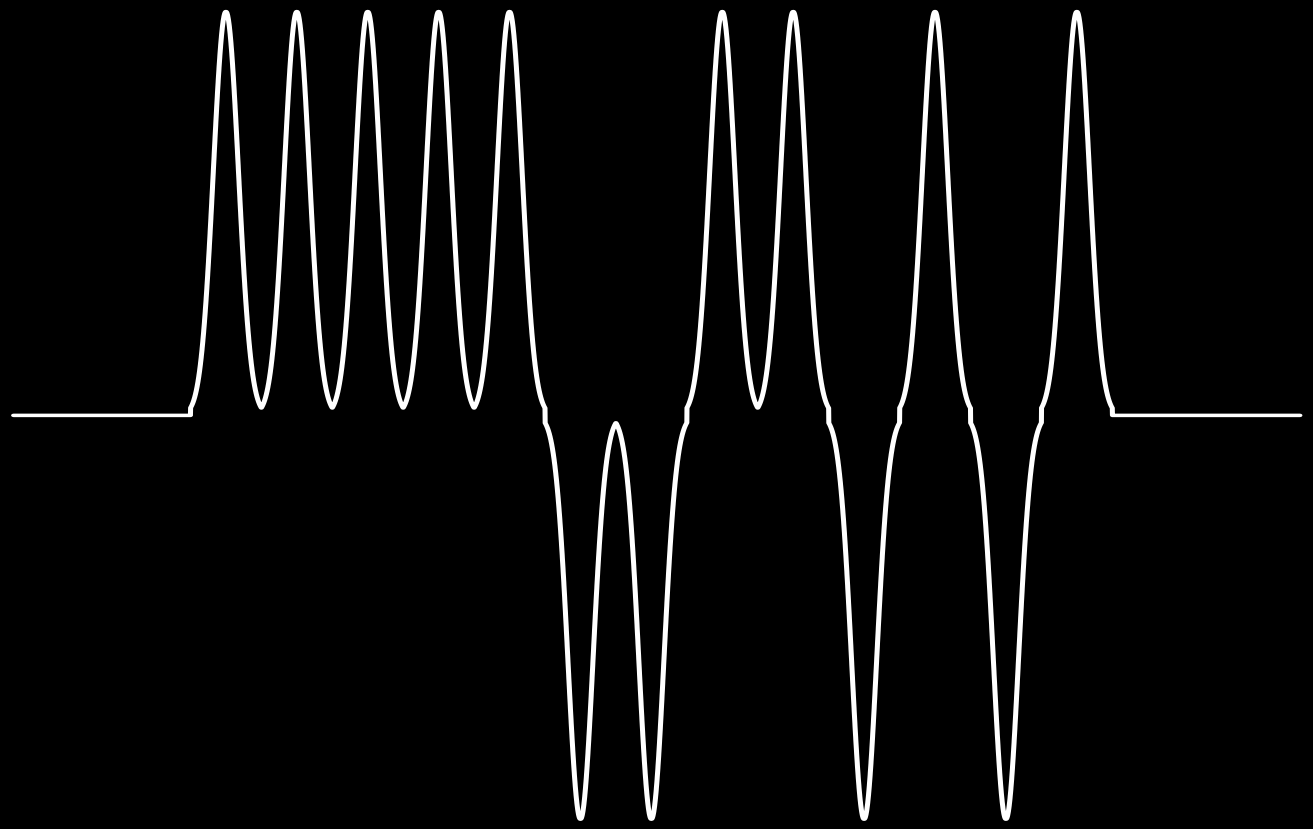
