Snowmass pMSSM *Grand Scan*

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Snowmass pMSSM scan meeting

January 13, 2021

Recap: scan setup

- The goal is to perform a ***grand scan*** that populates all regions of parameter space relevant for Snowmass studies
- The scan will need to cover a large region of parameter space. Goal: ***retain high granularity*** at low values of pMSSM mass parameters
- This talk outlines some of the technical options for how to achieve this

First: Proposed ranges

- For 100 TeV pp collider, expect sensitivity up to ~20 TeV masses. Assume 50 TeV is sufficient for decoupling

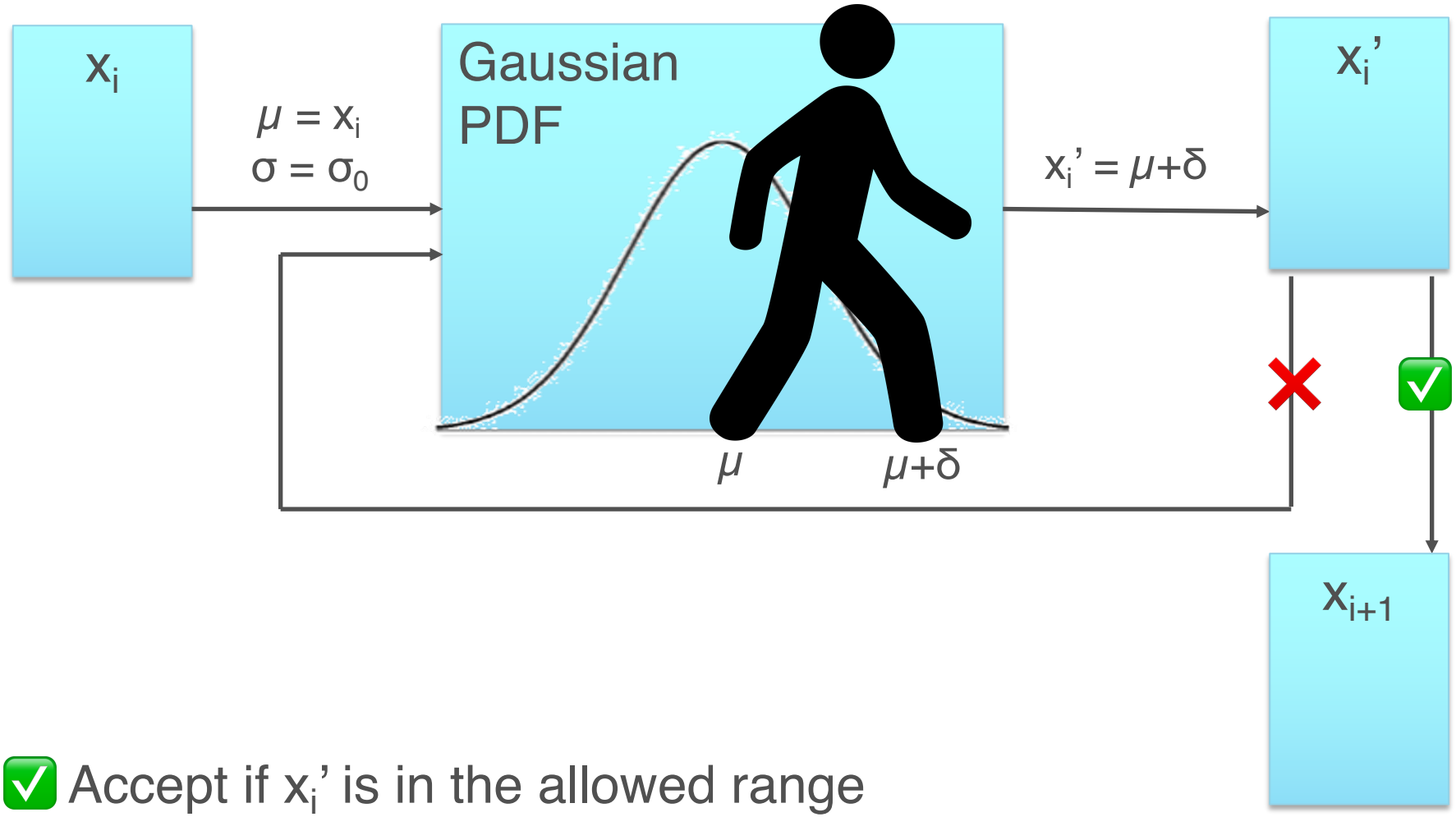
Parameter	Range	Stepping
tan β	[1, 60]	
M_A	[0, 25] TeV	
$\|\mu\|$	[0, 25] TeV	
$\|M_1\|$	[0, 25] TeV	
$\|M_2\|$	[0, 25] TeV	
M_3	[0, 50] TeV	
$m_L123\sim$, $m_e123\sim$	[0, 25] TeV	
$m_Q12\sim$, $m_u12\sim$, $m_d12\sim$	[0, 50] TeV	
$m_Q3\sim$, $m_u3\sim$, $m_d3\sim$	[0, 50] TeV	
$\|A_t\|$, $\|A_b\|$, $\|A_\tau\|$	[0, 7]	

