



Higgs hadronic decay at CEPC



TDR draft

• Advanced Tagging algorithm——ParticleTransformer deeply used in TDR research



Figure 15.15: The confusion matrix M_{11} of JOI using realistic PID of leptons and charged hadrons for $v\bar{v}H$, $H \rightarrow qq$ events at $\sqrt{s} = 240$ GeV, with the reference detector. The matrix is normalized to unity for each truth label.

Jet Origin Identification (JOI)



Figure 15.20: The migration matrix for the seven classes is shown. The horizontal axis represents the prediction of the model for each event in the test set, while the vertical axis indicates the true labels. The sum of values in each row equals 1.

Higgs hadronic decay

Motivation



- Better flavor ID enhances sensitivity in rare Higgs decay channels
- JOI -> physics analysis
- Test Higgs couplings across generations



Advanced Tagging: Particle Transformer



- Particle transformer: attention on particle and their "interactions"
- **Particle attention**: particle <-> particle
- Class attention: particles -> class/jet flavor

$$\Delta = \sqrt{(y_a - y_b)^2 + (\phi_a - \phi_b)^2},$$

$$k_{\rm T} = \min(p_{{\rm T},a}, p_{{\rm T},b})\Delta,$$

$$z = \min(p_{{\rm T},a}, p_{{\rm T},b})/(p_{{\rm T},a} + p_{{\rm T},b}),$$

$$m^2 = (E_a + E_b)^2 - \|\mathbf{p}_a + \mathbf{p}_b\|^2,$$

interactions



https://arxiv.org/abs/2202.03772

Advanced Tagging: More–Interaction Particle Transformer

 よ 済 え 通 大 学 Shanghai Jiao Tong University

- Particle transformer: attention on particle and their "interactions"
- **Particle attention**: particle <-> particle
- Class attention: particles -> class/jet flavor
- More-Interaction attention: reduces model complexity compared with particle attention

model	Params
ParticleNet	370k
ParT	2.14M
MIParT	720.9k



Advanced Tagging: ParticleNet

- Dynamic Graph Convolutional Neural Network
 - Dynamically updates the graph to reflect the changes in the edges
- Permutationally symmetric operation
 - Particles are connected to neighbors
- Stackability
 - Graph can evolve with more blocks

Variable	Definition
$\Delta \eta$	Difference in pseudorapidity between the particle and the jet axis
$\Delta \phi$	Difference in azimuthal angle between the particle and the jet axis
$\log p_T$	Logarithm of the particle's p_T
log E	Logarithm of the particle's energy
$\log \frac{p_T}{p_T(\text{jet})}$	Logarithm of the particle's p_T relative to the jet p_T
$\log \frac{E}{E(\text{iet})}$	Logarithm of the particle's energy relative to the jet energy
ΔR	Angular separation between the particle and the jet axis $\left(\sqrt{(\Delta \eta)^2 + (\Delta \phi)^2}\right)$
q	Electric charge of the particle



JOI sample





- $e^+e^- \rightarrow \nu \bar{\nu} H$, $H \rightarrow qq/gg$ at 240GeV, fast simulation, CDR card
- Whizard(1.95+pythia6.4)
- 1 Million samples each, 0.8M for tagging, 0.2M for event selection



Jet tagging output



• Capable of tagging light jets even charged jets

	b -	0.736	0.144	0.029	0.022	0.004	0.003	0.002	0.002	0.002	0.002	0.055
	- <i>b</i>	0.143	0.737	0.022	0.029	0.003	0.004	0.003	0.002	0.001	0.001	0.055
	с-	0.013	0.013	0.736	0.054	0.026	0.023	0.017	0.007	0.006	0.011	0.094
	. -	0.013	0.013	0.052	0.739	0.022	0.027	0.007	0.017	0.011	0.006	0.093
	s -	0.004	0.003	0.017	0.016	0.522	0.087	0.019	0.065	0.045	0.034	0.188
True	5 -	0.003	0.004	0.016	0.018	0.087	0.522	0.061	0.020	0.035	0.044	0.189
	u -	0.004	0.004	0.016	0.011	0.030	0.094	0.353	0.053	0.064	0.144	0.227
	u -	0.004	0.004	0.011	0.016	0.091	0.031	0.051	0.358	0.144	0.063	0.228
	d -	0.004	0.004	0.012	0.016	0.071	0.068	0.071	0.197	0.267	0.061	0.229
	d -	0.004	0.004	0.016	0.012	0.068	0.071	0.193	0.074	0.062	0.266	0.230
	G -	0.014	0.013	0.022	0.022	0.045	0.045	0.042	0.042	0.034	0.033	0.689
		b	$\frac{1}{b}$	c	$\frac{1}{c}$	S	s	u	\overline{u}	d	d	Ġ
						Pr	edicte	ed				