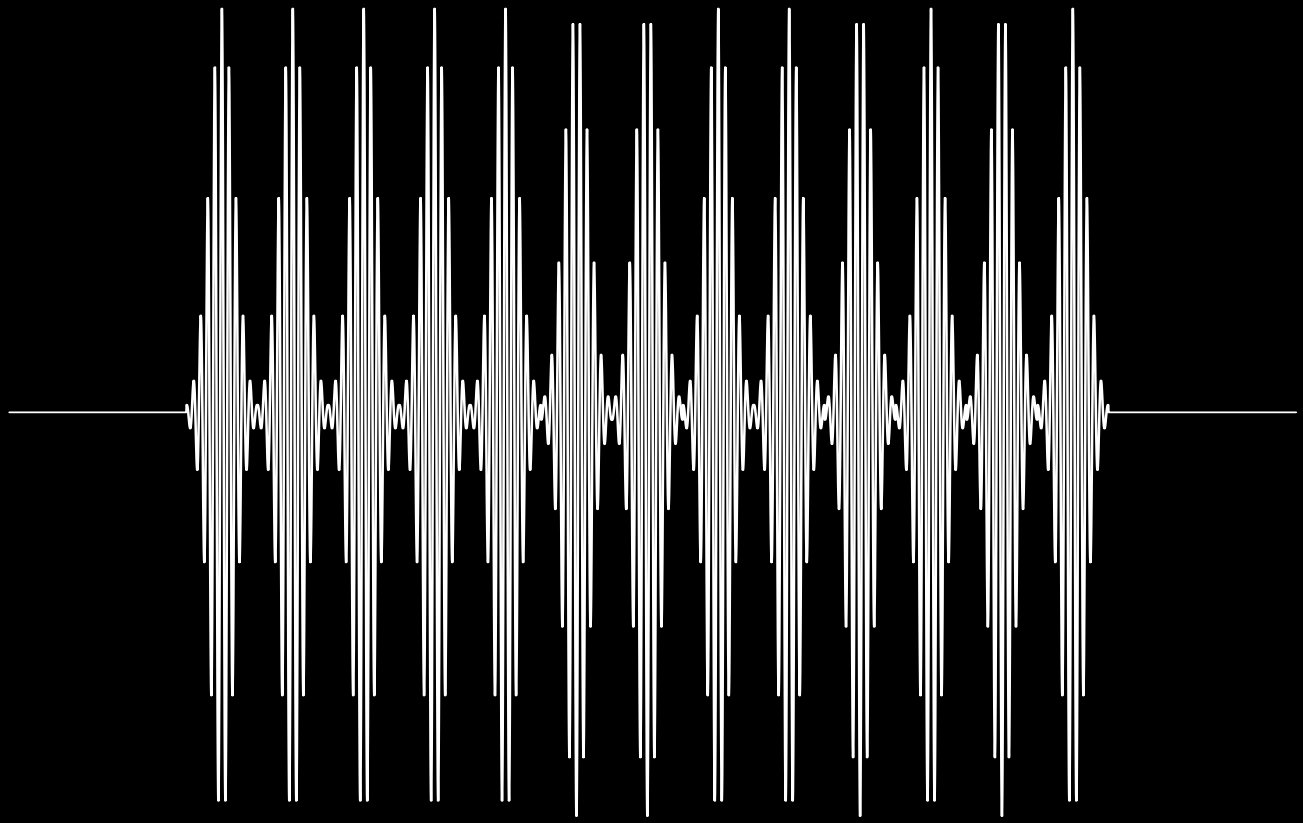
Simple pulses