Parameters restricted to values ≥ 0

Parameter	Range	Stepping
tan β	[1, 60]	
M_A	[0, 25] TeV	
M_3	[0, 50] TeV	
$m_L123\sim$, $m_e123\sim$	[0, 25] TeV	
$m_Q12\sim$, $m_u12\sim$, $m_d12\sim$	[0, 50] TeV	
$m_Q3\sim$, $m_u3\sim$, $m_d3\sim$	[0, 50] TeV	

- Next few slides: review stepping options

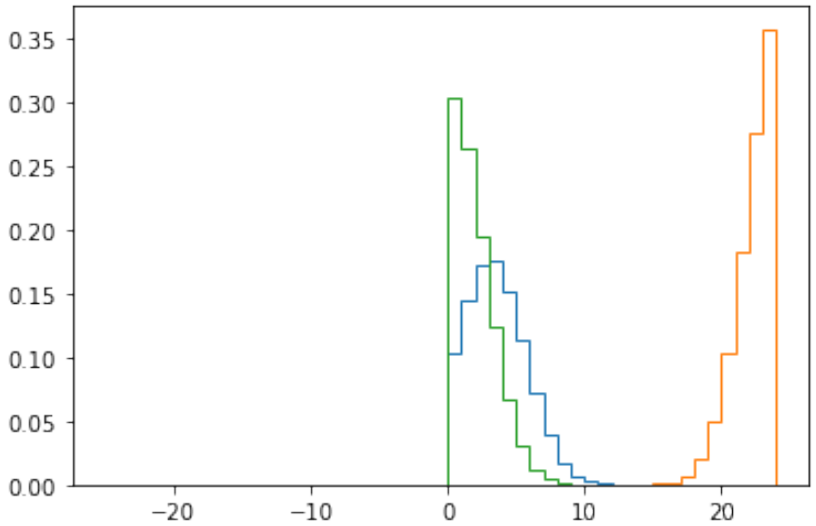
Most basic: linear stepping, fixed width gaussian



