Report of Entropy estimates based on NIST SP 800-90B non-IID track

2023-Jul-29 16:58:40.350142

1 Identification information

1.1 Identification of acquisition data from entropy source

Table 1 Identification information of acquisition data from entropy source

URL of the acquisition data	`https://github.com/usnistgov/SP800-90B_EntropyAssessment/blob/master/bin/rand1_short.bin`
SHA-256 hash value of the acquisition data [hex]	`38144044 97a3b912 f8d3db6b c05a9933 8f0986cd 75fe54af 2a5f1bdb 0a12a583`

- Name of the submitter of the acquisition data :
- Brief explanation of the acquisition data (or entropy source) :

1.2 Identification of analysis environment

Table 2 Identification information of analysis environment

Analysis tool	Name	Another entropy estimation tool with extensions
	Versioning information	1.0.49
	built as	64-bit application
	built by	Intel C++ Compiler (`__INTEL_LLVM_COMPILER`: 20230200)
	linked libraries	Boost C++ 1.82.0
Analysis environment	Hostname	TIGER140A
	CPU information	AMD Ryzen 5 PRO 5650U with Radeon Graphics
	Physical memory size	47950 MiB
	OS information	Windows 10 or greater 64-bit
	Username	genya

1.3 Identification of analysis conditions

Table 3 Identification information of analysis conditions

Number of samples	10000
Bits per sample	1

1.4 Identification of analysis method

NIST SP 800-90B [1] 6.3 with corrections [2] is applied

2 Executive summary

2.1 Numerical results of min-entropy estimates based on non-IID track

Table 4 Numerical results

Estimator	$H_{\text{bitstring}}$ [a] [bit / 1 - bit]
The Most Common Value Estimate	0.961059
The Collision Estimate	0.691464
The Markov Estimate	0.987596
The Compression Estimate	0.611716
The t-Tuple Estimate	0.867624
The Longest Repeated Substring (LRS) Estimate	0.962626
Multi Most Common in Window Prediction Estimate	0.952618
The Lag Prediction Estimate	0.943334
The MultiMMC Prediction Estimate	0.961617
The LZ78Y Prediction Estimate	0.961446
The intial entropy source estimate [bit / 1 -bit] $H_I = H_{\text{bitstring}}$	0.611716

[a] Entropy estimate of the sequential dataset [source: NIST SP 800-90B [1] 3.1.3]