Barker codes





Matched filtering

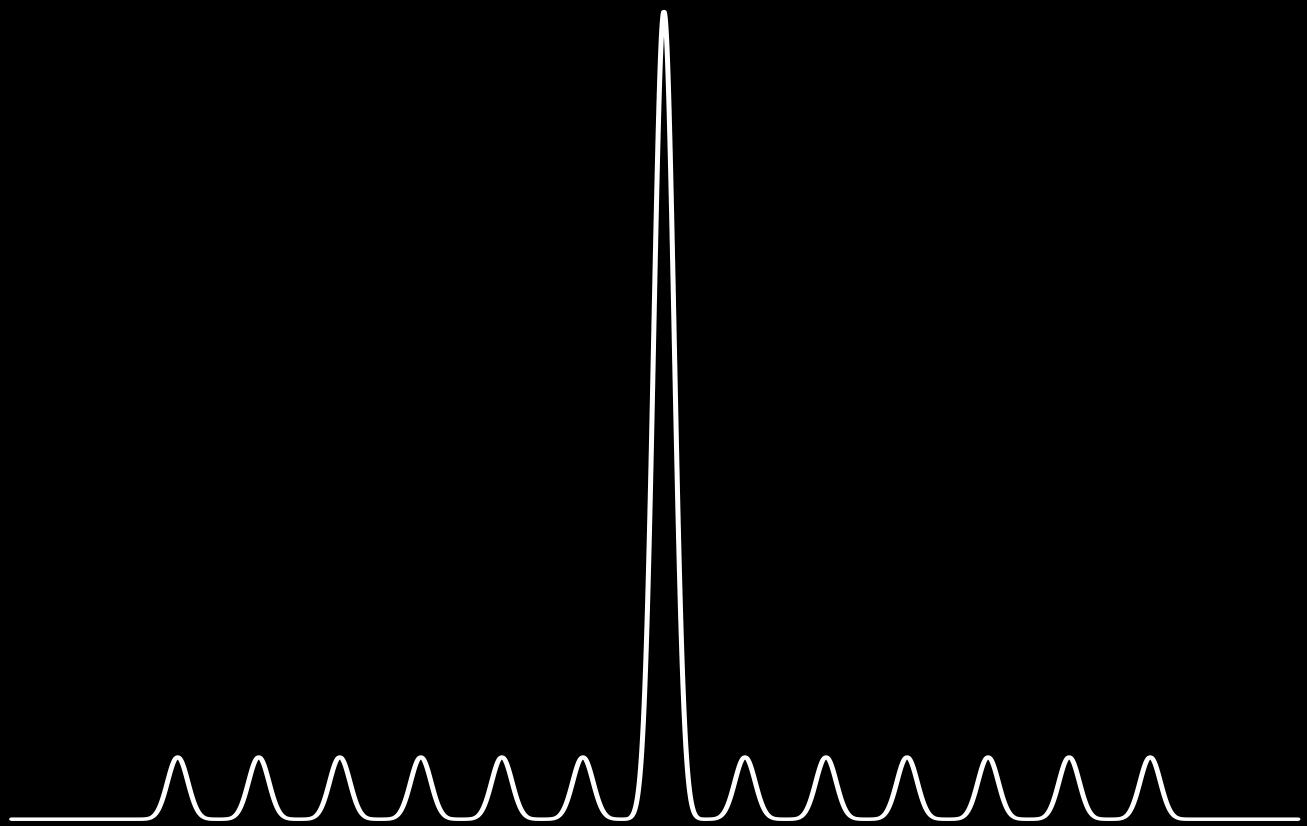
- Transmission envelope $\mathrm{env}(t)$
- Received signal $z(t)$
- Decoding filter is the transmission envelope in reversed order