✅ Accept if x_i' is in the allowed range and $L(x_i')$ satisfies criteria

Run a simplified McMC test

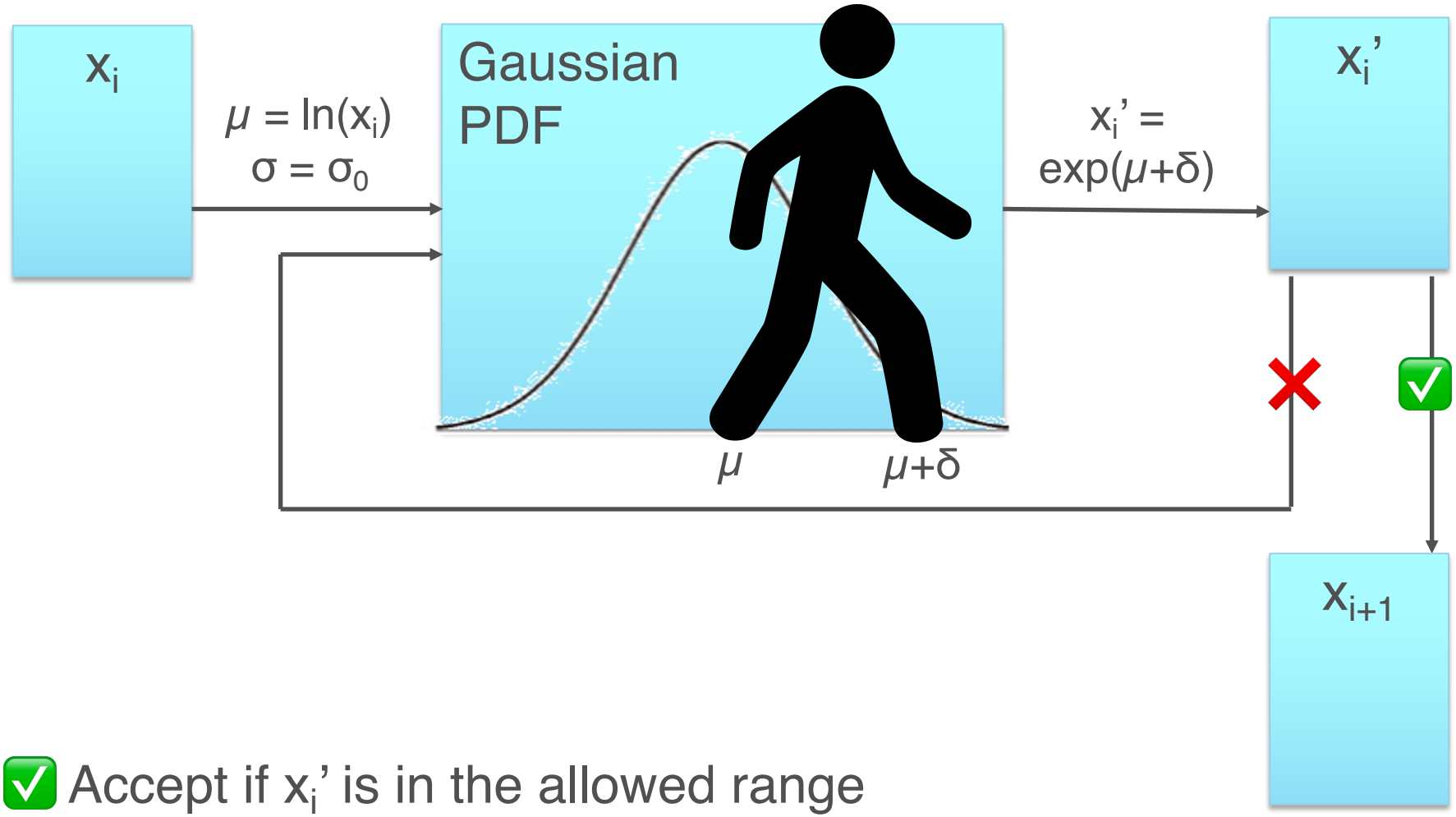
- Use a 1D parameter space with $0 < x < 25$
- Use a flat likelihood for simplicity
- Run McMC with 1,000,000 iterations
- Do this 3 times with random starting points
  - **3.1**, **24.6**, **0.1**



Linear stepping, fixed width gaussian, x > 0

Parameter is decoupled at 25

Log stepping, fixed width gaussian



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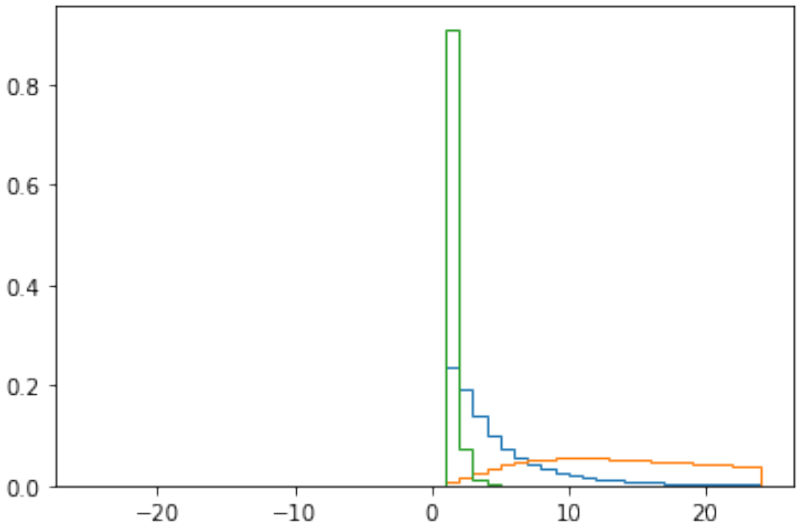


Log stepping, fixed width gaussian, x > 0

Higher fraction of points near zero are sampled

Parameters restricted to values ≥ 0

Parameter	Range	Stepping
tan β	[1, 60]	Propose: log
M_A	[0, 25] TeV	Propose: log
M_3	[0, 50] TeV	Propose: log
$m_L123\sim$, $m_e123\sim$	[0, 25] TeV	Propose: log
$m_Q12\sim$, $m_u12\sim$, $m_d12\sim$	[0, 50] TeV	Propose: log
$m_Q3\sim$, $m_u3\sim$, $m_d3\sim$	[0, 50] TeV	Propose: log