2.2 Visual comparison of min-entropy estimates from binary samples

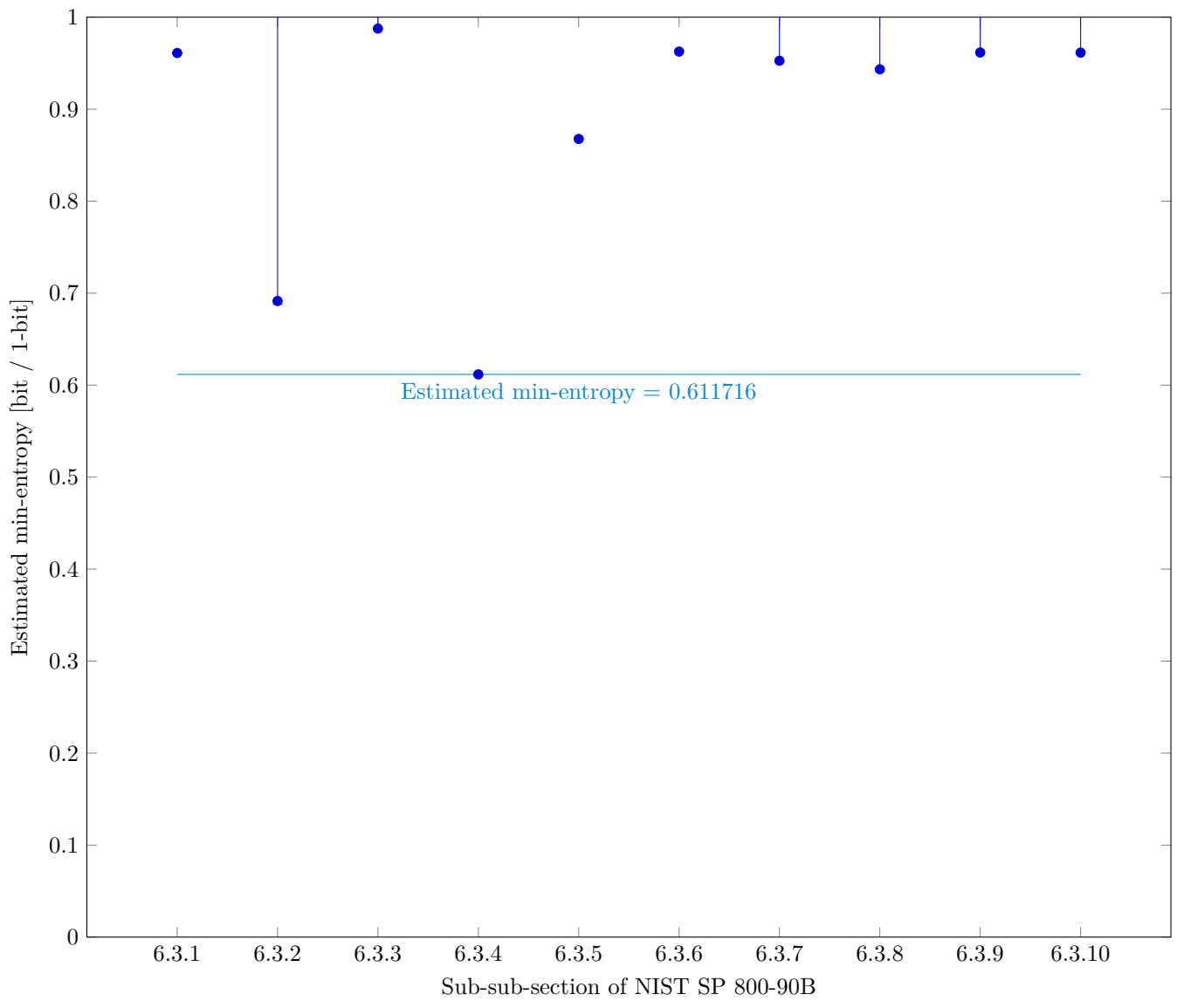

Fig. 1 Estimated Min-Entropy using §6.3 of NIST SP 800-90B

3 Detailed results of analysis from original samples

3.1 The Most Common Value Estimate (NIST SP 800-90B Section 6.3.1)

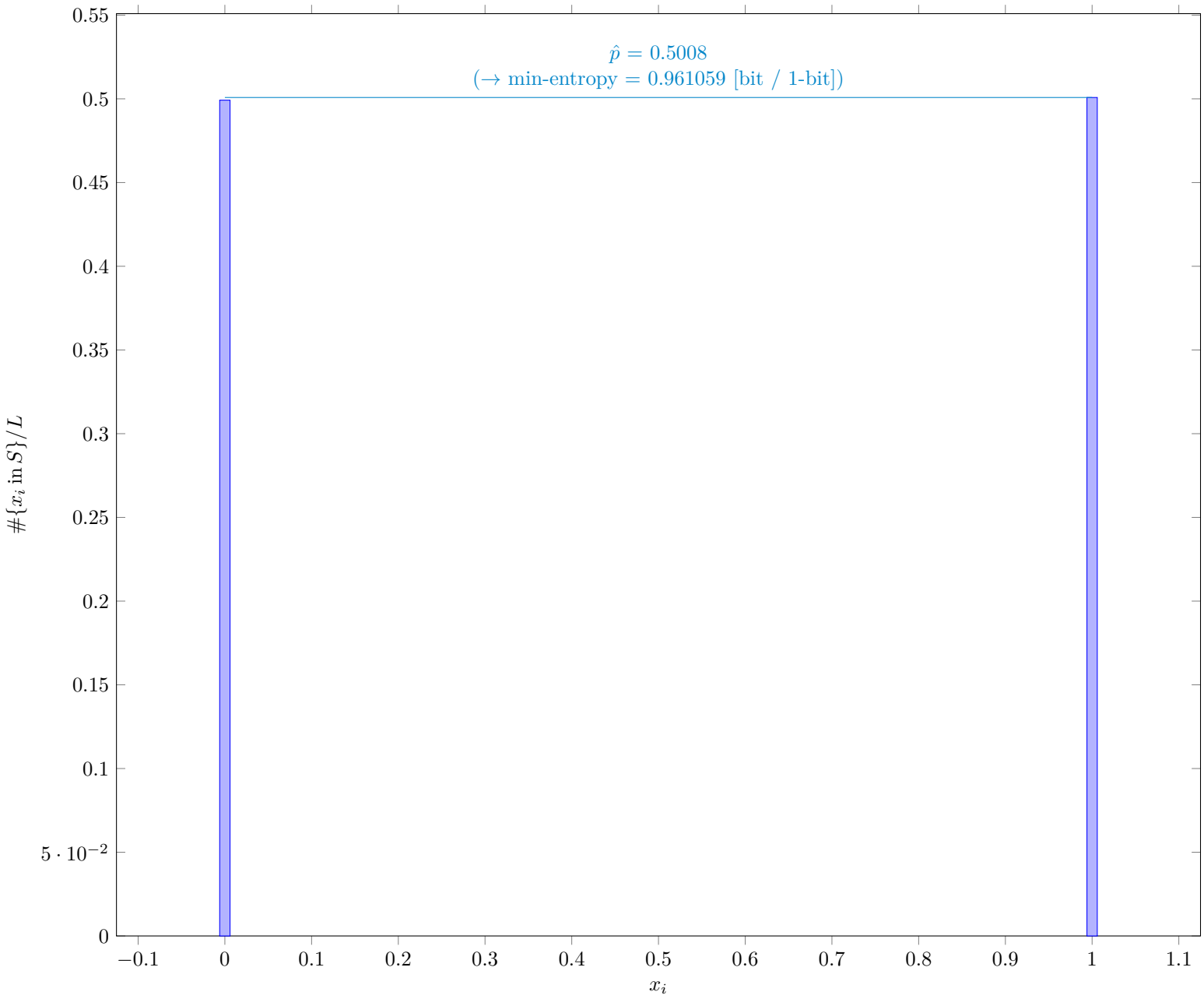

Fig. 2 Distribution of x_i

3.1.1 Supplemental information for traceability

Table 5 Supplemental information for traceability (NIST SP 800-90B Section 6.3.1)

