❊'❧❧ ❤🖳 ❣♦❧❧♦✇🖳❤❣ ✐ ✉' ✐♦❤ ' ♠♦ '❧ "✐❧🖳♠♠'✿ ②♦✉ ' 🖳 ✉❤"🖳 '❤ '❧❧❊ ❤✐❤❣ ❊"♦❤ ✐"🖳 🖳"

♦'❧✐❣' ✐♦❤ ♦ ♣🖳 ❣♦ ♠ ♦❤🖳 '" ✐♦❤✱ '❤" ②♦✉ ' 🖳 ✉❤"🖳 '❤ '❧❧❊ ❤✐❤❣ ❊"♦❤ ✐"🖳 🖳" ♦'❧✐❣' ✐♦❤

♦ ♣🖳 ❣♦ ♠ '❤♦ ❤🖳 '" ✐♦❤✱ '✉ ✐ ✐ ♣ '" ✐"'❧❧② ✐♠♣♦ ✐'❧🖳 ❣♦ ②♦✉ ♦ ♣🖳 ❣♦ ♠ '♦ ❤ ❤🖳 🖳

'" ✐♦❤ ✳ ❖♣♣♦❤🖳❤ ♦❣ ♠♦ '❧ "✐❧🖳♠♠' ♦❣ 🖳❤ 🖳♠♣❧♦② "🖳♦❤ ✐" ❧♦❣✐" ♦ ' ❣✉🖳 ❤' ♠♦ '❧

"✐❧🖳♠♠' ' 🖳 ✐♠♣♦ ✐'❧🖳✳ ❊'✈✐" ❊ ✐❤❦ ❤' ♣ ♦♠✐❤🖳❤ ❧② "🖳✈🖳❧♦♣🖳" ✇♦ ✉"❤ ' ❣✉♠🖳❤ ✱

'✐♠✐❤❣ ♦ ❤♦✇ ❤' ✐❤ "♦♠'✐❤' ✐♦❤ ✇✐ ❤ "🖳 '✐❤ ✐❤ ✉✐ ✐✈🖳❧② ♣❧'✉ ✐'❧🖳 ♣ ✐❤"✐♣❧🖳 ✱ ❤🖳 ' ❊

✉♠♣ ✐♦❤ ❤' ❤🖳 🖳 ' 🖳 ♠♦ '❧ "✐❧🖳♠♠' ❧🖳" ✐❤ ♦ "♦❤ '"✐" ✐♦ ✳ ■ ❧♦♦❦ ' ✇♦ ✐❤✐ ✐'❧

♦'❧🖳 "✐♦❤ ♦ ❊ ✐❤❦❦ ' ❣✉♠❤ '❤" ' ❣✉🖳 ❤' ❤🖳② "♦ ❤♦ ❤♦❧" ✉♣ ♦ " ✉ ✐❤②✳ ■ ❤🖳❤

"🖳✈🖳❧♦♣ ♠② ♦✇❤ " ✐ ✐"✐ ♠ ♦❣ ❊ ✐❤❦❦ ❣✉❤ '② ❣♦"✉ ✐❤✐❣ ♦❤ ♦❤🖳 ♦❣ ❤🖳 ♣ ✐❤"✐♣❧🖳

❤🖳 ✐❤✈♦❦🖳 ✱ ❖'❧✐❣' ✐♦❤ ✳①🖳"✉ ✐♦❤✳ ■ ❤♦❧" ❤' ✐❣ ② ♦✉ ' 🖳 '❧❧❊ ❤✐❤❣ ❊"♦❤ ✐"🖳 🖳" ♦'❧✐❊

❣' 🖳" ♦ φ '❤" ψ❊✐❤❣ ✇❊✉✱ ❤🖳❤ ② ♦✉❧" ♣ 🖳✈🖳❤ φ❊✐❤❣✱ ❤🖳❤ ② ♦✉ ' 🖳 ✉❤"🖳 '❤ '❧❧❊ ❤✐❤❣ ❊"♦❤ ✐"🖳 🖳"

♦'❧✐❣' ✐♦❤ ♦ ❤♦ ❊ψ✳ ❊ ✐❤❦ 🖳❤"🖳 ❤✐ ' (O(φ) ∧ (ψ →¬φ)) → O(¬ψ) ♦ 🖳♠♣❧♦② '