• diag =
$$\frac{1}{Num \ of \ classes}$$
 trace(matrix)

• Each model trained **3** times, the below tabel shows average value

	ParticleNet	ParT	MIParT
diag	0.537	0.550	0.546
b tag as b/ $ar{b}$	0.878	0.891	0.885
c tag as c/ $ar{c}$	0.790	0.800	0.797
s tag as s/ s	0.608	0.616	0.618
g tag as g	0.686	0.670	0.664



Jet tagging output



• Comparable results from ParT & MIParT

d - G -	0.004 0.004 0.004 0.014	0.004 0.004 0.004 0.014 $\frac{1}{b}$	0.013 0.017 0.022 <i>C</i>	0.017 0.013 0.023	0.067 0.066 0.046	0.065 0.066 0.047	0.072 0.169 0.043	0.178 0.075 0.044	0.308 0.067 0.039	0.066 0.312 0.040	0.207 0.208 0.668
d - G -	0.004 0.004 0.004 0.004	0.004 0.004 0.004 0.014	0.013 0.017 0.022	0.017 0.013 0.023	0.067 0.066 0.046	0.065 0.066 0.047	0.072 0.169 0.043	0.178 0.075 0.044	0.308 0.067 0.039	0.066 0.312 0.040	0.207 0.208 0.668
d -	0.004	0.004 0.004 0.004	0.013	0.017 0.013	0.067 0.066	0.065 0.066	0.072 0.169	0.178 0.075	0.308 0.067	0.066 0.312	0.207 0.208
_	0.004	0.004	0.013	0.017	0.067	0.065	0.072	0.178	0.308	0.066	0.207
d -	0.004	0.004									
ū -		0.004	0.011	0.017	0.085	0.030	0.051	0.353	0.169	0.071	0.206
u -	0.004	0.004	0.017	0.012	0.030	0.086	0.342	0.054	0.071	0.174	0.206
an Ir -	0.004	0.004	0.017	0.019	0.085	0.531	0.061	0.022	0.040	0.052	0.166
s -	0.004	0.003	0.018	0.017	0.531	0.084	0.021	0.066	0.051	0.040	0.164
. -	0.013	0.013	0.050	0.751	0.022	0.026	0.007	0.017	0.013	0.007	0.082
с-	0.014	0.013	0.746	0.054	0.027	0.021	0.016	0.007	0.007	0.013	0.083
b -	0.139	0.751	0.019	0.026	0.003	0.004	0.003	0.002	0.002	0.002	0.049
b -	0.754	0.137	0.027	0.019	0.004	0.003	0.002	0.002	0.002	0.002	0.048