Symbol	Value
mode	5008
$\hat{p}$	0.5008
p_u	0.51368

3.2 The Collision Estimate (NIST SP 800-90B Section 6.3.2)

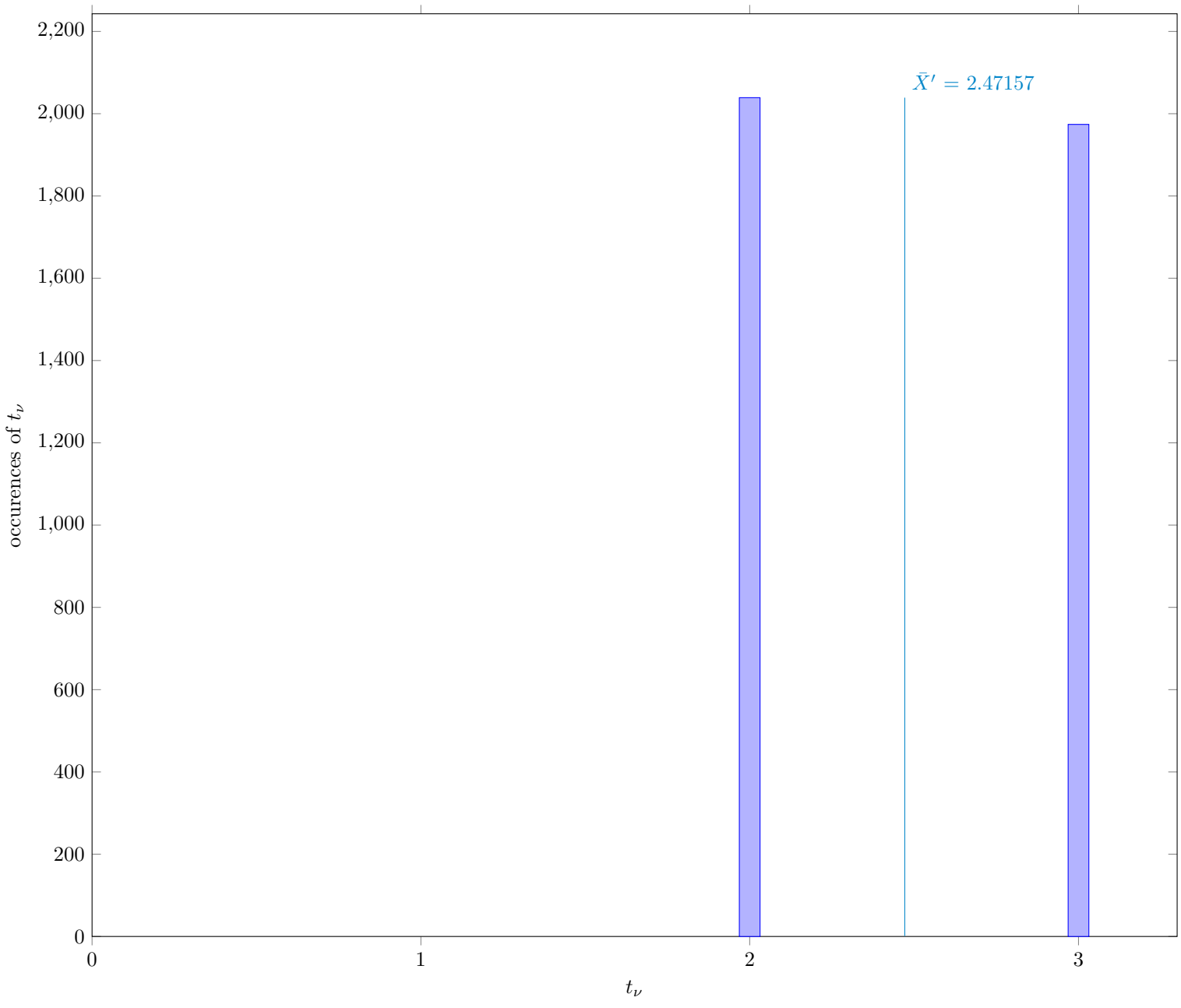

Fig. 3 Distribution of intermediate value t_ν

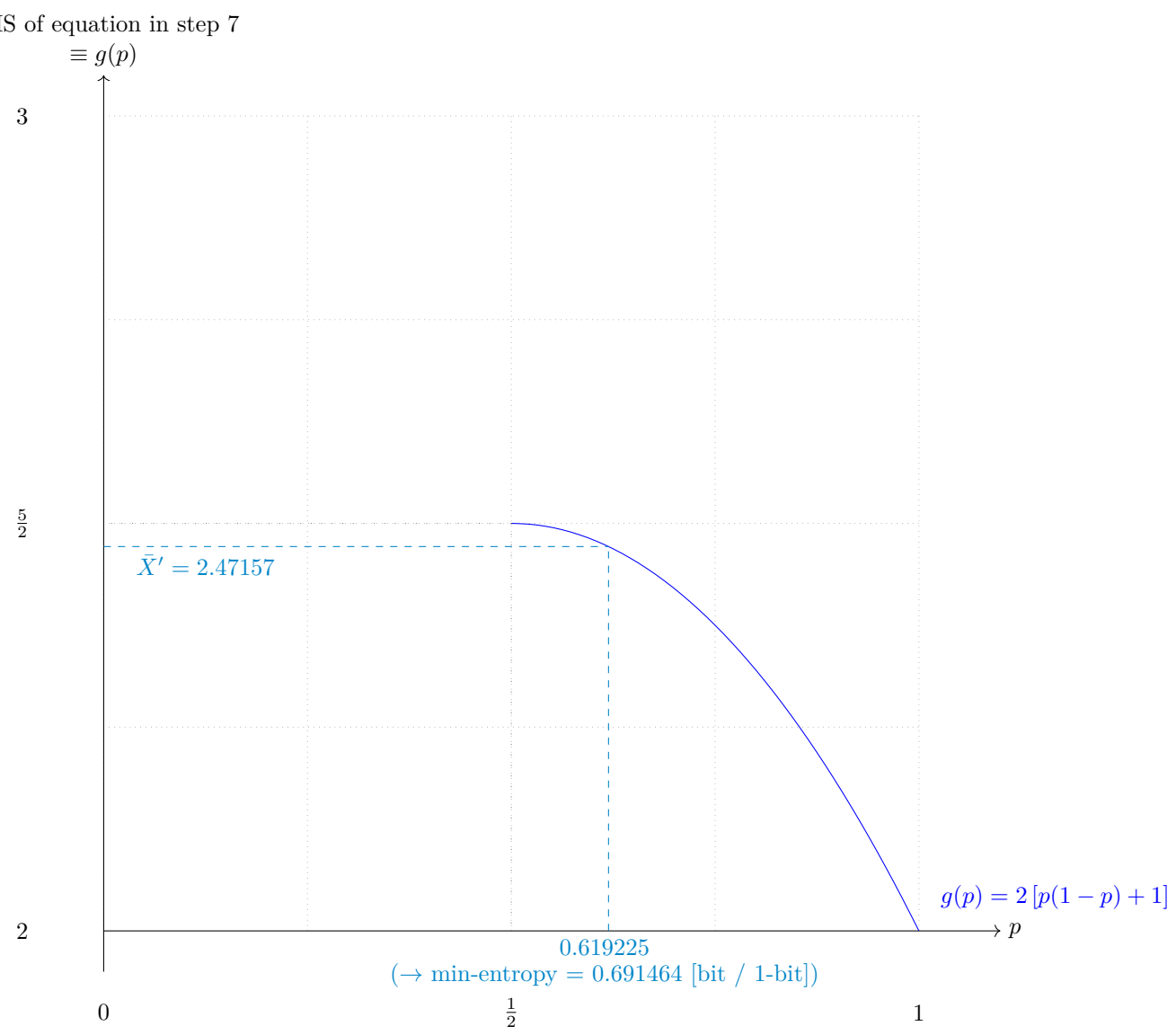

Fig. 4 Solution to the equation in step 7

3.2.1 Supplemental information for traceability

Table 6 Supplemental information for traceability (NIST SP 800-90B Section 6.3.2)

Symbol	Value
p	0.619225
$\bar{X}$	2.4919
$\bar{X}'$	2.47157
$\hat{\sigma}$	0.499997