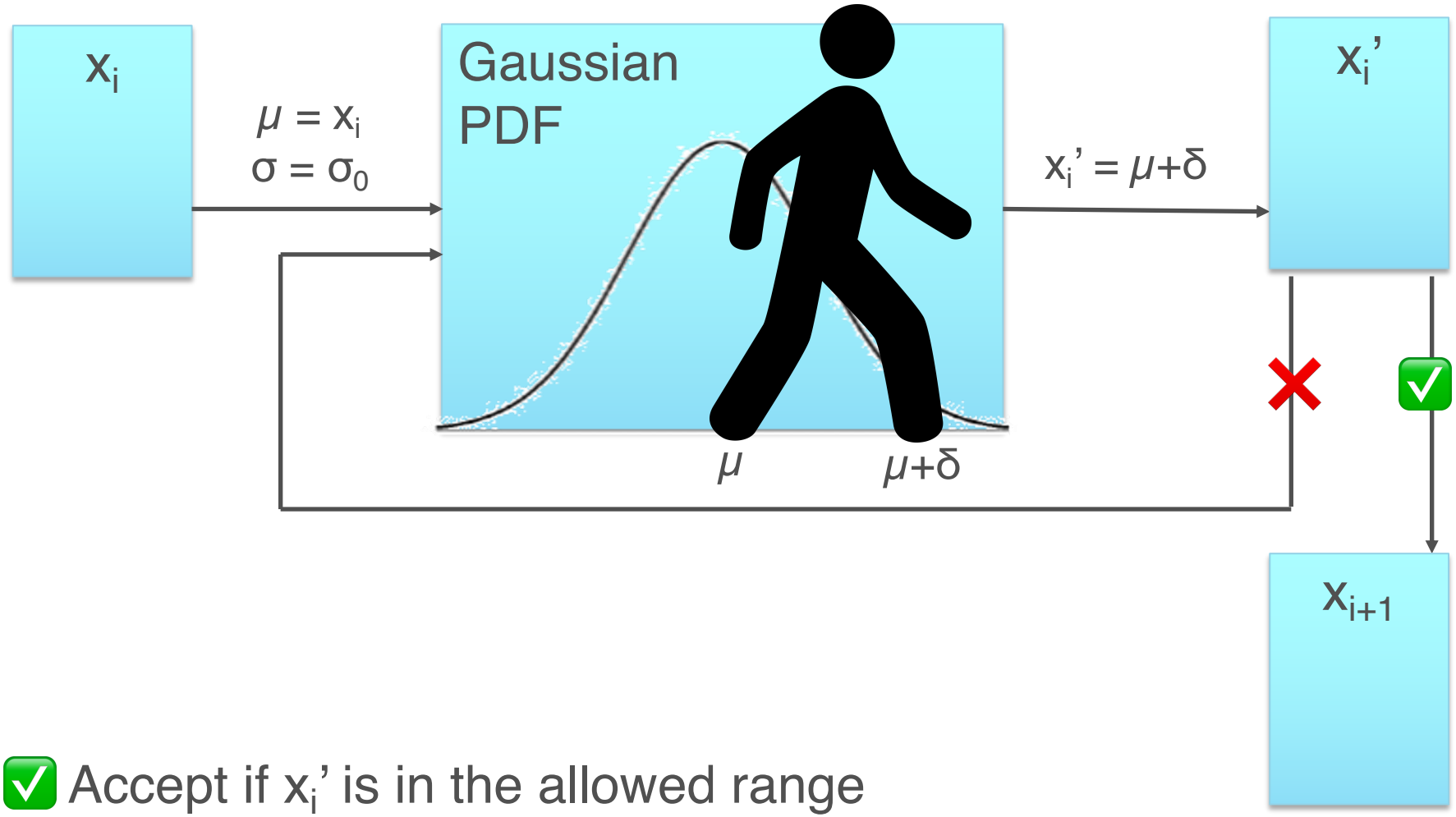
- Will need to tune:
  - Width of the gaussian
  - Base of the logarithm

Parameters that can take on negative values

Parameter	Range	Stepping
$\|\mu\|$	[0, 25] TeV	
$\|M_1\|$	[0, 25] TeV	
$\|M_2\|$	[0, 25] TeV	
$\|A_t\|$, $\|A_b\|$, $\|A_\tau\|$	[0, 7]	