$$p_d(t) = \mathrm{env}(-t)$$

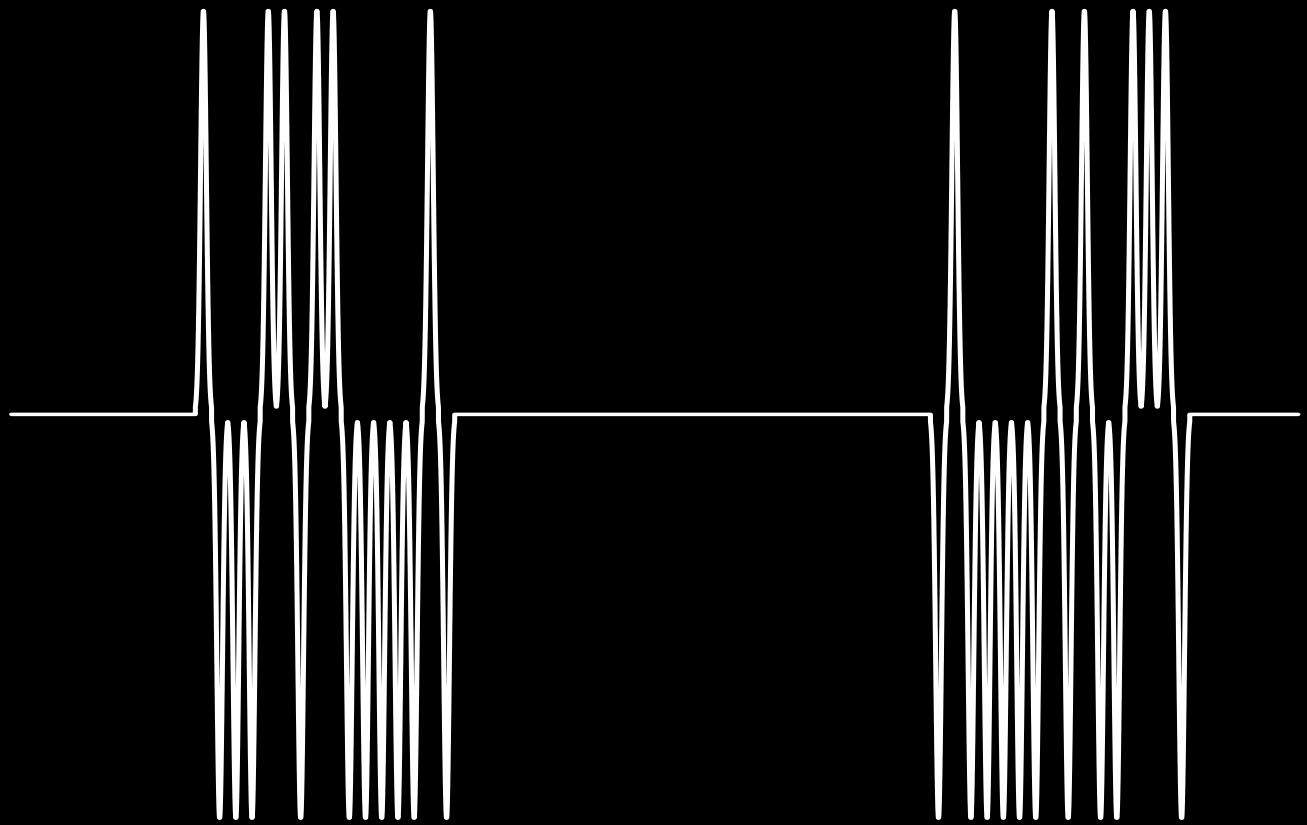
- Decoded signal is the convolution

$$z_d(t) = \int