0.004 0.004 0.003 0.014	0.003 0.003 0.004 0.013 <u>b</u>	0.012 0.013 0.017 0.022 c	0.017 0.017 0.013 0.022 $\frac{1}{c}$	0.089 0.067 0.068 0.047	0.029 0.065 0.067 0.047 $\frac{1}{5}$	0.046 0.067 0.166 0.042	0.359 0.188 0.077 0.045	0.161 0.297 0.065 0.038	0.073 0.069 0.310 0.041 $\frac{1}{d}$	0.208 0.209 0.210 0.670
0.004 0.004 0.003 0.014	0.003 0.003 0.004 0.013	0.012 0.013 0.017 0.022	0.017 0.017 0.013 0.022	0.089 0.067 0.068 0.047	0.029 0.065 0.067 0.047	0.046 0.067 0.166 0.042	0.359 0.188 0.077 0.045	0.161 0.297 0.065 0.038	0.073 0.069 0.310 0.041	0.208 0.209 0.210 0.670
0.004 0.004 0.003	0.003 0.003 0.004	0.012 0.013 0.017	0.017 0.017 0.013	0.089 0.067 0.068	0.029 0.065 0.067	0.046 0.067 0.166	0.359 0.188 0.077	0.161 0.297 0.065	0.073 0.069 0.310	0.208 0.209 0.210
0.004 0.004	0.003 0.003	0.012	0.017	0.089	0.029	0.046 0.067	0.359 0.188	0.161	0.073	0.208
0.004	0.003	0.012	0.017	0.089	0.029	0.046	0.359	0.161	0.073	0.208
										0.000
0.004	0.004	0.017	0.012	0.030	0.088	0.335	0.056	0.068	0.180	0.207
0.003	0.004	0.017	0.018	0.084	0.528	0.062	0.021	0.040	0.051	0.170
0.004	0.003	0.019	0.017	0.530	0.084	0.020	0.063	0.052	0.038	0.170
0.013	0.012	0.053	0.744	0.021	0.026	0.007	0.018	0.013	0.007	0.086
0.013	0.012	0.744	0.053	0.027	0.022	0.017	0.007	0.007	0.013	0.086
0.141	0.744	0.021	0.027	0.003	0.004	0.003	0.002	0.002	0.002	0.051
0.749	0.137	0.028	0.020	0.004	0.003	0.002	0.002	0.002	0.002	0.051
	0.749 0.141 0.013 0.013 0.004 0.003 0.004	0.7490.1370.1410.7440.0130.0120.0130.0120.0040.0030.0030.0040.0040.004	0.7490.1370.0280.1410.7440.0210.0130.0120.7440.0130.0120.0530.0040.0030.0190.0030.0040.0170.0040.0040.017	0.7490.1370.0280.0200.1410.7440.0210.0270.0130.0120.7440.0530.0130.0120.0530.7440.0040.0030.0190.0170.0030.0040.0170.0180.0040.0040.0170.012	0.7490.1370.0280.0200.0040.1410.7440.0210.0270.0030.0130.0120.7440.0530.0270.0130.0120.0530.7440.0210.0040.0030.0190.0170.5300.0030.0040.0170.0180.0840.0040.0040.0170.0120.030	0.7490.1370.0280.0200.0040.0030.1410.7440.0210.0270.0030.0040.0130.0120.7440.0530.0270.0220.0130.0120.0530.7440.0210.0260.0040.0030.0190.0170.5300.0840.0030.0040.0170.0180.0340.5280.0040.0040.0170.0120.0300.088	0.7490.1370.0280.0200.0040.0030.0020.1410.7440.0210.0270.0030.0040.0030.0130.0120.7440.0530.0270.0220.0170.0130.0120.0130.7440.0210.0260.0070.0140.0150.0170.5300.0840.0200.0030.0040.0170.0180.0840.5280.0620.0040.0040.0170.0120.0300.0880.335	0.7490.1370.0280.0200.0040.0030.0020.0020.1410.7440.0210.0270.0030.0040.0030.0020.0130.0120.7440.0530.0270.0220.0170.0070.0130.0120.0130.7440.0530.0270.0220.0170.0070.0130.0120.0130.7440.0210.0220.0170.0180.0040.0030.0170.0180.0840.2280.0200.0210.0040.0040.0170.0120.0300.0880.3350.056	0.749 0.137 0.028 0.020 0.004 0.003 0.002 0.002 0.002 0.141 0.744 0.021 0.027 0.003 0.004 0.003 0.002 0.002 0.013 0.012 0.744 0.027 0.003 0.004 0.003 0.002 0.002 0.013 0.012 0.744 0.025 0.027 0.022 0.017 0.007 0.007 0.013 0.012 0.744 0.053 0.027 0.022 0.017 0.007 0.007 0.013 0.012 0.053 0.744 0.021 0.026 0.007 0.017 0.007 0.014 0.019 0.017 0.530 0.084 0.020 0.021 0.040 0.004 0.004 0.017 0.018 0.084 0.335 0.056 0.068 0.004 0.017 0.012 0.030 0.088 0.335 0.056 0.068	0.7490.1370.0280.0200.0040.0030.0020.0020.0020.0020.1410.7440.0210.0270.0030.0040.0030.0020.0020.0020.0020.0130.0120.7440.0530.0270.0220.0170.0070.0070.0070.0130.0130.0120.7440.0530.0270.0220.0170.0070.0070.0070.0130.0130.0120.0530.7440.0210.0220.0170.0170.0130.0270.0170.0130.0170.0040.0030.0170.0170.5300.0840.0200.0630.0520.0510.0040.0040.0170.0120.0300.0880.3350.0560.0680.180