3.3 The Markov Estimate (NIST SP 800-90B Section 6.3.3)

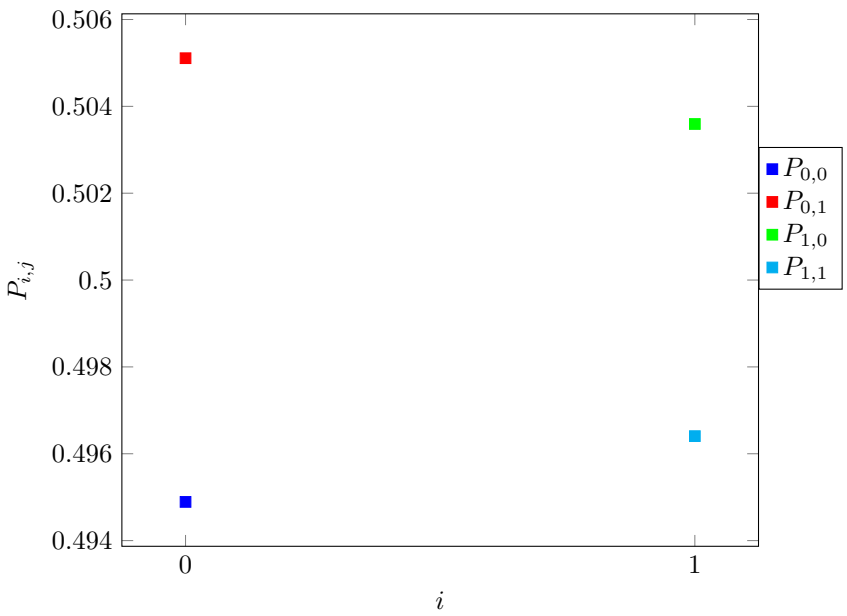

Fig. 5 Transition probability $P_{i,j}$ of §6.3.3 of NIST SP 800-90B

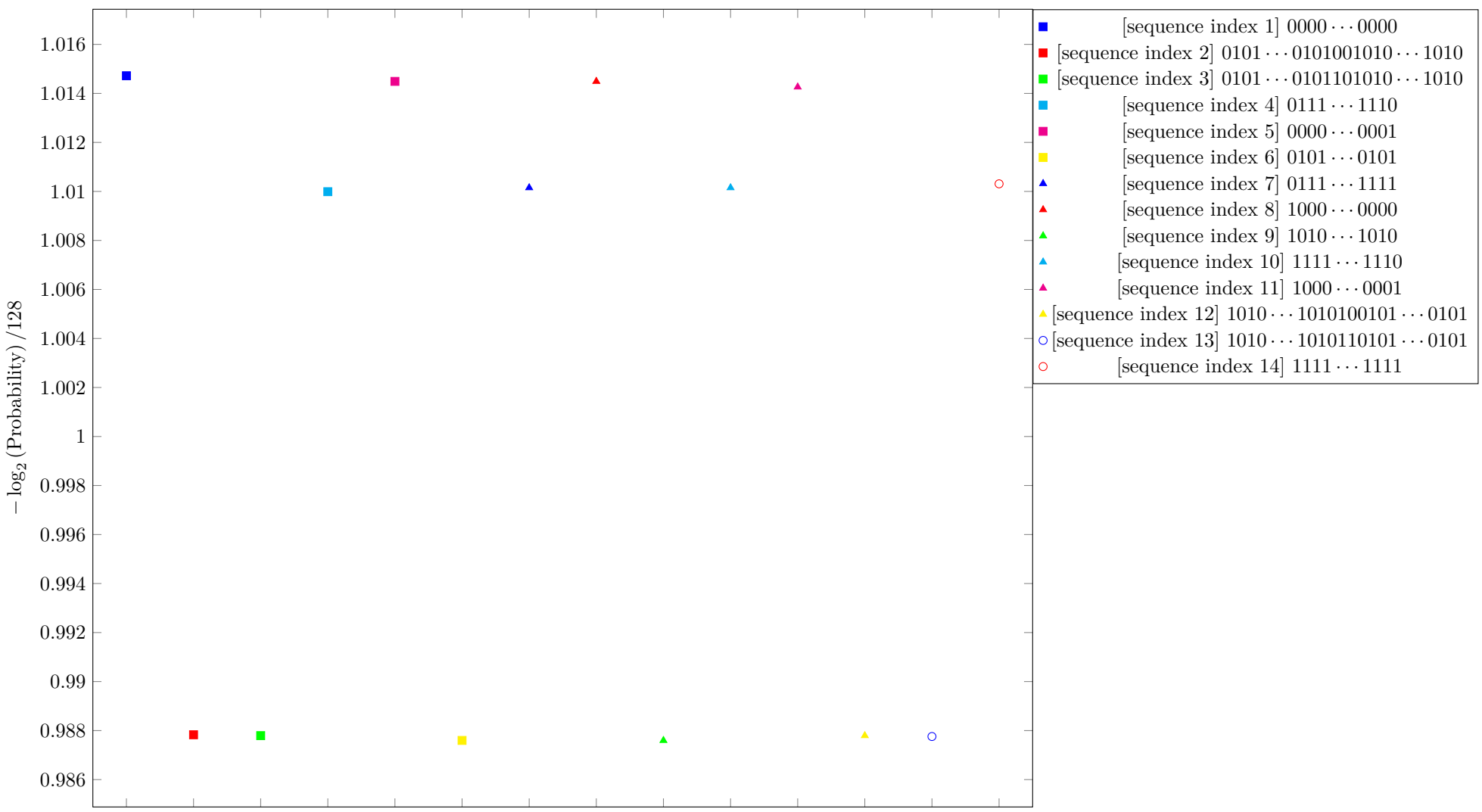

Fig. 6 Estimated Min-Entropy using §6.3.3 of NIST SP 800-90B

3.4 The Compression Estimate (NIST SP 800-90B Section 6.3.4)

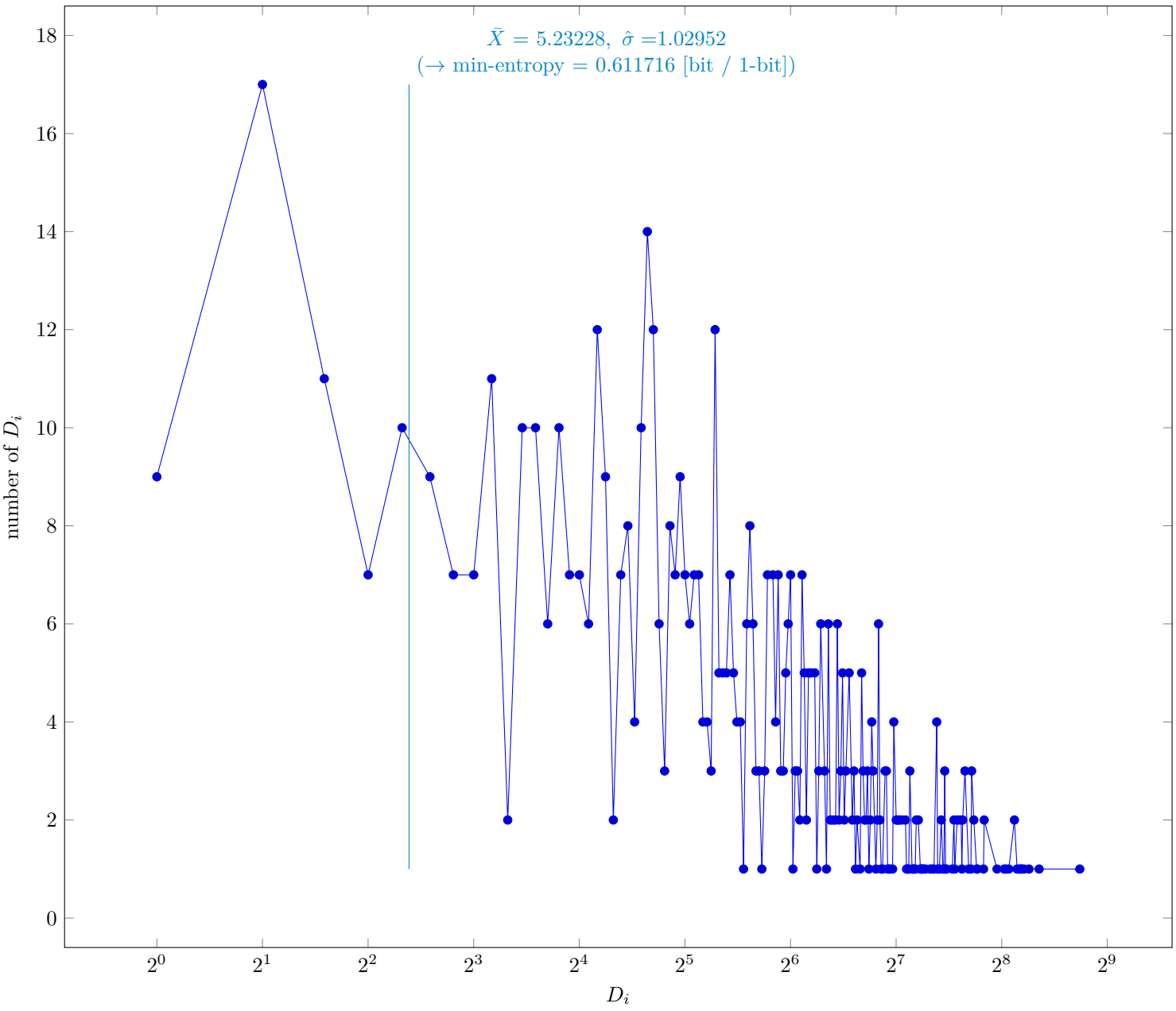

Fig. 7 Distribution of intermediate value D_i

3.4.1 Supplemental information for traceability

Table 7 Supplemental information for traceability (NIST SP 800-90B Section 6.3.4)

Symbol	Value
p	0.0785472
$\bar{X}$	5.23228
$\hat{\sigma}$	1.02952
$\bar{X}'$	5.12953