z(\tau) p_d(t - \tau) d\tau$$

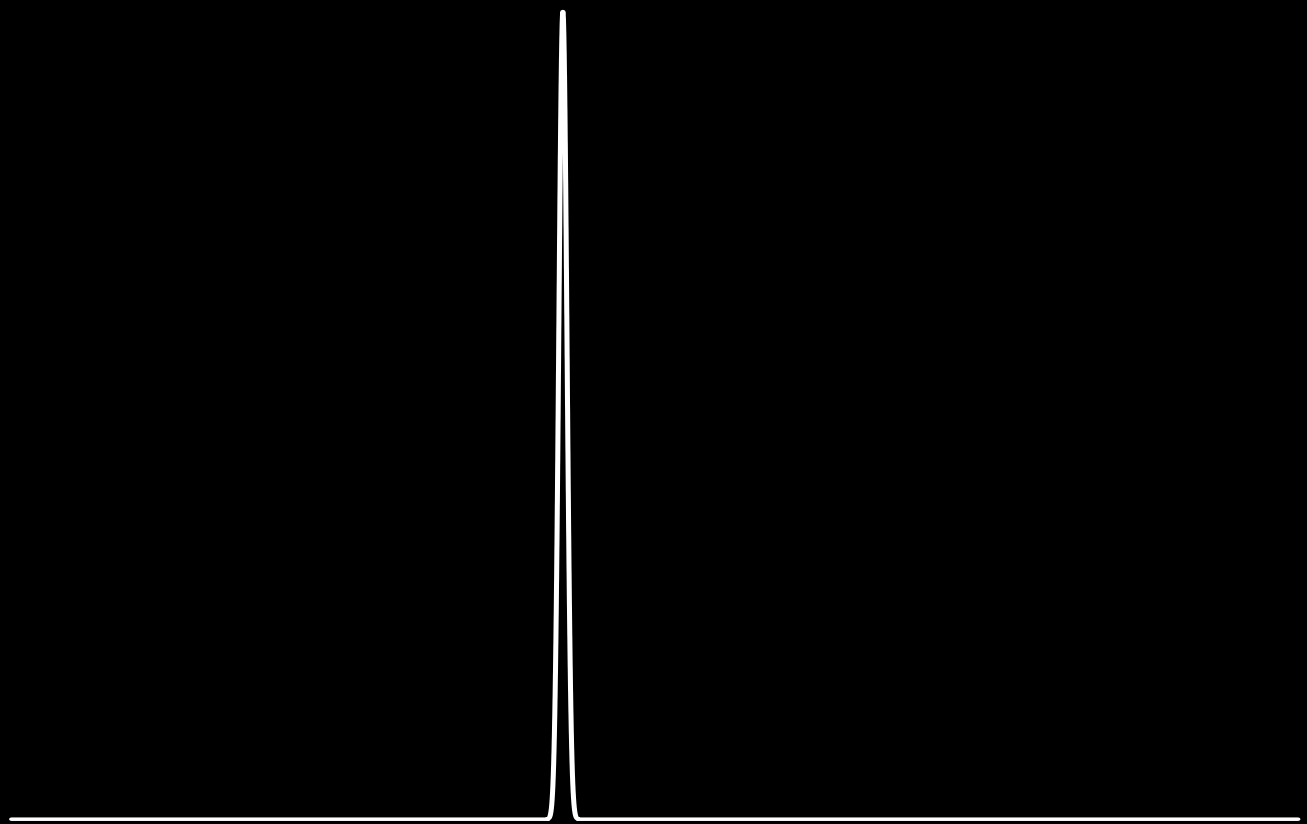
Barker code after matched filtering



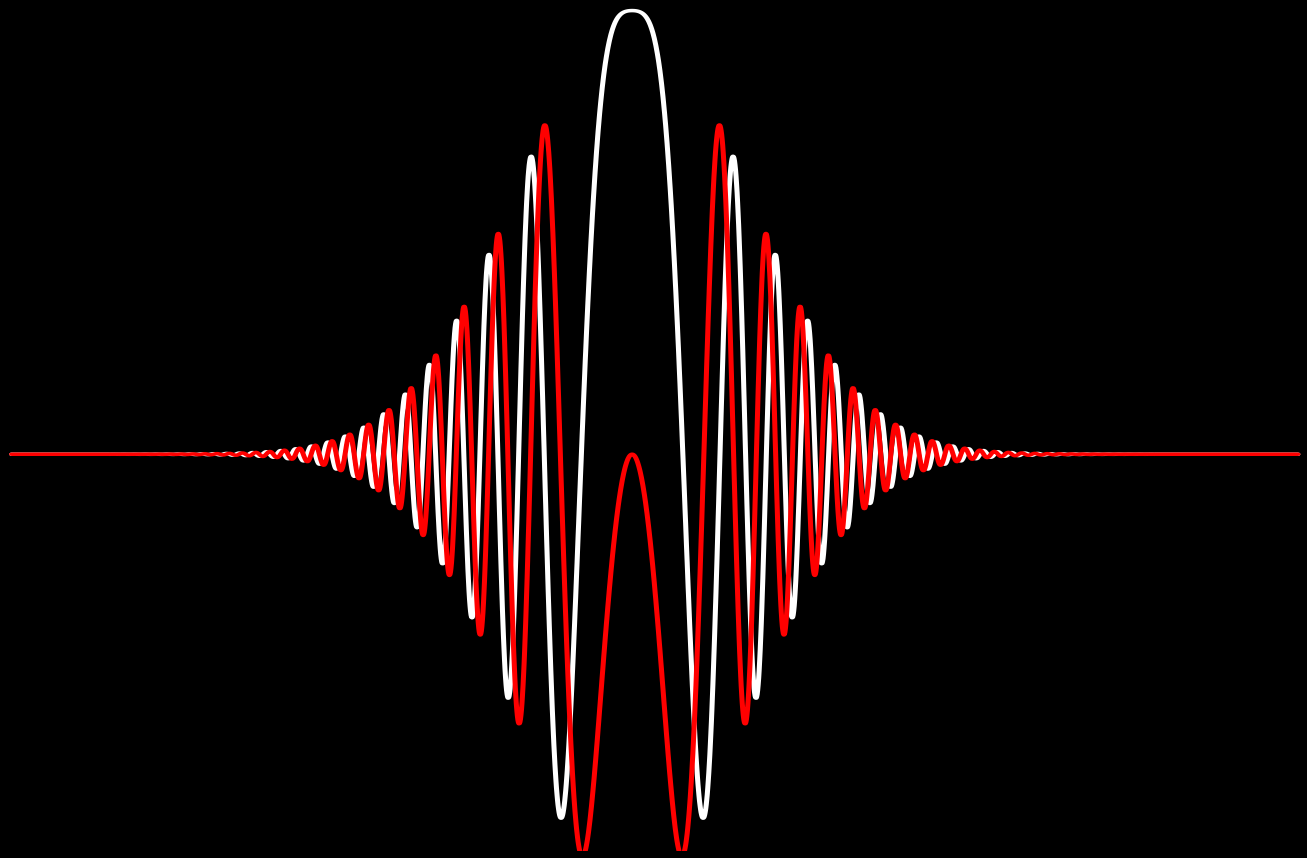
