

# Coordinate Hit-and-run

Amit Rajaraman

27th November 2021

# Table of Contents

## 1 Introduction

# Table of Contents

## 1 Introduction

# The setting

Uniformly sampling points from a high-dimensional convex body is a basic problem that relates to problems such as volume computation of convex bodies in high dimensions.

# The setting

Uniformly sampling points from a high-dimensional convex body is a basic problem that relates to problems such as volume computation of convex bodies in high dimensions.

## Definition 1

A compact convex body  $K \subseteq \mathbb{R}^n$  is said to have a *well-guaranteed membership oracle* if

# The setting

Uniformly sampling points from a high-dimensional convex body is a basic problem that relates to problems such as volume computation of convex bodies in high dimensions.

## Definition 1

A compact convex body  $K \subseteq \mathbb{R}^n$  is said to have a *well-guaranteed membership oracle* if

- it has a *membership oracle*, that is, an oracle that given any  $x \in \mathbb{R}^n$  returns whether or not  $x \in K$ .

# The setting

Uniformly sampling points from a high-dimensional convex body is a basic problem that relates to problems such as volume computation of convex bodies in high dimensions.

## Definition 1

A compact convex body  $K \subseteq \mathbb{R}^n$  is said to have a *well-guaranteed membership oracle* if

- it has a *membership oracle*, that is, an oracle that given any  $x \in \mathbb{R}^n$  returns whether or not  $x \in K$ .
- we have  $R > r > 0$  such that  $rB_2^n \subseteq K \subseteq RB_2^n$ , where  $B_2^n$  is the unit ball in the  $L_2$  norm in  $\mathbb{R}^n$ .

# The setting

Uniformly sampling points from a high-dimensional convex body is a basic problem that relates to problems such as volume computation of convex bodies in high dimensions.

## Definition 1

A compact convex body  $K \subseteq \mathbb{R}^n$  is said to have a *well-guaranteed membership oracle* if

- it has a *membership oracle*, that is, an oracle that given any  $x \in \mathbb{R}^n$  returns whether or not  $x \in K$ .
- we have  $R > r > 0$  such that  $rB_2^n \subseteq K \subseteq RB_2^n$ , where  $B_2^n$  is the unit ball in the  $L_2$  norm in  $\mathbb{R}^n$ .

Given a well-guaranteed membership oracle for  $K$ , the problem is to approximately uniformly sample points for  $K$ .



# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

---

<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶

# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

We synthesize a Markov chain whose stationary distribution is the uniform distribution on the given body

---

<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶

# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

We synthesize a Markov chain whose stationary distribution is the uniform distribution on the given body and try to determine how fast we get 'close' to this stationary distribution.

---

<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶

# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

We synthesize a Markov chain whose stationary distribution is the uniform distribution on the given body and try to determine how fast we get 'close' to this stationary distribution.

The first such random walk<sup>1</sup> was proposed in [DFK91] by Dyer, Frieze, and Kannan.

---

<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶

# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

We synthesize a Markov chain whose stationary distribution is the uniform distribution on the given body and try to determine how fast we get 'close' to this stationary distribution.

The first such random walk<sup>1</sup> was proposed in [DFK91] by Dyer, Frieze, and Kannan. This random walk was on a grid superimposed on the convex body.

---

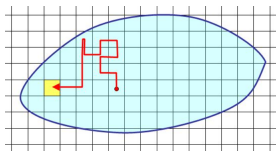
<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶

# The approach in broad strokes

The primary method to approximately uniformly sample points is through a *Markov chain*.

We synthesize a Markov chain whose stationary distribution is the uniform distribution on the given body and try to determine how fast we get 'close' to this stationary distribution.

The first such random walk<sup>1</sup> was proposed in [DFK91] by Dyer, Frieze, and Kannan. This random walk was on a grid superimposed on the convex body.



---

<sup>1</sup>and consequently, algorithm to approximate the volume of a convex body ▶



Martin Dyer, Alan Frieze, and Ravi Kannan.

A random polynomial-time algorithm for approximating the volume of convex bodies.

*J. ACM*, 38(1):1–17, January 1991.