MIParT, Fast simulation, CDR

2025-7-25

ParT,Fast simulation, CDR

Jet tagging infer



- Inference on 2f
- Similar flavor score distributions
 –> has good generalization ability

	b -	0.736	0.136	0.025	0.019	0.006	0.006	0.058	0.008	0.003	0.002
	<u></u> -	0.144	0.729	0.018	0.025	0.006	0.007	0.058	0.008	0.003	0.003
	с -	0.024	0.014	0.737	0.058	0.033	0.030	0.066	0.015	0.010	0.013
	. -	0.015	0.022	0.060	0.735	0.031	0.032	0.059	0.024	0.013	0.010
ar	s -	0.002	0.002	0.015	0.013	0.571	0.119	0.085	0.080	0.067	0.046
Ъ	<u>s</u> -	0.002	0.002	0.012	0.016	0.124	0.565	0.129	0.036	0.046	0.068
	u -	0.002	0.002	0.011	0.008	0.057	0.134	0.434	0.087	0.085	0.180
	<u>u</u> -	0.002	0.002	0.008	0.012	0.137	0.055	0.122	0.406	0.166	0.090
	d -	0.002	0.002	0.008	0.012	0.120	0.097	0.152	0.220	0.304	0.085
	d -	0.002	0.002	0.011	0.009	0.098	0.118	0.249	0.112	0.080	0.320
	3	b	$\frac{1}{b}$	c	Ċ	S	5	ů	\overline{u}	d	đ
						Pred	icted				

ParT,Fast simulation, TDR

Input channels



• 2 fermions process

• ZH, $Z \rightarrow vv$, $H \rightarrow qq/gg/ZZ$



for H->ZZ, Z->vv, Z->qq



• 4 fermions_nu process



Feynman diagram from the CEPC note

Input channels

2025-7-25



- Fast simulation: whizard (1.95+pythia6.4, CDR card)
 - H->ZZ sample used TDR card

for event selection

channel	cross section [fb]	expected events [M]	simulated events [M]	scale factor
ZH, Z→vv, H–>bb	26.71	0.5342	0.2	2.671
ZH, Z→vv, H–>cc	1.35	0.027	0.2	0.135
ZH, Z→vv, H–>ss	0.01	0.0002	0.2	0.001
ZH, Z→vv, H–>gg	3.97	0.0794	0.2	0.397
ZH, Z→vv, H–>ZZ; Z–>vv, Z–>qq	0.34	0.0068	10	0.0007
ZZ, Z→vv, Z→dd/ss/bb	139.71	2.7942	1	2.80
ZZ, Z→νν, Z→uu/cc	84.38	1.6876	1	1.69
Single Z, vv, Z→dd/ss/bb	90.03	1.8006	1	1.80
Single Z, vv, Z→uu/cc	55.59	1.1118	1	1.11
2f, qq	54106.86	1082.1372	4	270.53
	ł	https://arxiv	.org/pdf/22	03.01469

Input features



- Jet constructed by <u>eekt algorithm</u>, each event has 2 jets
 - each jet-level feature, both leading and subleading jet are contained
- For PN/ParT/MIParT, each trained three times
 - 3 scores per type of tagging model per jet
 - Single Jet Kinematics: jet_pt, jet_pz, jet_eta, jet_theta, jet_phi, jet_energy
 - Jet Shape & Composition: jet_nParticles, jet_dR, jet_dPT
 - Jet Pair Observables: mjj, detajj, dthetajj, dphijj
 - Missing Energy: MET, ME_eta, ME_theta, ME_phi, MEZ, METOHT
 - Jet-MET Angular Correlations: jet_ME_deta/dphi/dtheta
 - Jet Flavor Tagging Scores: jet_flavor_score(PN/ParT/MIParT)