Complementary code pair



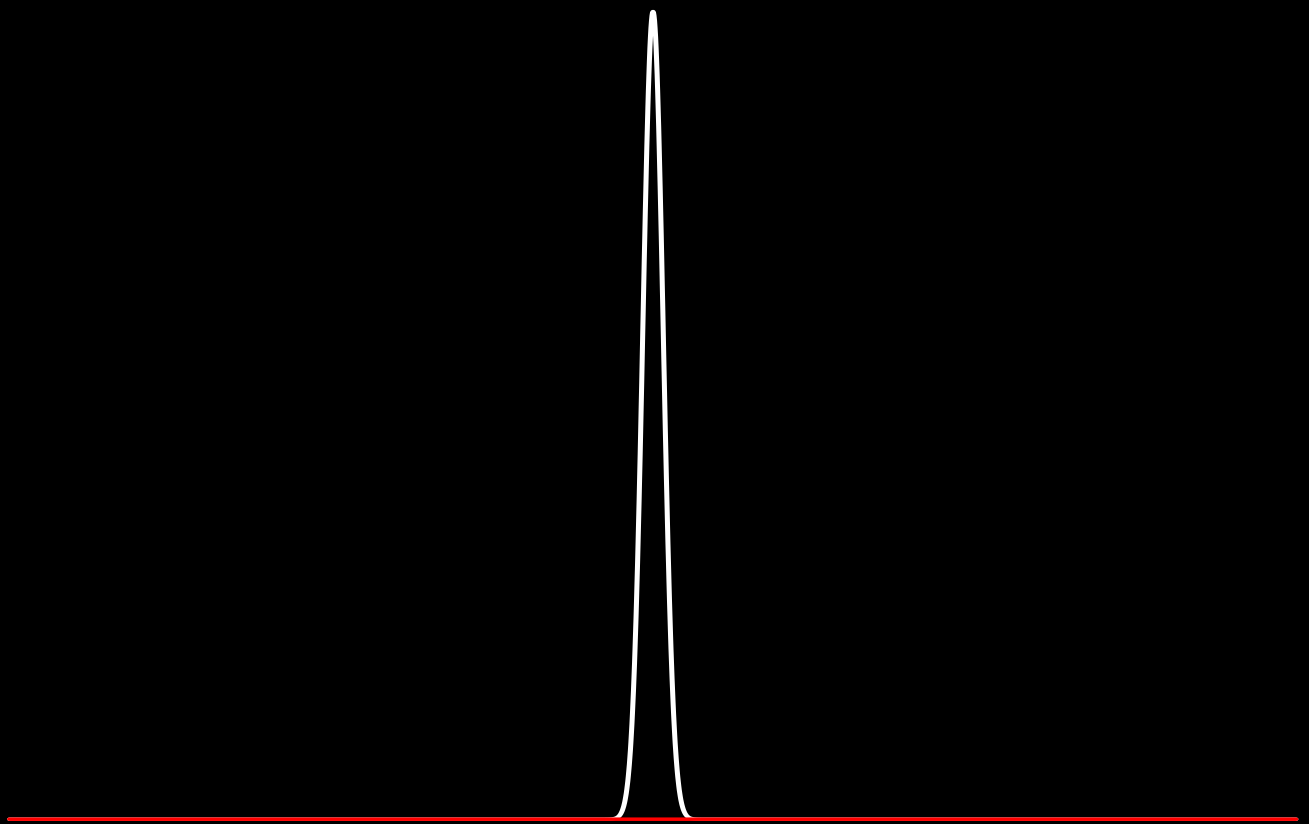
Complementary code pair after matched filtering