3.5 The t-tuple Estimate (NIST SP 800-90B Section 6.3.5)

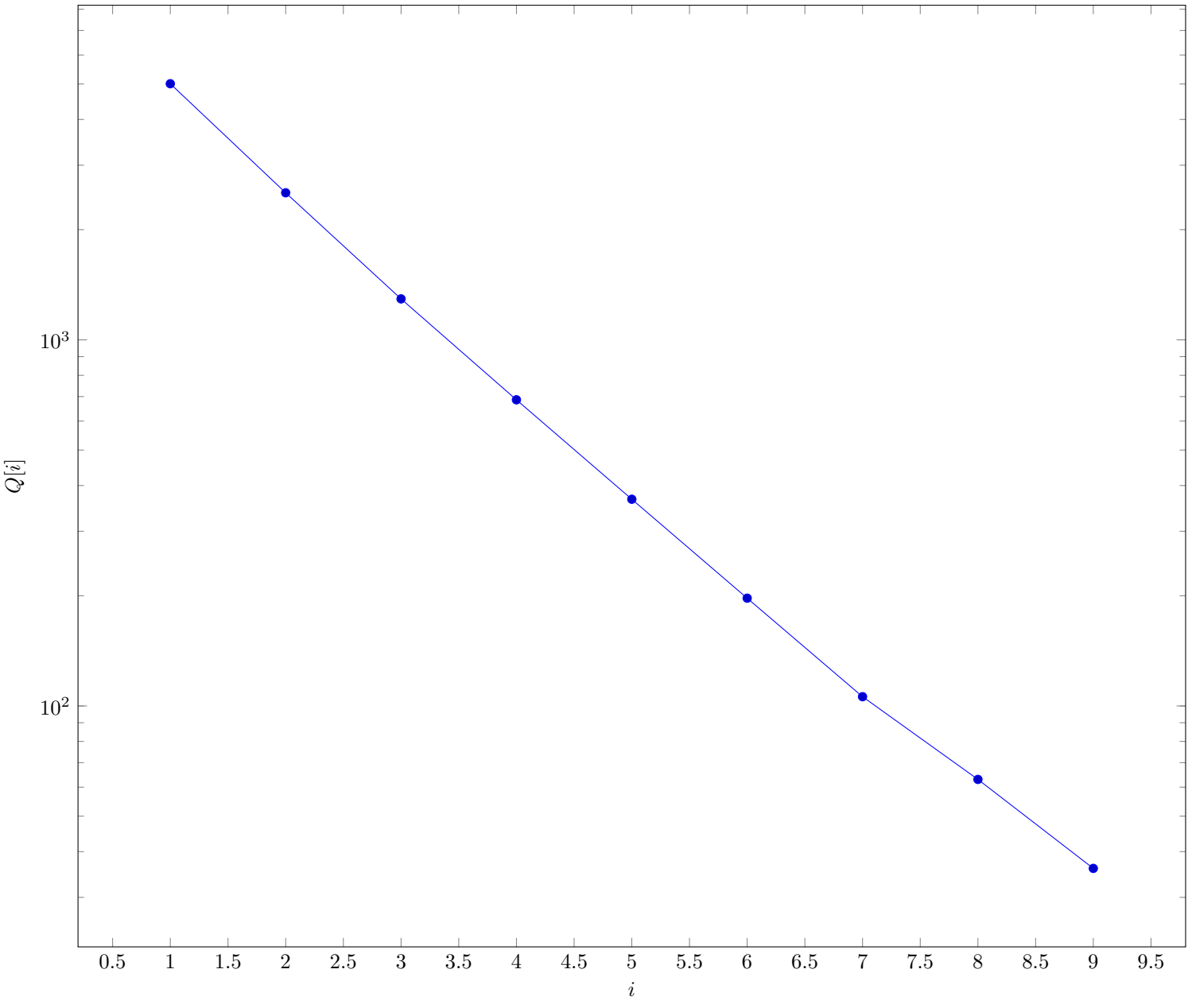

Fig. 8 Intermediate value $Q[i]$ in §6.3.5 of NIST SP 800-90B

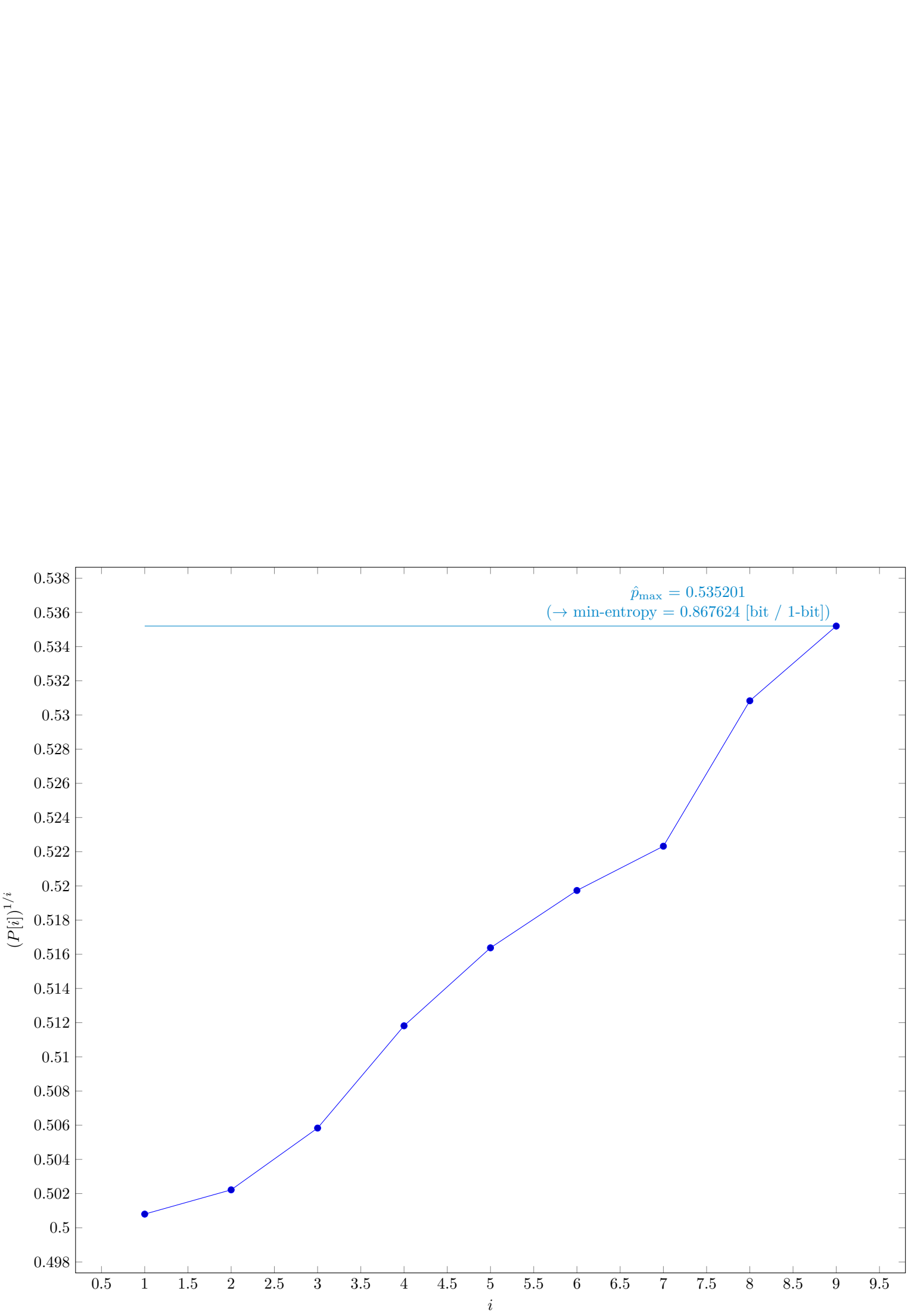

Fig. 9 $P[i]^{1/i}$ in §6.3.5 of NIST SP 800-90B

3.5.1 Supplemental information for traceability

Table 8 Supplemental information for traceability (NIST SP 800-90B Section 6.3.5)