Jet score distribution

- Distribution for different models' score
- the same model was used to perform inference three times





Raw distribution







Region

bbccgg/ss region



leading jet pz: (-95~95)GeV leading jet pt: (15~100)GeV MEZ: (-55,55)GeV mass peak: (110, 140)GeV

bbccgg region

same as above, plus leading_score_b_PN<0.2 leading_score_c_PN<0.2

ss region



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set ss region: Suppress bkg variation from other processes





Pre Cutflow table



- bbccgg region
- Keep enough events/topology for ML training
- Suppress 2f, 4f and HZZ process

cut	H->bb	H->cc	H–>gg	H->ss	H->ZZ	4f_nu	2f
No cut	200,000	200,000	200,000	200,000	10M	4,000,000	4,000,000
leading jet pz (–95~95)GeV	99.93%	99.91%	99.95%	99.89%	99.99%	99.67%	78.70%
leading jet pt (15~100)GeV	99.39%	99.42%	99.52%	99.38%	82.38%	97.04%	78.85%
MEZ (–55,55)GeV	97.81%	97.67%	97.81%	97.56%	98.69%	63.21%	32.18%
mass peak (110,140)GeV	77.76%	89.70%	95.54%	90.85%	0.20%	3.51%	1.06%
pre–cut eff	75.54%	87.03%	92.96%	87.99%	0.16%	24.31%	0.21%
remaining	151082	174061	180418	175984	15621	140277	8491
2025-7-25							SITU

Pre Cutflow table

• ss region



cut	H->bb	H->cc	H–>gg	H->ss	H->ZZ	4f_nu	2f	
No cut	200,000	200,000	200,000	200,000	10M	4,000,000	4,000,000	
leading jet pz (–95~95)GeV	99.93%	99.91%	99.95%	99.89%	99.99%	99.67%	78.70%	
leading jet pt (15~100)GeV	99.39%	99.42%	99.52%	99.38%	82.38%	97.04%	78.85%	
MEZ (–55~55)GeV	97.81%	97.67%	97.81%	97.56%	98.69%	63.21%	32.18%	
mass peak (110~140)GeV	77.76%	89.70%	95.54%	90.85%	0.20%	5.74%	1.06%	
lead_score_b (0~0.2)	39.76%	98.10%	98.00%	99.80%	94.48%	91.57%	83.75%	
lead_score_c (0~0.2)	94.80%	53.46%	97.16%	98.37%	87.66%	86.45%	86.04%	
pre–cut eff	28.48%	45.64%	88.51%	86.38%	0.13%	2.78%	0.15%	
remaining	56950	91289	177020	172761	12109	111052	6118	
2025-7-25								

BDT setting





- main model: XGBoost
 - num_boost_round = **300**,
 - learning_rate = **0.1**
 - max_depth = **3**
 - train:val:test = **6:2:2**

For PN/ParT/MIParT, each trained three times
 → 3 scores per type of tagging model per jet

• 6 classes: h->bb, h->cc, h->gg, h->ss, 2fermions, 4fermions

BDT output



• Strong discriminative power for main classes



Cutflow table

- H->bb/cc/gg as signal
- XGB Combined
- ML-cut at the point which makes the highest significance of signal

signal	eff & remain	H->bb	H->cc	H–>gg	H->ss	H->ZZ	4f_nu	2f
	total-cut	58.40%	1.95E-04	0.75%	1.20E-04	1.09E-05	0.19%	5.94E-06
H–>bb	Events after ML–cut (20/ab)	311979.35	5.26	592.39	0.02	0.08	14408.67	6423.24
	total-cut	1.45E-04	36.34%	0.30%	6.50E-05	3.40E-06	0.08%	2.47E-07
H->cc	Events after ML–cut (20/ab)	77.46	9810.80	240.55	0.01	0.02	6161.97	267.63
	total-cut	0.13%	0.35%	39.70%	1.06%	1.20E-06	0.02%	2.47E-07
H–>gg	Events after ML–cut (20/ab)	675.75	95.85	31523.73	2.12	0.01	1736.05	267.63