- Next slides: review stepping options

Most basic: linear stepping, fixed width gaussian



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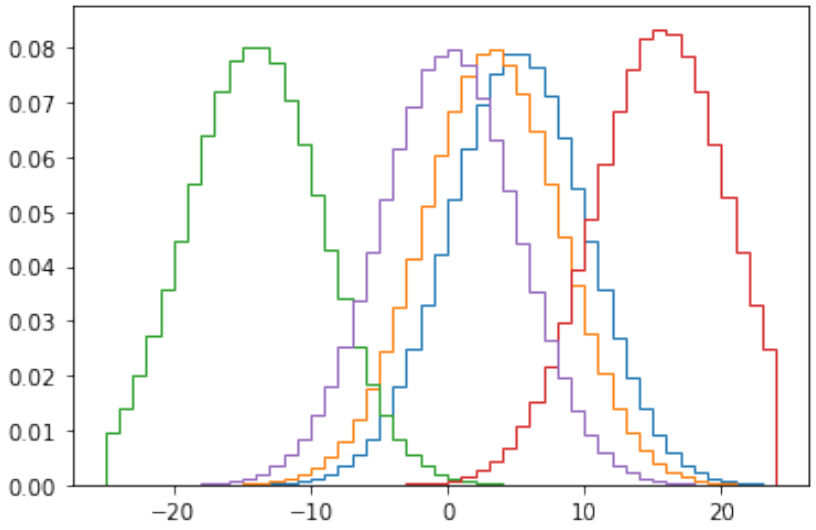
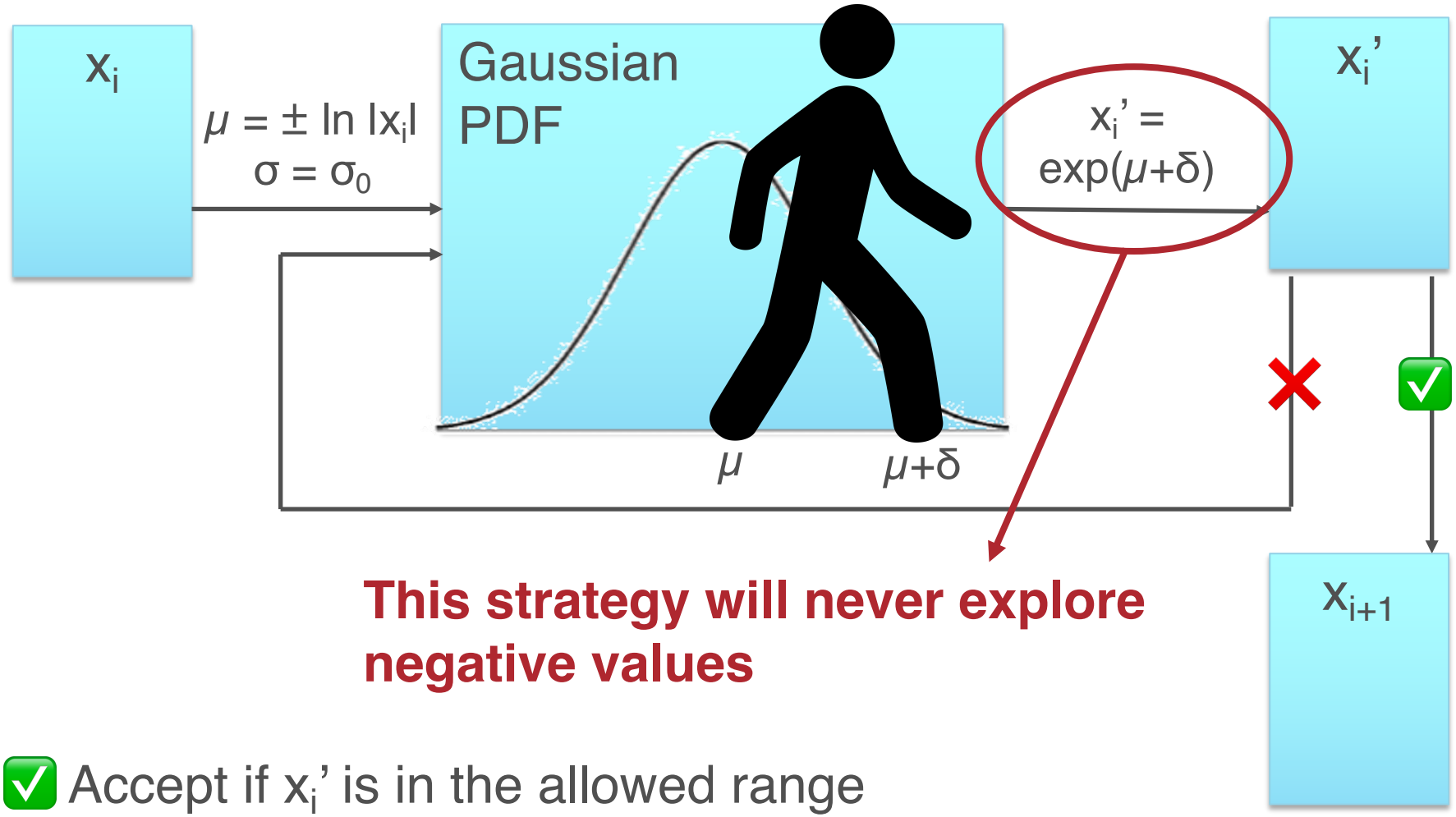
  - **5.1**, **3.2**, **-14.1**, **15.7**, **0.1**