Chirped waveform



Chirp after matched filtering



Inverse filtering

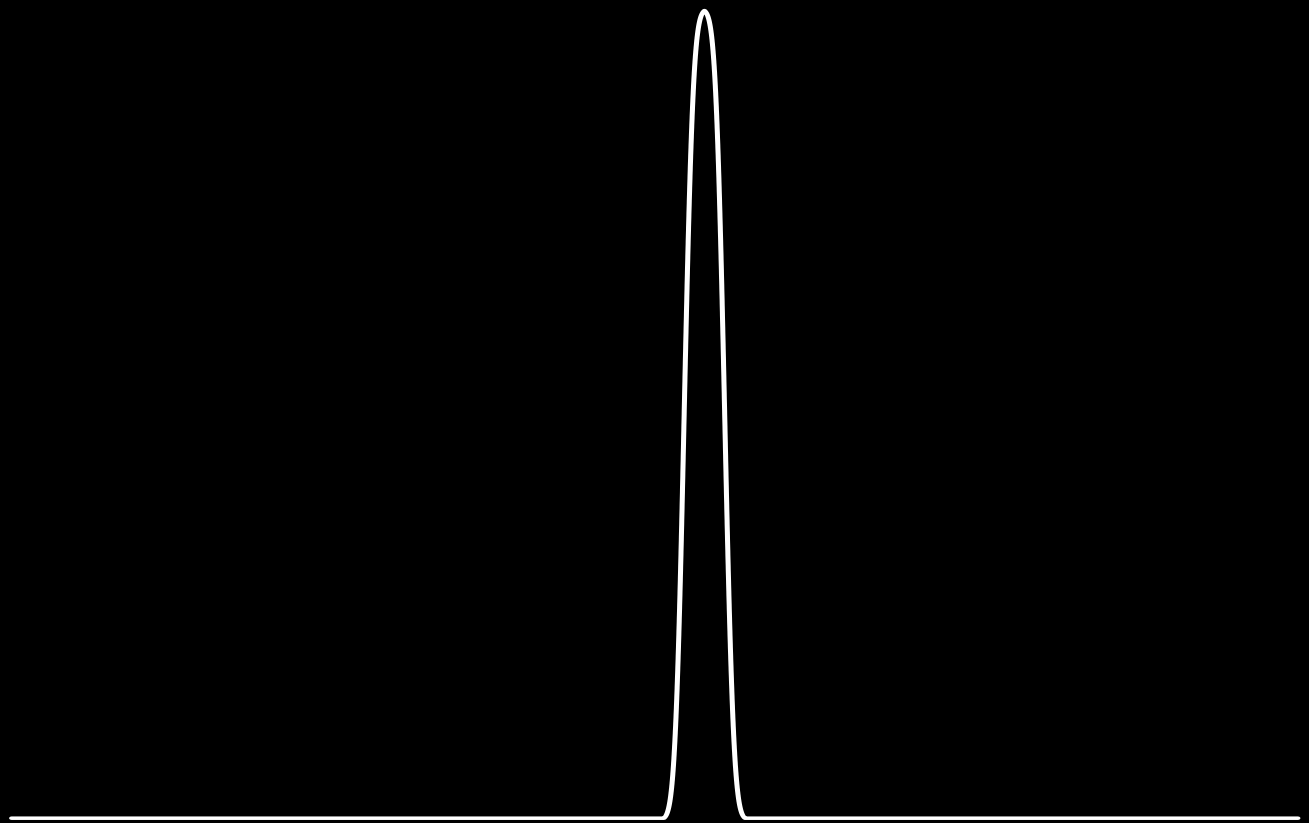
- Transmission envelope $\mathrm{env}(t)$
- Received signal $z(t)$
- Decoding filter is

$$p_d(t) = \mathcal{F}^{-1}\left\{\frac{1}{\mathcal{F}\left\{\mathrm{env}(t)\right\}}\right\}$$