Cutflow table

- H–>ss as signal
- XGB Combined
- ML-cut at the point which makes the highest significance of signal

				Signal				
cut	H->bb	H->cc	H–>gg	H–>ss	H->ZZ	4f_nu	2f	
No cut	100%	100%	100%	100%	100%	100%	100%	
pre-cut	28.48%	45.64%	88.51%	86.38%	0.13%	2.78%	0.15%	
ML-cut	0	0.11%	0.46%	35.55%	0.10%	1.34%	0	
total-cut	0	0.05%	0.41%	30.70%	1.29E-06	0.04%	0	
σ[fb]	26.71	1.35	3.97	0.01	0.36	369.71	54106.86	3
Events after pre–cut (20/ab)	152140.16	12322.80	70276.94	172.76	9.36	205558.76	1623205.8	30
Events after ML–cut (20/ab)	0	13.90	324.83	61.41	0.01	2745.05	0	



Relative Error



• Relative error =
$$\frac{\sqrt{S+B}}{S}$$

 Lower relative error implies better precision in measuring signal yield



Relative Error



- Relative error compare with published paper, at $20ab^{-1}$ (5.6 ab^{-1})
 - encourage result
 - precision of "Z $\rightarrow vv$, H->cc" has significant improvement (~35%)

	Z →vv, H–>bb %	Z →vv, H–>cc %	Z →vv, H–>gg %	Z →vv, H–>ss %
published	0.2 (0.4)	1.85 (3.7)	0.7 (1.4)	_
XGB_PN	0.18 (0.35)	1.24 (2.35)	0.61 (1.14)	93.34(176.40)
XGB_ParT	0.19 (0.35)	1.23 (2.33)	0.59 (1.11)	93.62(176.93)
XGB_MIParT	0.19 (0.35)	1.22 (2.31)	0.59 (1.11)	92.10(174.05)
XGB_Combined	0.18 (0.35)	1.22 (2.31)	0.58 (1.09)	91.33(172.59)



Compare with the lastest result

• Compare with the lastest holistic result



						20 ab_
https://arxiv.org/pdf/25	506.11783					
			$H ightarrow b ar{b}$	$H \to c \bar c$	$H \to gg$	$H\to s\bar{s}$
Only considered pro	ocess H->bb/cc/gg/ss	cut + BDT	0.26%[21]	3.04%[21]	0.96%[21]	190.00%[19]
Bevond "cut+BDT"		holistic	0.14%	0.72%	0.46%	29.34%
Near the holistic		holistic with CSI	-	-	-	-
		holistic with ideal CSI	-	1 7.6	1.5	-
		statistical limit	0.14%	0.61%	0.36%	6.91%
model	$Z \rightarrow vv$, H–>bb % Z	→vv, H–>cc % Z -	→vv, H–>g	g %	Z →vv, H–	>ss %
XGB_PN	0.17	0.84	0.49			9
XGB_ParT	0.17	0.84	0.49		32.08	
XGB_MIParT	0.17	0.86	0.48		32.58	
XGB_Combined	0.17	0.82	0.48		32.3	0
2025-7-25						

Summary & todo



- Three advanced tagging algorithms have been evaluated for jet tagging task
- Jet-based study of Higgs hadronic decay considered main background
- Relative error:

0.18% for $H \rightarrow bb$, **1.22%** for cc, **0.58%** for gg, and **91.33%** for ss at $20ab^{-1}$

• Results are close to the lastest performance

- Todo
 - Large data: 1M->10M
 - H->ss further
 - new model structure







Input channels 4f

single Z_nu



Feynman diagram from the CEPC note



Input channels 4f_nu







Feynman diagram from the CEPC note

Performance





- Jet level kinematics + PID from Quark–gluon tagging dataset
- Representation suit with model structure

