4-13 Randomized Algorithms

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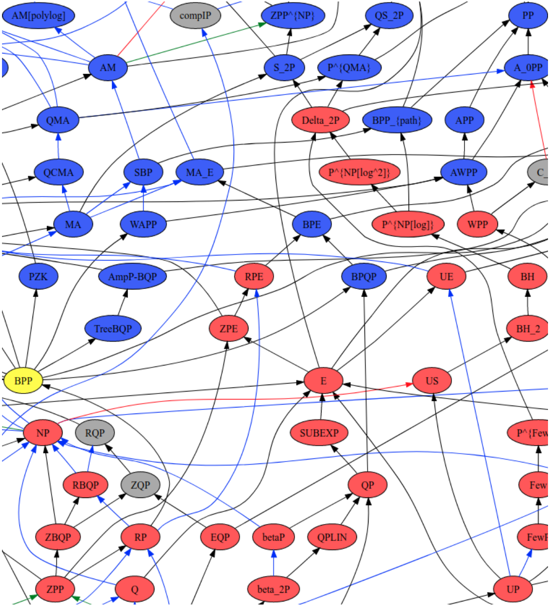
AM[polylog]
compIP
ZPP^{NP}
QS_2P
PP
AM
S_2P
P^{QMA}
A_0PP
QMA
Delta_2P
BPP_{path}
APP
QCMA
SBP
MA_E
P^{NP[log^2]}
AWPP
MA
WAPP
BPE
P^{NP[log]}
WPP
PZK
AmpP-BQP
RPE
BPQP
UE
BH
TreeBQP
ZPE
BH_2
BPP
E
US
NP
RQP
SUBEXP
RBQP
ZQP
QP
ZBQP
RP
EQP
betaP
QPLIN
ZPP
Q
beta_2P
UP

$$P \subseteq ZPP \subseteq RP \subseteq BPP \subseteq PP$$

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Exercise 5.2.2.9

Definition (ZPP: Zero-error Probabilistic Polynomial Time)

$$L \in ZPP$$

$$\iff$$

$$\exists A \ (\textit{probabilistic polynomial-time algorithm}):$$

$$Pr\Big(A(x) = L(x)\Big) \geq \frac{1}{2}$$

$$Prob\Big(A(x) =?\Big) = 1 - Pr\Big(A(x) = L(x)\Big) \leq \frac{1}{2}$$

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$$ZPP_\delta : ZPP_{1/3} = ZPP_{1/2} = ZPP_{2/3}$$

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$A^{(k)}$: Repeat A k times independently

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$$Pr\Big(A^{(k)}(x) = L(x)\Big) = 1 - Pr\Big(A^{(k)}(x) = ?\Big) \geq 1 - (1-\delta)^k$$

$$L \in ZPP_{1-(1-\delta)^k}$$

Definition (RP: Randomized Polynomial time (One-Sided Error))

$$L \in RP$$

$$\Longleftrightarrow$$

$$\exists A \; (\textit{probabilistic polynomial-time algorithm}):$$

$$x \in L \implies Pr\Big(A(x) = 1\Big) \geq \frac{1}{2}$$

$$x \notin L \implies Pr\Big(A(x) = 0\Big) = 1$$

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Definition (BPP: Bounded-error Probabilistic Polynomial time (Two-Sided Error))

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$$\exists A \ (\textit{probabilistic polynomial-time algorithm}):$$

$$\exists \epsilon, 0 < \epsilon \leq 1/2 : Pr\Big(A(x) = L(x)\Big) \geq \frac{1}{2} + \epsilon$$

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$$Pr\Big(A^{(k)}(x) = L(x)\Big) \geq 1 - \sum_{i=0}^{\lfloor k/2 \rfloor} \binom{t}{i} p^i (1-p)^{k-i} > 1 - \frac{1}{2}(1-4\delta^2)^{k/2}$$

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$$L \in BPP_{1-\epsilon} \implies k \geq \frac{2 \ln 2\epsilon}{\ln(1-4\delta^2)}$$

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Q : What about $Pr\Big(A(x) = L(x)\Big) \geq \frac{1}{2} + n^{-c}$ for some constant c?

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Indicator random variables

$$X_i = \begin{cases} 1, & x_i = L(x) \\ 0, & \text{otherwise} \end{cases}$$

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$$L \in BPP_{1-e^{-n^d}}$$

$$\boxed{\forall \text{ constant } c, d > 0 : BPP_{\frac{1}{2}+\frac{1}{n^c}} = BPP_{1-\frac{1}{e^{n^d}}}}$$

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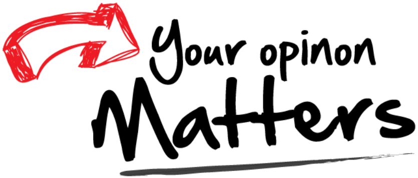
$$Pr\Big(A^{(k)}(x) = L(x)\Big) \geq 1 - \delta$$

k may be exponential of n


THANK YOU



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