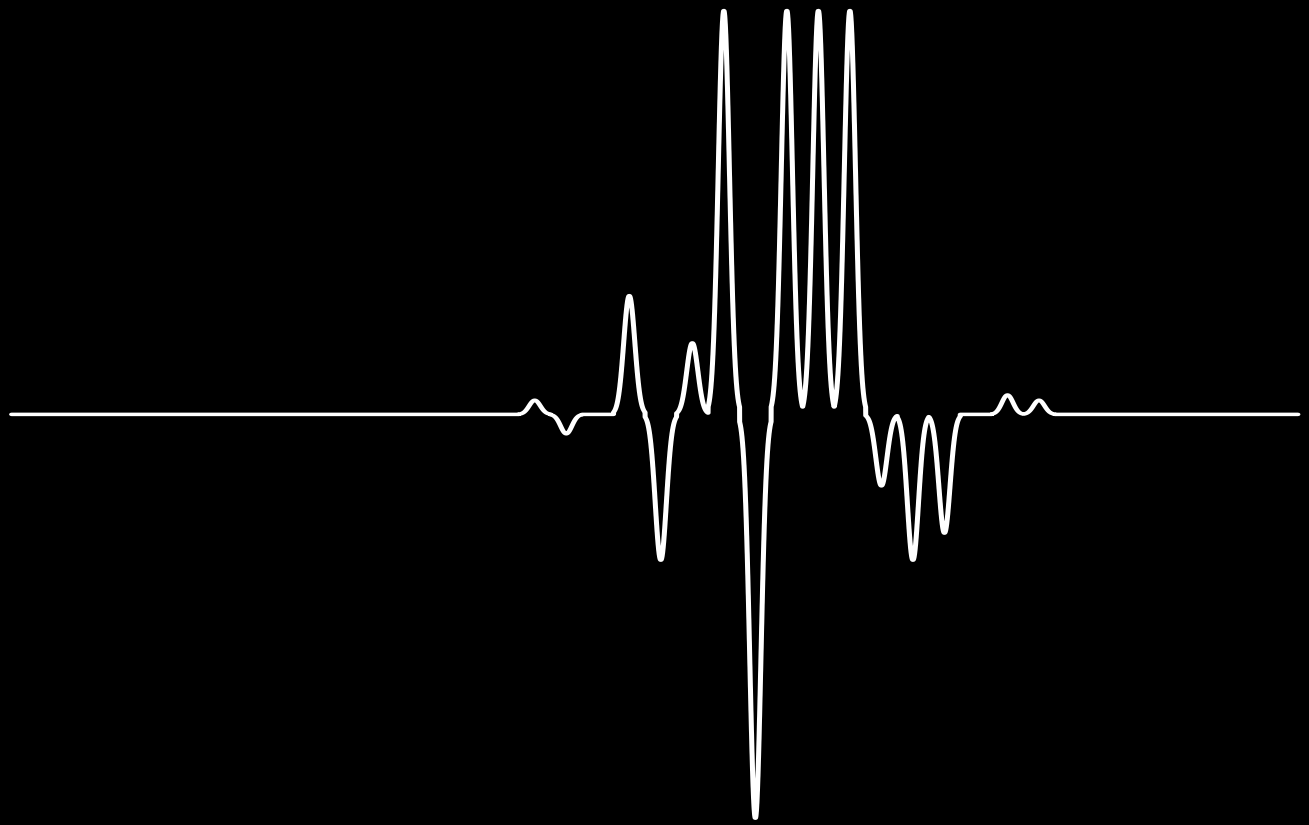
- Decoded signal is the convolution

$$z_d(t) = \int z(\tau) p_d(t-\tau) d\tau$$

Barker code after inverse filtering



A perfect code



A perfect code after matched filtering