Linear stepping, fixed width gaussian

Log stepping, fixed width gaussian



This strategy will never explore negative values

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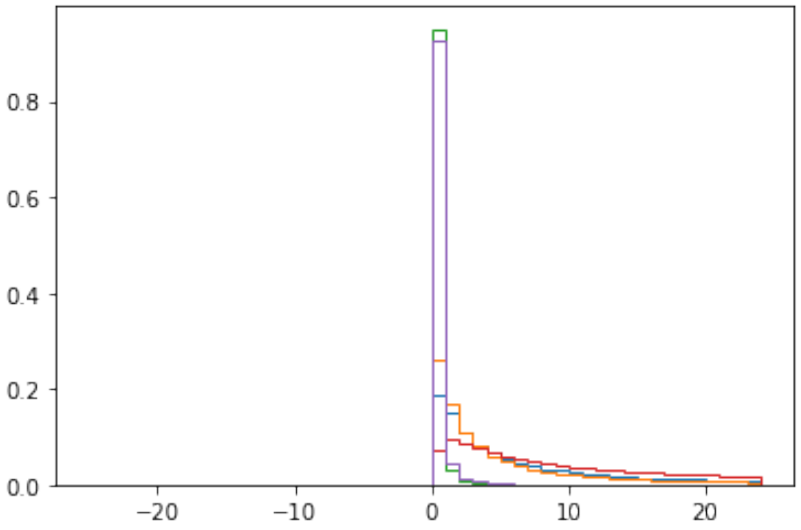
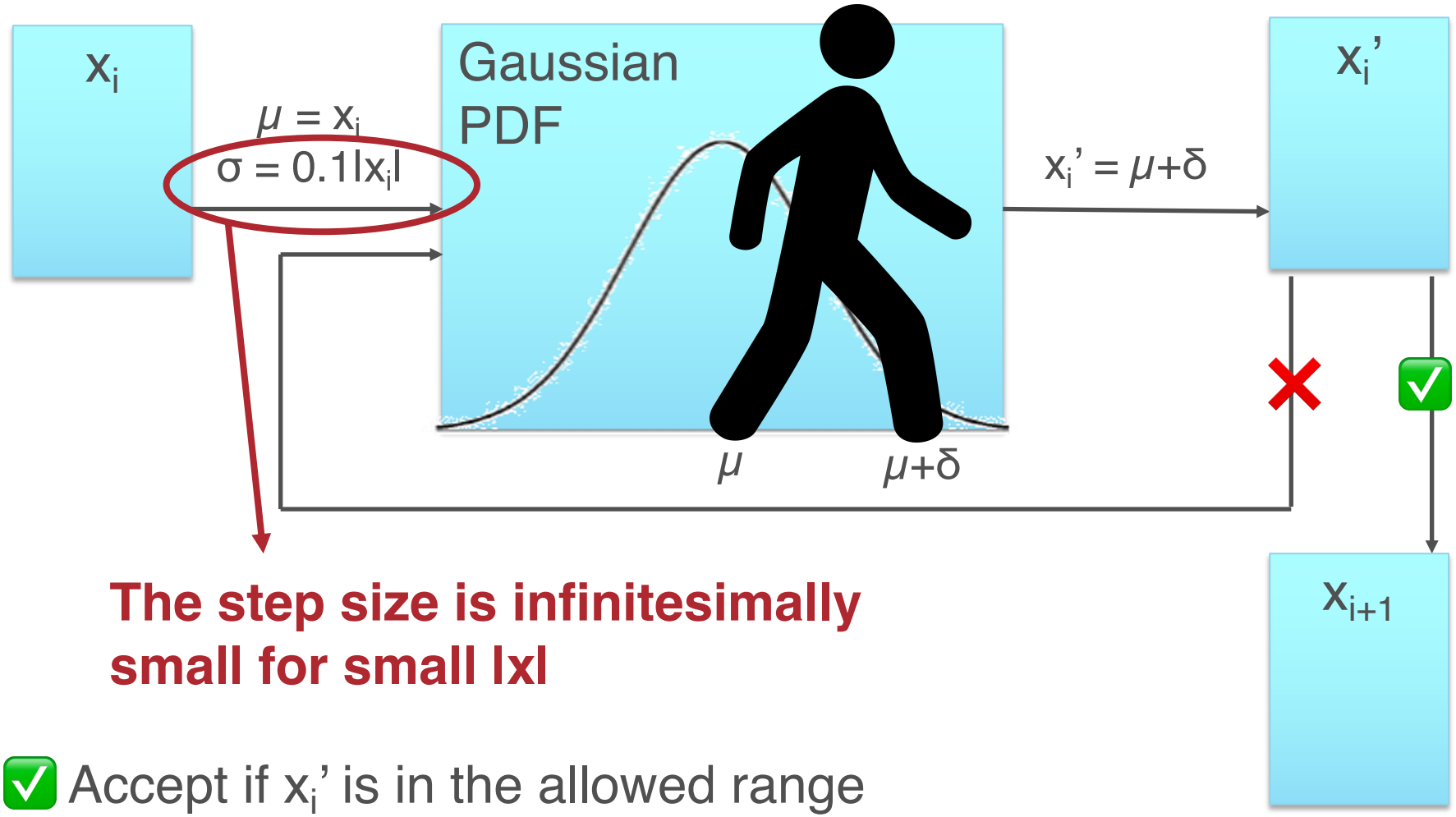