Symbol	Value
t	9
$\hat{p}_{\max}$	0.535201
p_u	0.548049

3.6 The LRS Estimate (NIST SP 800-90B Section 6.3.6)

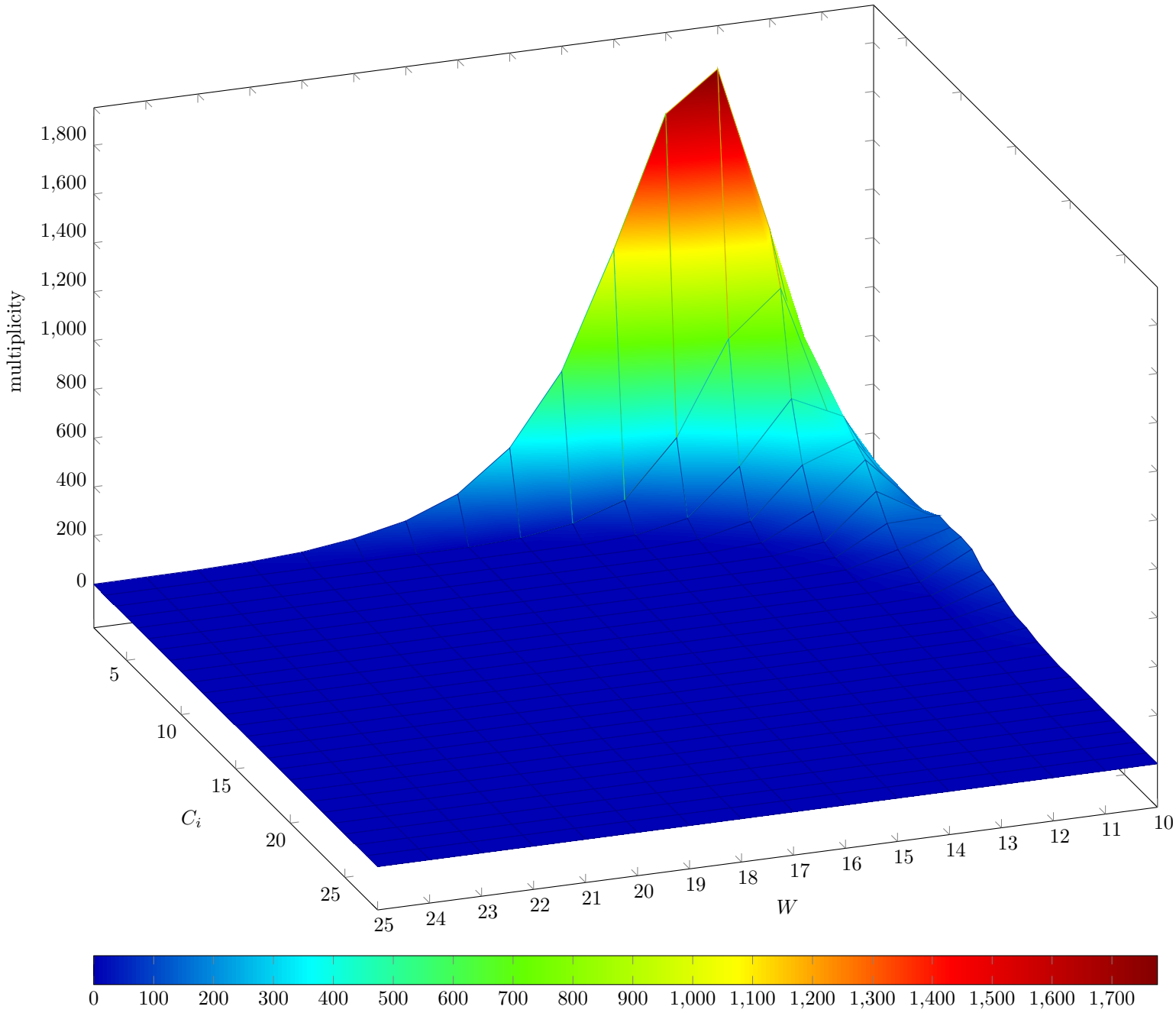

Fig. 10 Estimated W-tuple collision probability in Step 3 of §6.3.6 of NIST SP 800-90B

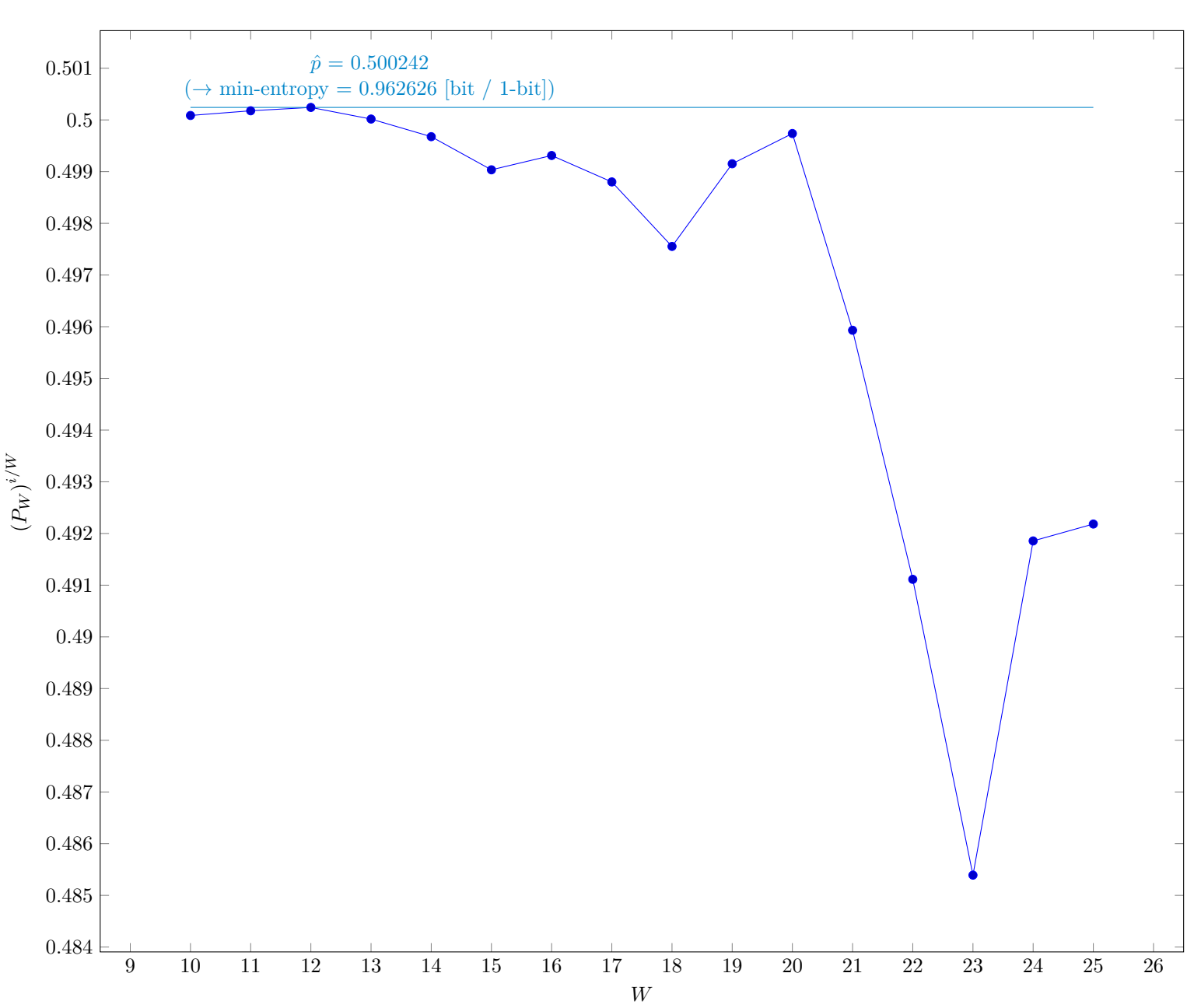

Fig. 11 Estimated average collision probability per string symbol in Step 3 of §6.3.6 of NIST SP 800-90B

3.6.1 Supplemental information for traceability

Table 9 Supplemental information for traceability (NIST SP 800-90B Section 6.3.6)