 $\operatorname{Rej}_{50\%} = \frac{1}{\operatorname{bkg \,mis-id \,rate}} \Big|_{\operatorname{signal \,efficiency} [\%]}$

	Accuracy	AUC	$\mathrm{Rej}_{50\%}$
PFN		0.9052	$37.4 {\pm} 0.7$
ABCNet	0.840	0.9126	42.6 ± 0.4
\mathbf{PCT}	0.841	0.9140	$43.2 {\pm} 0.7$
LorentzNet	0.844	0.9156	42.4 ± 0.4
ParT	0.849	0.9203	$47.9 {\pm} 0.5$
MIParT (ours)	0.851	0.9215	49.3 ± 0.4
ParT f.t.	0.852	0.9230	$50.6 {\pm} 0.2$
MIParT-L f.t. (ours)	0.853	0.9237	51.9 ± 0.5

PN CDR





	5.902											
					5	a	าว					
	b	$\frac{1}{b}$	c	Ċ	s Pr	हं redicte	u ed	ū	d	$\frac{1}{d}$	Ġ	
G	0.013	0.014	0.022	0.022	0.045	0.046	0.042	0.042	0.034	0.035	0.686	
d ·	0.004	0.004	0.016	0.012	0.067	0.072	0.181	0.068	0.066	0.281	0.229	
d	0.004	0.004	0.012	0.017	0.071	0.069	0.072	0.181	0.278	0.064	0.228	
ū	0.004	0.004	0.011	0.016	0.091	0.032	0.050	0.342	0.157	0.067	0.227	
u ·	0.004	0.005	0.016	0.011	0.030	0.094	0.340	0.048	0.068	0.158	0.227	
2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0.003	0.005	0.016	0.017	0.085	0.521	0.061	0.019	0.035	0.048	0.190	
s ·	0.004	0.004	0.016	0.016	0.515	0.090	0.019	0.064	0.046	0.036	0.190	
ō.	0.013	0.014	0.052	0.736	0.023	0.027	0.007	0.017	0.011	0.005	0.094	
c ·	0.013	0.014	0.734	0.054	0.027	0.024	0.017	0.007	0.006	0.011	0.094	
b.	0.141	0.738	0.022	0.029	0.003	0.004	0.003	0.002	0.002	0.001	0.055	
b•	0.729	0.149	0.030	0.023	0.004	0.003	0.002	0.002	0.002	0.001	0.055	







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PN CDR

			D	_	_	Pr	edicte	ed			u	-
		b	$\frac{1}{h}$	ċ	÷	s	5	ů	u	d	d	Ġ
	G -	0.014	0.014	0.022	0.022	0.047	0.047	0.044	0.043	0.039	0.039	0.670
	<u>d</u> -	0.004	0.004	0.017	0.013	0.067	0.066	0.174	0.075	0.067	0.304	0.209
	d -	0.004	0.004	0.013	0.017	0.068	0.064	0.073	0.180	0.305	0.065	0.209
	u -	0.004	0.004	0.012	0.017	0.088	0.029	0.051	0.354	0.164	0.069	0.208
	u -	0.004	0.005	0.016	0.012	0.031	0.086	0.348	0.054	0.070	0.168	0.206
True	5 -	0.004	0.004	0.017	0.019	0.086	0.531	0.063	0.022	0.039	0.049	0.165
	s -	0.004	0.004	0.019	0.018	0.533	0.085	0.021	0.063	0.051	0.037	0.164
	. -	0.013	0.015	0.051	0.749	0.022	0.025	0.007	0.017	0.013	0.006	0.082
	с -	0.015	0.014	0.745	0.053	0.026	0.021	0.017	0.007	0.007	0.012	0.083
	<u></u> -	0.141	0.750	0.019	0.026	0.003	0.004	0.003	0.002	0.002	0.002	0.049
	b-	0.756	0.135	0.027	0.018	0.004	0.003	0.002	0.003	0.002	0.002	0.049