Log stepping, fixed width gaussian

This strategy will never explore negative values

Linear stepping, variable width gaussian



The step size is infinitesimally small for small |x|

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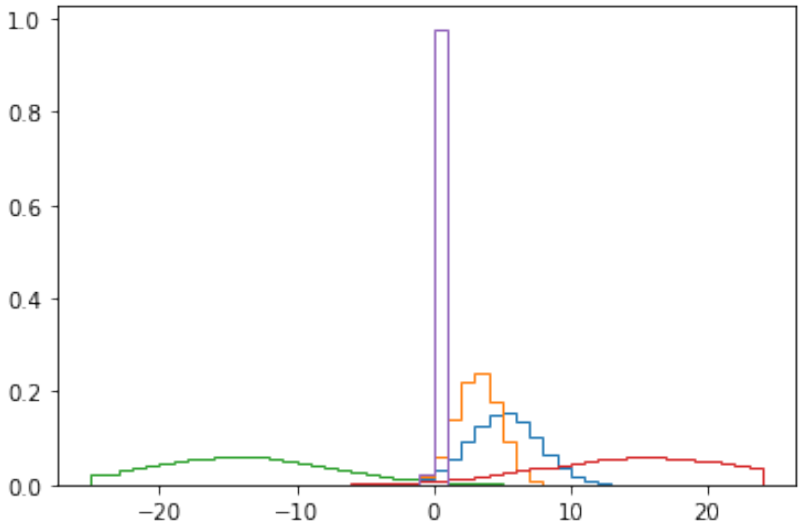
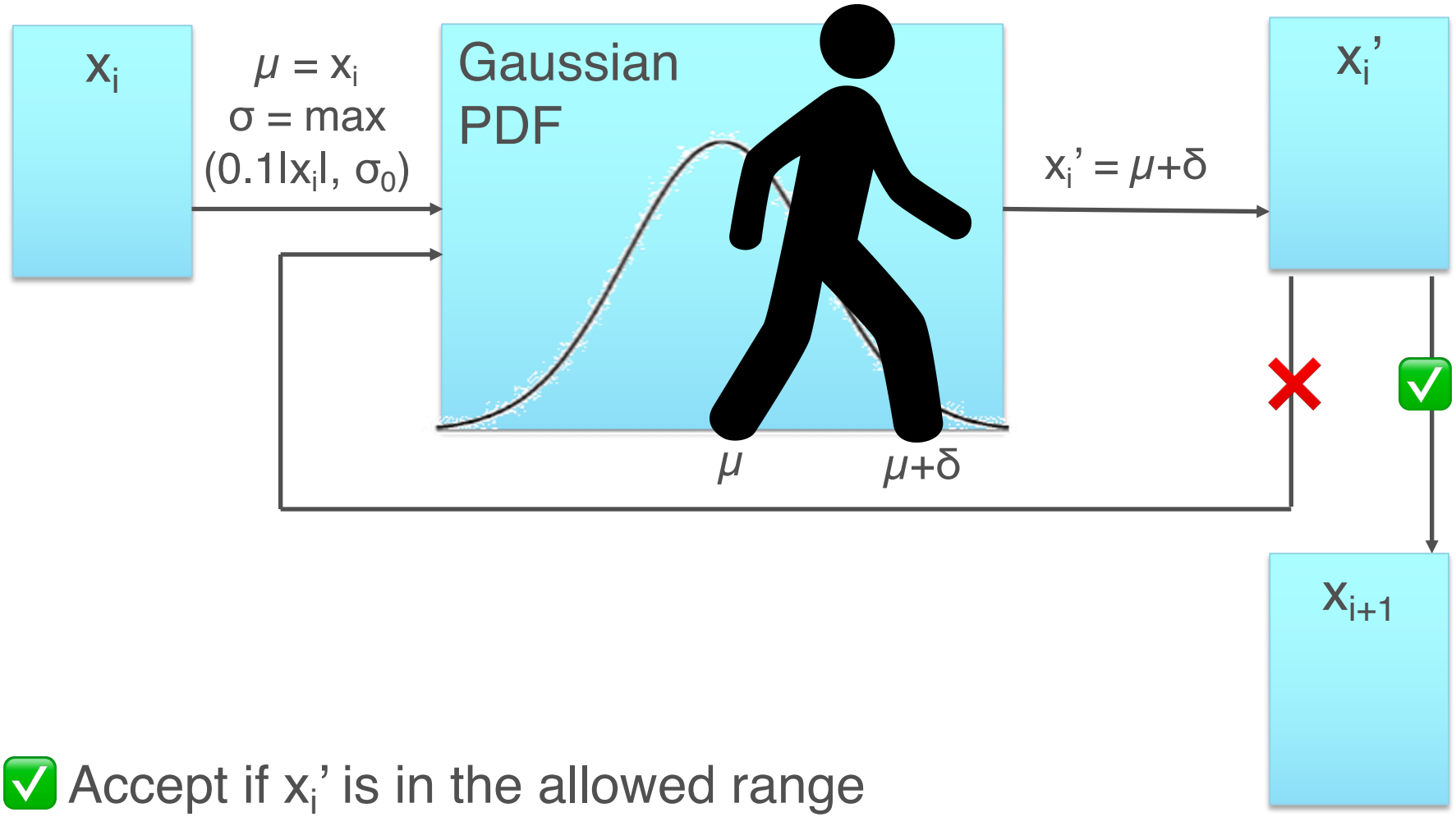


