Signal Processing

**Continuous functions**

**What：**

连续变量函数

**Why:**

拍照，录音，CT等领域

**How:**

**如何用计算机表示连续函数**

采样与重建

**Aliasing**

**What:**

混叠：对模拟信号进行抽样，当抽样频率小于信号最大频率2倍时，不满足奈奎斯特采样定律，信号在频域会产生混叠效应。

**Why:**

高频信号会被误采样为低频信号。

**How:**

提高采样频率。

**Filter**

**What:**

**Why:**

**How:**

**过滤器在采样和重构时候的作用分别是什么？**

采样：采样过疏情况下，使高频率信号平滑。

重构：DAC产生的电压在新样本进入时发生变化，但在下一个样本进入前保持不变，从而产生阶梯状图形。过滤器使阶梯状图形过滤平滑。

**Artifacts**

**What:**

在图形学里，artifacts泛指一些不准确或者与我们预期不一样的结果。

**Why:**

A concrete example of the kind of artifacts that can arise from too-low sample frequencies.

**How:**

To avoid these **undersampling artifacts** the digital audio recorder filters the input to the ADC to remove high frequencies that can cause problems.

To remove this **reconstruction artifact**, the digital audio player filters the output from the DAC to smooth out the waveform.

The basic issues of sampling and reconstruction can be understood simplybased on features being too small or too large, but some more quantitative questions are harder to answer:

• What sample rate is high enough to ensure good results?

• What kinds of filters are appropriate for sampling and reconstruction?

• What degree of smoothing is required to avoid aliasing?

**Convolution**

**What:**

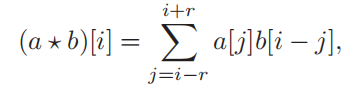
卷积是通过两个函数f和g 生成第三个函数的一种数学算子，表征函数f与g经过翻转和平移的重叠部分函数值乘积对重叠长度的积分。

**Why:**

用于采样，滤波和重建。

**How:**

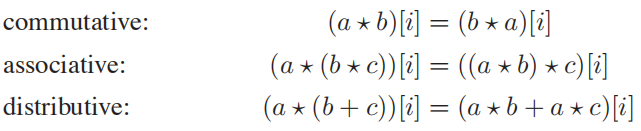
**Discrete Convolution**：



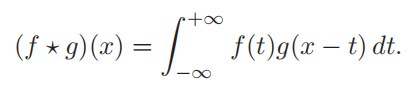
An identity for discrete convolution：

d[i] = ..., 0, 0, 1, 0, 0,...

**Properties of Convolution**



Convolution with Continuous Functions



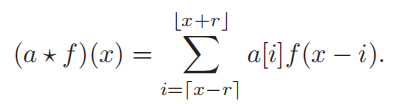
Discrete-Continuous Convolution

有两种方法将离散和连续的函数联系起来。

1. 采样

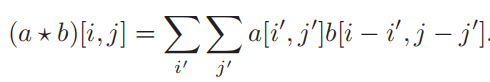
我们将连续的函数转换为离散的函数。给定一个连续函数f(x)，我们在采样时将其转换为离散函数a[i] = f(i)。

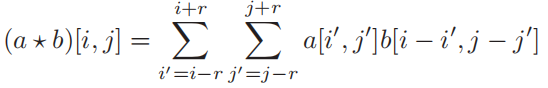
1. 重构



Convolution in More Than One Dimension

2D discrete convolution





**Moving Averages**

**What:**

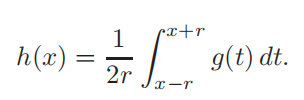
为了在任何一点得到平滑值，我们计算函数在每个方向上延伸距离r的范围内的平均值。距离r称为平滑操作的半径。

**Why:**

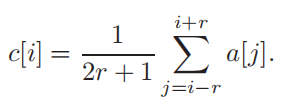
移动平均线的概念是卷积的精髓;唯一的区别是在卷积中移动平均线是一个加权平均线。

**How:**

continuous function：



discrete function：



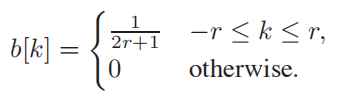
**Box filter**

**What:**

在其为非零的区间内具有一个常数值的过滤器。

**Why:**

**How:**



Convolution Filters

What:

Why:

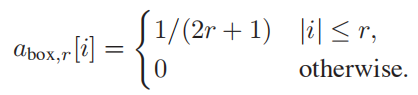
How:

For a filter f(x), we can define a version of scale s:

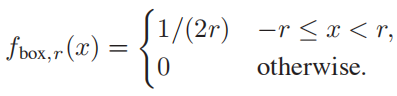
fs(x) = f(x/s) / s

The Box Filter

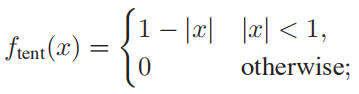
离散卷积



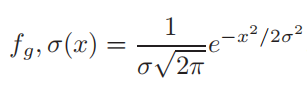
连续卷积



The Tent Filter



The Gaussian Filter



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