Symbol	Value
u	10
v	25
$\hat{p}$	0.500242
p_u	0.513122

3.7 Multi Most Common in Window Prediction Estimate (NIST SP 800-90B Section 6.3.7)

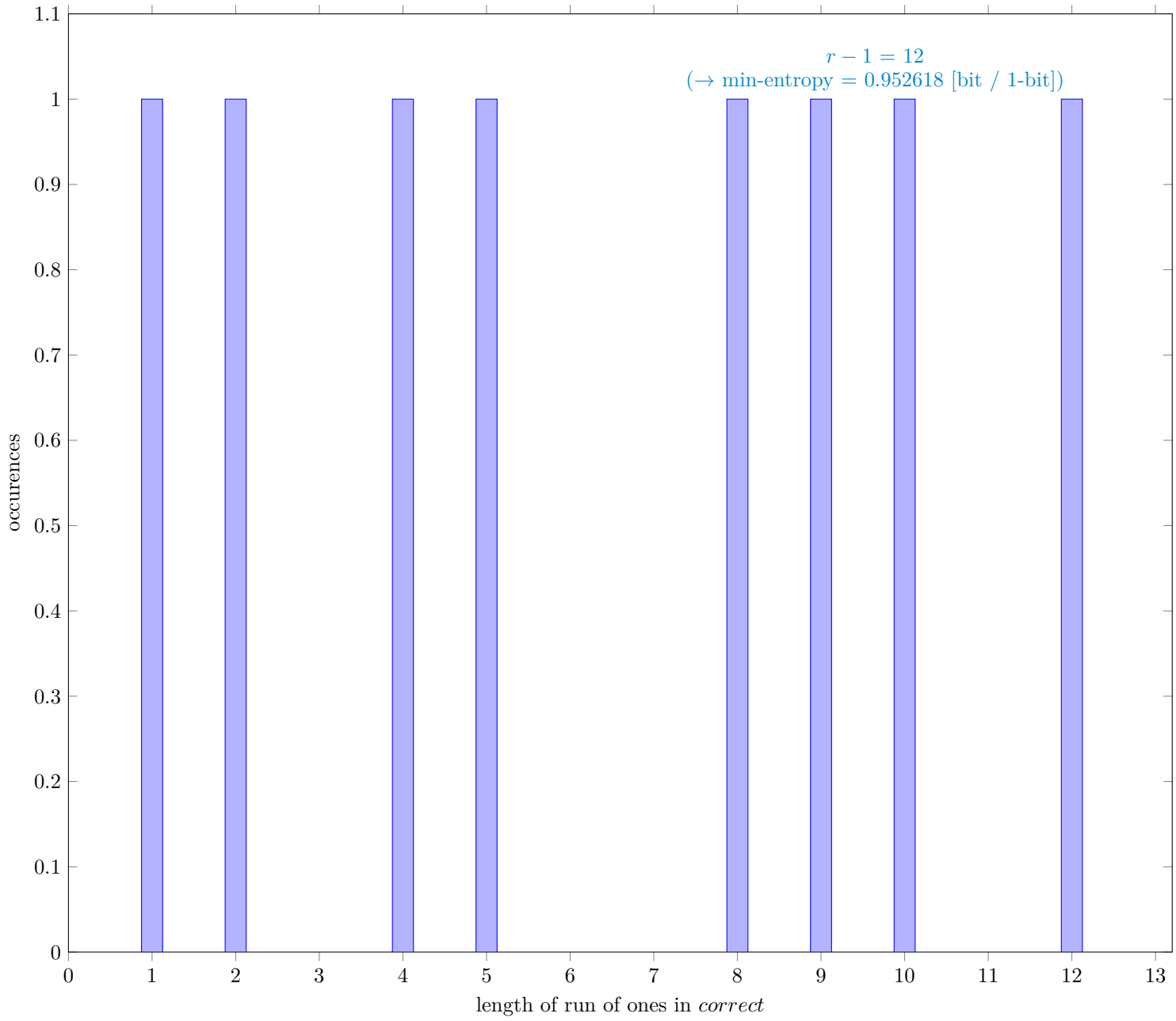

Fig. 12 Distribution of *correct*

3.7.1 Supplemental information for traceability

Table 10 Supplemental information for traceability (NIST SP 800-90B Section 6.3.7)

Symbol	Value
N	9937
C	5006
P_{global}	0.503774
P'_{global}	0.516694
r	13
P_{local}	0.357828

3.8 Lag Prediction Estimate (NIST SP 800-90B Section 6.3.8)

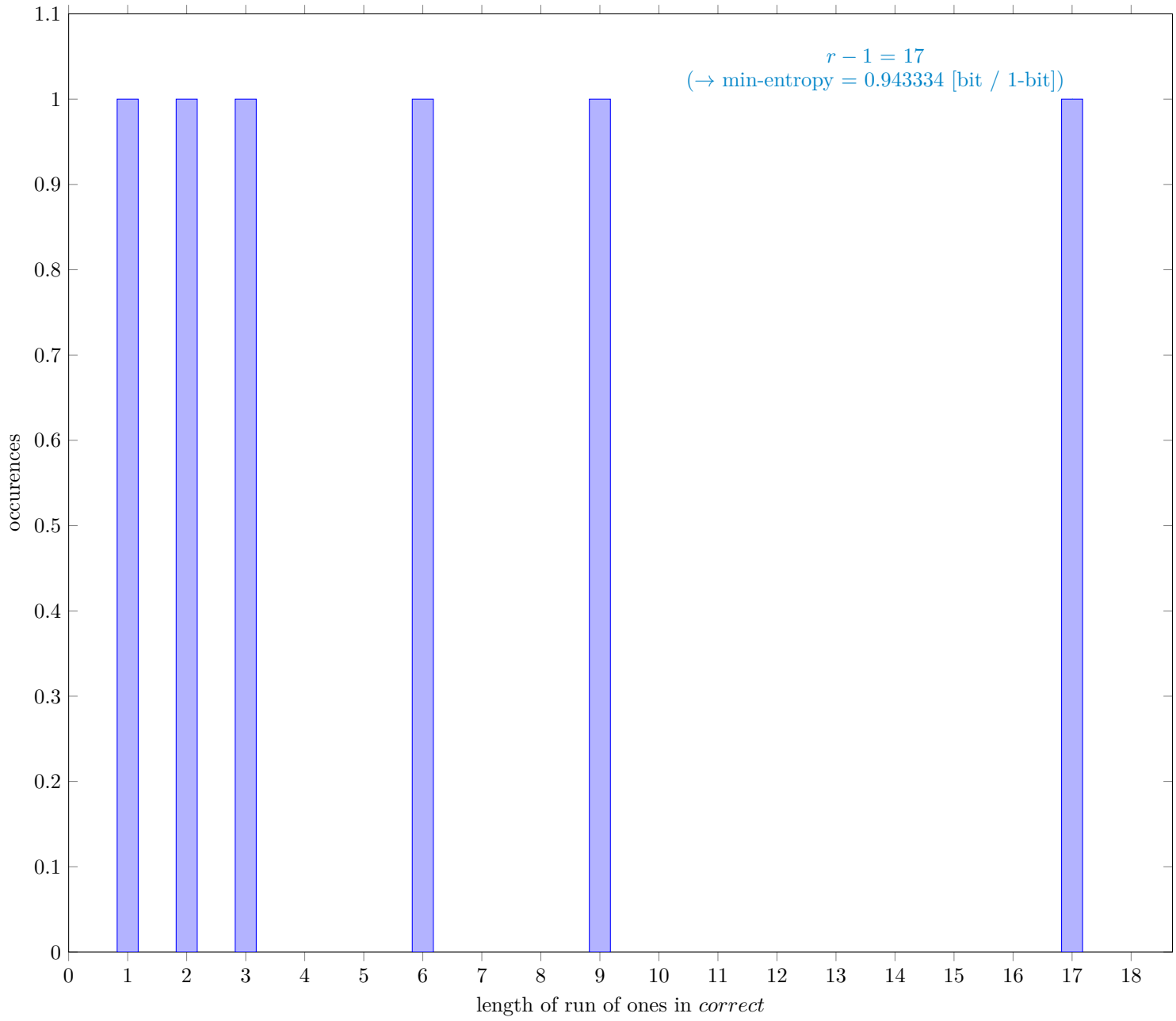

Fig. 13 Distribution of *correct*

3.8.1 Supplemental information for traceability

Table 11 Supplemental information for traceability (NIST SP 800-90B Section 6.3.8)

Symbol	Value
N	9999
C	5071
P_{global}	0.507151
P'_{global}	0.52003
r	18
P_{local}	0.481593