Linear stepping, variable width gaussian

For small lxl, step size is infinitesimally small. This strategy will not populate large lxl

Linear stepping, variable width gaussian with minimum



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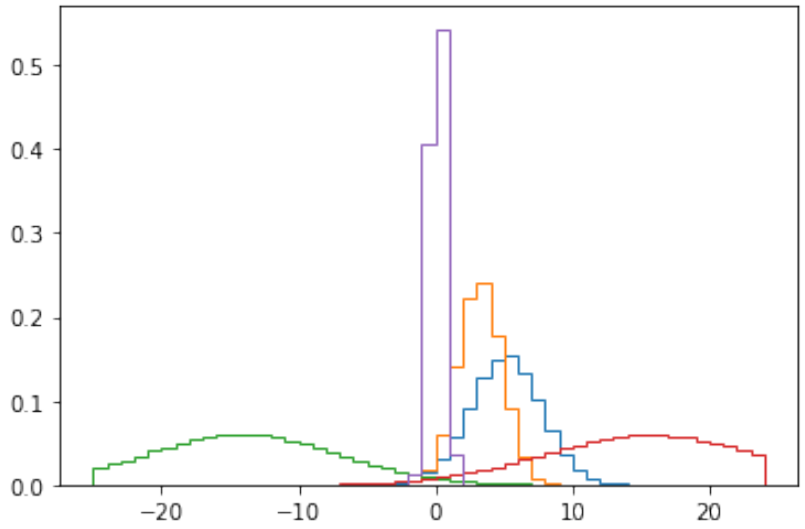

Linear stepping, variable width gaussian with minimum

Parameters that can take on negative values

Parameter	Range	Stepping
$\|\mu\|$	[0, 25] TeV	Propose: linear, vary width with min
$\|M_1\|$	[0, 25] TeV	Propose: linear, vary width with min
$\|M_2\|$	[0, 25] TeV	Propose: linear, vary width with min
$\|A_t\|$, $\|A_b\|$, $\|A_\tau\|$	[0, 7]	Propose: linear

- Will need to tune:
  - Coefficient of variable width (0.5 $|x_i|$? 0.1 $|x_i|$? etc.)
  - Minimum width of the gaussian

Discussion

- Any questions?
- Let’s hear what people think!