' ♣ 🖳♠✐ 🖳 ✐❤ ❤✐ ' ❣✉♠❤ ✳ ○♦✇🖳✈🖳 ✱ ✐❤ 🖳 ♣ 🖳 ✐❤❣ ❤🖳 🖳♠'🖳""🖳" "♦❤"✐ ✐♦❤'❧ ✐❤ ❤🖳

'❤ 🖳"🖳"🖳❤ ' ' "♦✉❤ 🖳 ❣'" ✉'❧ '❧❧♦✇ ✉ ♦ "🖳 ✐✈🖳 " ✉ " ♦'❧✐❣' ✐♦❤ ✐❣ ❤🖳 ♦ ✐❣✐✐❤'❧

♦'❧✐❣' ✐♦❤ O(φ) ✐ ✈✐♦❧' 🖳"✳ ■ ♠✐❣❤ '🖳 "♦✉❤ 🖳 🖳" ❤' ✐❤"🖳 | '❤"' " ❊🖳♦❤ ✐" ▲♦❣✐"

' ' ✇❤♦❧🖳 ❣'"🖳 ❤✐ ♣' '"♦① ❣ ♦♠ ✈✐♦❧' 🖳" ♦'❧✐❣' ✐♦❤ ✱ ✐ ❤♦✉❧" ❤♦ '🖳 ❣✐✈🖳❤ ♠✉"❤

✇🖳✐❣❤ ✳ ■❤ 🖳 ♣♦❤ 🖳✱ ■ ❤♦✇ ❤♦✇ ❤🖳 ✇♦ "' 🖳 ' 🖳 🖳❧🖳✈'❤ ❧② "✐✛🖳 🖳❤ ✐❤ '♦ ❤ "'✉ 🖳

'❤" "♦♣🖳 ♦❣ ❤🖳 ♣ ♦'❧🖳♠✳ ■❤ 🖳"✱ ✇🖳 ♠✐❣❤ ② ♦ ✇🖳'✈🖳❤ ❖'❧✐❣' ✐♦❤ ❊✳①🖳"✉ ✐♦❤ '②

✉ ❤✐❤❣ ❤🖳 🖳♠'🖳""🖳" "♦❤"✐ ✐♦❤'❧ ✐❤ ♦ ' ✐"✐♠♣❧✐"' ✐♦❤✳ ▌❤✐ ✱ ❤♦✇🖳✈🖳 ✱ ♠'✈🖳 ❤🖳

♣ ✐❤"✐♣❧🖳 ♦♦ ✇🖳'✈ ❣♦ ❊ ✐❤❦❦ ❣✉ ♦ '🖳 ✈'❧✐"✳ ✱✐❤'❧❧②✱ ✇🖳 ♠✐❣❤ ♣ ✐❤ 🖳 ♣ 🖳 ❤🖳

"♦❤"✐ ✐♦❤'❧ ' 🖳①♣ 🖳 ✐❤❣ ♣ '" ✐"'❧ ❤🖳"🖳 ✐ ② ❣♦ ❤✉♠'❤ ✱ '❤'❧♦❣♦✉ ♦ ❤🖳 ♣ '"❊

✐"'❧ ✐♠♣❧ ♦♦ '✐❧✐❧ ② ✐❤✈♦❧✈🖳" ✐❤ ❤🖳 "🖳✛❤✐ ✐♦❤ ♦❣ ♠♦ '❧ "✐❧🖳♠♠' ✳ ❊✉ ❤✐ ✇♦✉✉❧" ❧❧❧♦✇

✉ ♦ ✐❤❣🖳 ❤' ❤🖳 ❤🖳❣' ✐♦❤ ♦❣ ♣ '" ✐"'❧ ✐♠♣❧ ✐🖳 ' 🖳 ♦'❧✐❣' ♦ ②✳ ⎡ 🖳 "♦✉❧"✱

❣♦ 🖳①'♠♣❧🖳✱ "🖳 ✐✈🖳 ♦'❧✐❣' ✐♦❤ ♦ "✐🖳✱ ♦ '🖳 ♦♠🖳✇' ✐ ' ✐♦❤'❧ ♦ ♦ ❤♦ ❤'✈🖳 '❧❧

✈'❧✉"❧🖳 ✇❤♦✇❧🖳"❣🖳✳ ■ "♦❤"❧✉"🖳 ❤' ❤🖳 🖳 ✐ ❤♦ 🖳❤"❧🖳 ❣♦ ♠'❧✐③' ✐♦❤

♦❣ ❖’❧✐❣’ ✐♦♥

❊①❦“✉ ✐♦♥ ♦♥❣ ❦♥♦✉❣♥ ♦ ♠’❦❦ ❊ ✐♥❦✿ ’ ❣✉♠♠ ❤♥ ♣♦ ✐’✐❧✐ ②
♦❣ ♠♦ ’❧

”✐❧❦♠♠’ ✈’❧✐”✳