3.9 The MultiMMC Prediction Estimate (NIST SP 800-90B Section 6.3.9)

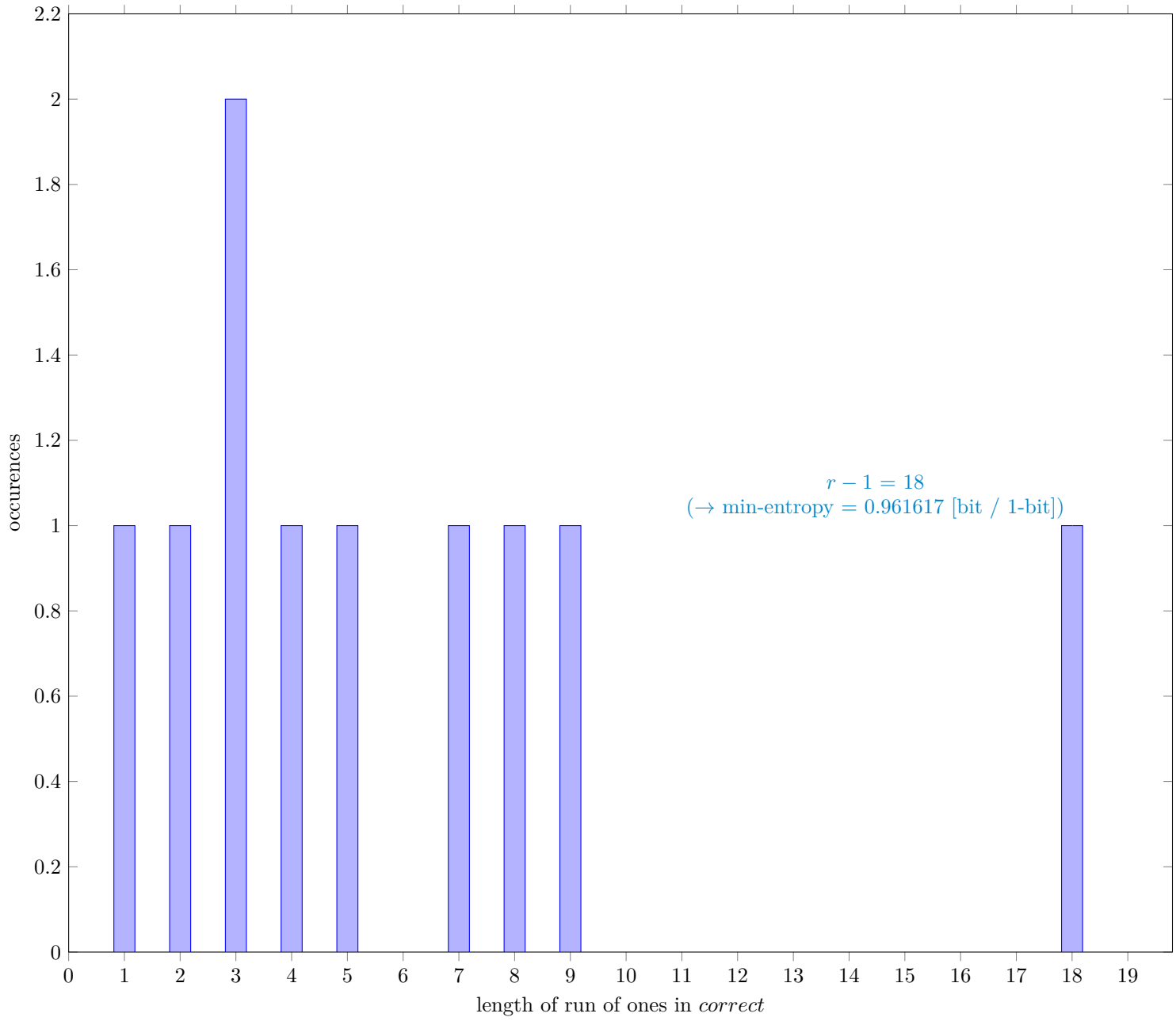

Fig. 14 Distribution of *correct*

3.9.1 Supplemental information for traceability

Table 12 Supplemental information for traceability (NIST SP 800-90B Section 6.3.9)

Symbol	Value
N	9998
C	5005
P_{global}	0.5006
P'_{global}	0.513481
r	19
P_{local}	0.501512

3.10 The LZ78Y Prediction Estimate (NIST SP 800-90B Section 6.3.10)

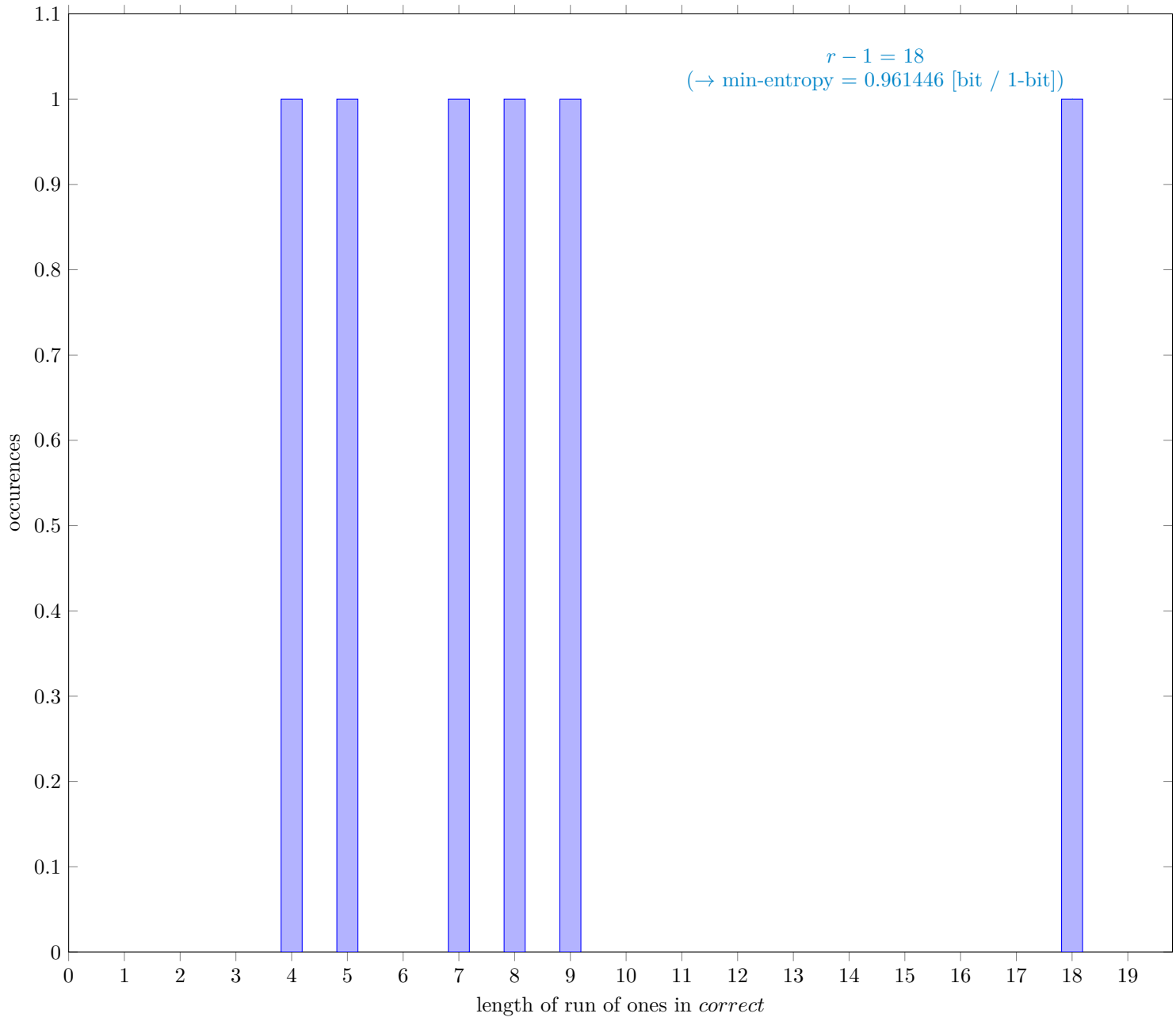

Fig. 15 Distribution of *correct*

3.10.1 Supplemental information for traceability

Table 13 Supplemental information for traceability (NIST SP 800-90B Section 6.3.10)

Symbol	Value
N	9983
C	4998
P_{global}	0.500651
P'_{global}	0.513542
r	19
P_{local}	0.501554

3 References

[1] Meltem Sönmez Turan, Elaine Barker, John Kelsey, Kerry A. McKay, Mary L. Baish, Mike Boyle *Recommendation for the Entropy Sources Used for Random Bit Generation*, NIST Special Publication 800-90B, Jan. 2018 `https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-90B.pdf`

[2] G. Sakurai, *Proposed list of corrections for NIST SP 800-90B 6.3 Estimators*, Dec. 2022 `https://github.com/g-g-sakura/AnotherEntropyEstimationTool/blob/main/documentation/ProposedListOfCorrections_SP800-90B.pdf`