Music

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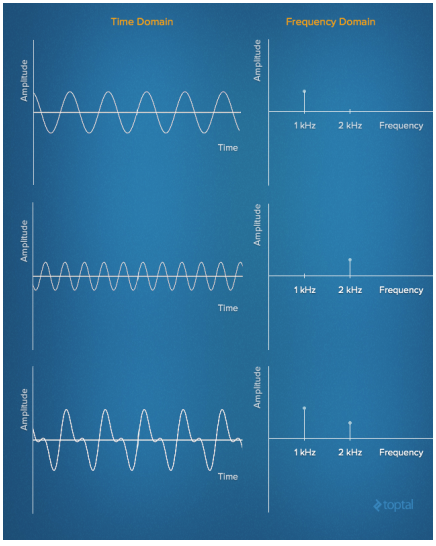

http://www.toptal.com/algorithms/shazam-it-music-processing-fingerprinting-and-recognition

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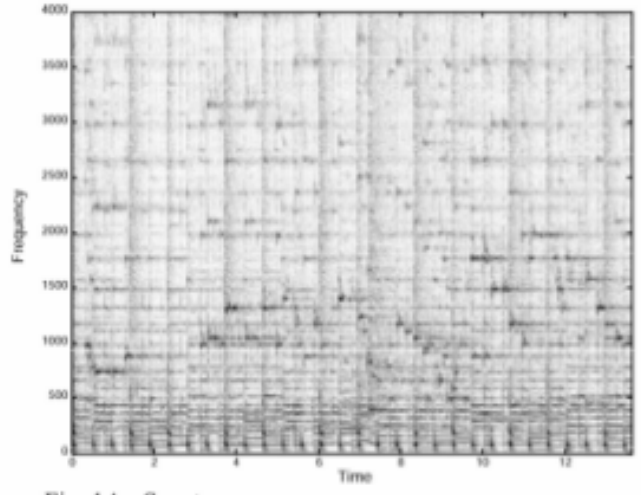

Fig. 1A - Spectrogram

https://www.ee.columbia.edu/~dpwe/papers/Wang03-shazam.pdf

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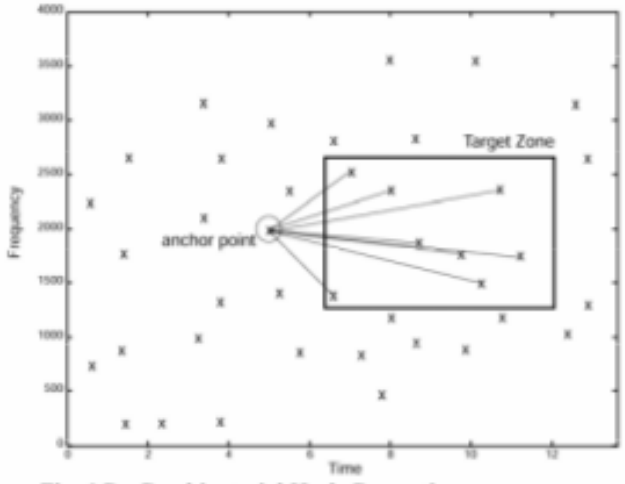

Fig. 1C - Combinatorial Hash Generation

https://www.ee.columbia.edu/~dpwe/papers/Wang03-shazam.pdf

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Time Series

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Introduction to time series

This is hard, but it depends on your goals. And on context.

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Introduction to time series

Definition (discrete time series):

$$\{s_t \mid t \in \mathbb{R}^+ \wedge s \in \mathbb{R}\}$$

(though s in any vector space is fine)

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Introduction to time series

Examples domains:

- Weather
- Economics
- Industry (e.g., factories)
- Medicine
- Web
- Biological processes

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Introduction to time series

Why?

- Predict
- Control
- Understand
- Describe

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Some strategies:

- Differencing:
$$y'_t = y_t - y_{t-1}$$
- Second-order differencing:
$$y''_t = (y_t - y_{t-1}) - (y_{t-1} - y_{t-2}) = y_t - 2y_{t-1} + y_{t-2}$$

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Some strategies:

- Clustering
- Hidden Markov Models (HMM)
- Recurrent neural networks (RNN)
- Autoregressive integrated moving average (ARIMA)
  - Generalisation of autoregressive moving average (ARMA) model
  - Regress on series' own lag

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One model:

$$s_t = g(t) + \phi_t$$

where

- $g(t)$ is deterministic: signal (or trend)
- ϕ_t is stochastic noise

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Variation types:

- Trend (g)
- Seasonal effect (g)
- Irregular fluctuation (residuals: ϕ)

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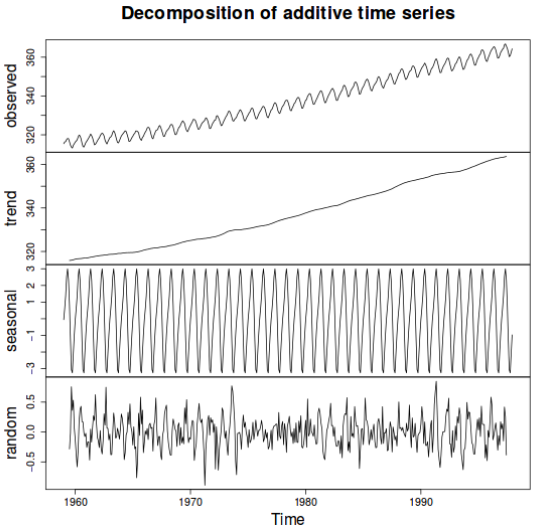

http://www.ulb.ac.be/di/map/gbonte/ftp/time_ser.pdf

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Some easy things to try

- Introduce features to break out seasonality
- Introduce lags as features
- Some domain-specific transformation

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Neural Networks

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