6.044
random2

	- -	0.136	0.754	0.019	0.026	0.003	0.004	0.003	0.002	0.002	0.002	0.049
	с-	0.014	0.013	0.748	0.053	0.025	0.021	0.017	0.007	0.007	0.012	0.083
	- 7	0.013	0.014	0.051	0.750	0.021	0.025	0.007	0.017	0.013	0.006	0.083
	s -	0.004	0.003	0.020	0.017	0.531	0.084	0.022	0.062	0.052	0.037	0.168
ומש	<u>s</u> -	0.004	0.004	0.017	0.019	0.084	0.531	0.063	0.022	0.039	0.049	0.168
	u -	0.004	0.004	0.017	0.012	0.029	0.086	0.354	0.052	0.070	0.163	0.210
	ū -	0.004	0.004	0.011	0.017	0.086	0.029	0.053	0.349	0.167	0.068	0.211
	d -	0.004	0.004	0.013	0.017	0.066	0.065	0.075	0.176	0.305	0.065	0.210
	d -	0.004	0.004	0.017	0.013	0.065	0.066	0.180	0.074	0.066	0.299	0.213
	G -	0.014	0.014	0.023	0.022	0.046	0.046	0.043	0.042	0.039	0.038	0.673
					_		_					

		D	D	Ľ	Ľ	Pr	edicte	ed	u	u	a	0
		h	+	Ċ	÷	5	÷			d	4	Ġ
	G -	0.014	0.014	0.022	0.023	0.046	0.047	0.043	0.044	0.039	0.040	0.668
	d -	0.004	0.004	0.017	0.013	0.066	0.066	0.169	0.075	0.067	0.312	0.208
	d -	0.004	0.004	0.013	0.017	0.067	0.065	0.072	0.178	0.308	0.066	0.207
	<u>u</u> -	0.004	0.004	0.011	0.017	0.085	0.030	0.051	0.353	0.169	0.071	0.206
	u -	0.004	0.004	0.017	0.012	0.030	0.086	0.342	0.054	0.071	0.174	0.206
True	<u>s</u> -	0.004	0.004	0.017	0.019	0.085	0.531	0.061	0.022	0.040	0.052	0.166
	s -	0.004	0.003	0.018	0.017	0.531	0.084	0.021	0.066	0.051	0.040	0.164
	. -	0.013	0.013	0.050	0.751	0.022	0.026	0.007	0.017	0.013	0.007	0.082
	с-	0.014	0.013	0.746	0.054	0.027	0.021	0.016	0.007	0.007	0.013	0.083
	- -	0.139	0.751	0.019	0.026	0.003	0.004	0.003	0.002	0.002	0.002	0.049
	b -	0.754	0.137	0.027	0.019	0.004	0.003	0.002	0.002	0.002	0.002	0.048

6.046 random1

6.047 random0

PN CDR

Irue





	ь -	0.744	0.140	0.030	0.022	0.004	0.003	0.002	0.002	0.002	0.002	0.049
	b -	0.138	0.744	0.023	0.029	0.003	0.004	0.003	0.002	0.002	0.002	0.049
	с-	0.014	0.013	0.748	0.053	0.027	0.022	0.017	0.007	0.006	0.012	0.081
	ē -	0.014	0.014	0.054	0.747	0.023	0.025	0.007	0.017	0.012	0.006	0.081
	s -	0.004	0.004	0.021	0.019	0.536	0.087	0.021	0.063	0.049	0.037	0.160
True	<u>-</u>	0.004	0.004	0.019	0.021	0.087	0.533	0.064	0.021	0.037	0.049	0.160
	u -	0.003	0.004	0.019	0.012	0.032	0.090	0.348	0.053	0.070	0.168	0.200
	<u>u</u> -	0.004	0.004	0.013	0.018	0.093	0.030	0.051	0.355	0.161	0.069	0.201
	d -	0.004	0.004	0.014	0.019	0.072	0.067	0.072	0.185	0.296	0.066	0.200
	d -	0.004	0.004	0.019	0.013	0.070	0.069	0.178	0.074	0.065	0.300	0.203
	G -	0.014	0.014	0.024	0.023	0.050	0.050	0.045	0.044	0.039	0.039	0.657
		b	$\frac{1}{b}$	c	Ċ	s Pr	ਤੂਂ edicte	u ed	ū	d	đ	Ġ



6.011 random0

6.007 random1

