1.

(i)

(a) $p \land (q \lor r)$[|= / `]$(p \land q) \lor (p \land r)$

YES

p	q	r	$p\land(q\lor r)$	$(p\land q)\lor(p\land r)$
T	T	T	T	T
T	T	F	T	T
T	F	T	T	T
F	T	T	F	F
T	F	F	F	F
F	T	F	F	F
F	F	T	F	F
F	F	F	F	F

Inference is valid.

(b) [|= / `]$p \to (q \to p)$

YES

p	q	$p \to (q \to p)$
T	T	T
T	F	T
F	T	T
F	F	T

Inference is valid.

(c) $\neg p \to \neg q$[|= / `]$p \to q$

NO

p	q	$\neg p \to \neg q$	$p \to q$
T	T	T	T
T	F	T	F
F	T	F	T
F	F	T	T

Inference is invalid

(d) $\neg p \to \neg q$, $\neg q \to \neg p$[|= / `]$p \leftrightarrow q$

YES

p	q	$\neg p \to \neg q$	$\neg q \to \neg p$	$p \leftrightarrow q$
T	T	T	T	T
T	F	T	F	F
F	T	F	T	F
F	F	T	T	T

Inference is valid

(e) $p \to q$, $q \to r$[|= / `]$\neg r \to \neg q$

YES

p	q	r	$p \to q$	$q \to r$	$\neg r \to \neg q$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	T	T
F	T	T	T	T	T
T	F	F	F	T	T
F	T	F	T	F	F
F	F	T	T	T	T
F	F	F	T	T	T

Inference is valid

(ii)

(a) $p \wedge (q \vee r)$[|= / `]$(p \wedge q) \vee (p \wedge r)$

YES

Proof:

$\mathrm{CNF}(p\wedge(q\vee r)) \equiv p\wedge(q\vee r)$

$\mathrm{CNF}\neg((p\wedge q)\vee(p\wedge r)) \equiv (\neg p\vee\neg q)\wedge(\neg p\vee\neg r)$

1. p (Hypothesis)
2. $q\vee r$ (Hypothesis)
3. $(\neg p\vee\neg q)$ (Negation of Conclusion)
4. $(\neg p\vee\neg r)$ (Negation of Conclusion)
5. $(\neg p\vee q)$ 2,4 Resolution
6. $\neg p$ 3,5 Resolution
7. [] 1,6 Resolution

(b) [|= / `]$p \to (q \to p)$

YES

Proof:

$\mathrm{CNF}\neg(p \to (q \to p)) \equiv \neg(\neg p\vee(\neg q\vee p)) \equiv p\wedge q\wedge\neg p$

1. p (Negation of Conclusion)
2. q (Negation of Conclusion)
3. $\neg p$ (Negation of Conclusion)
4. [] 1,3 Resolution

(c) $\neg p \to \neg q$[|= / `]$p \to q$

NO

$\text{CNF}(\neg p \rightarrow \neg q) \equiv p \lor \neg q$
$\text{CNF}\neg(p \rightarrow q) \equiv p \land \neg q$

1. $p \lor \neg q$ (Hypothesis)
2. p (Negation of Conclusion)
3. $\neg q$ (Negation of Conclusion)

(d) ¬p → ¬q, ¬q → ¬p[|= / `]p ↔ q
YES
Proof:
$\text{CNF}(\neg p \rightarrow \neg q) \equiv p \lor \neg q$
$\text{CNF}(\neg q \rightarrow \neg p) \equiv q \lor \neg p$
$\text{CNF}\neg(p \leftrightarrow q) \equiv \neg(\neg p \lor q) \lor \neg(\neg q \lor p) \equiv (p \land \neg q) \lor (q \land \neg p) \equiv (p \lor q) \land (\neg q \lor \neg p)$

1. $p \lor \neg q$ (Hypothesis)
2. $q \lor \neg p$ (Hypothesis)
3. $(p \lor q)$ (Negation of Conclusion)
4. $(\neg q \lor \neg p)$ (Negation of Conclusion)
5. [] 3,4 Resolution

(e) p → q, q → r[|= / `]¬r → ¬q
YES
Proof:
$\text{CNF}(p \rightarrow q) \equiv \neg p \lor q$
$\text{CNF}(q \rightarrow r) \equiv \neg q \lor r$
$\text{CNF}\neg(\neg r \rightarrow \neg q) \equiv \neg r \land q$

1. $\neg p \lor q$ (Hypothesis)
2. $\neg q \lor r$ (Hypothesis)
3. $\neg r$ (Negation of Conclusion)
4. q (Negation of Conclusion)
5. r 2,4 Resolution
6. [] 3,5 Resolution

2.

(a).

From: As subsequent investigation revealed, the March Hare and the Doormouse were not both speaking the truth.

$lying$ (marchHare) $\vee$ $lying$ $(doormouse)$

marchHare:

$\neg lying(marchHare) \leftrightarrow \neg\ stole(marchHare,jam)$

Mad$Hare$:

$\neg lying(\text{Mad}Hare) \leftrightarrow (\text{Stole}(\text{marchHare}) \vee \text{Stole}(doormouse))\ \ \wedge$

$\neg \text{Stole}(\text{Mad}Hare)$

$doormouse$:

$\neg lying(doormouse) \leftrightarrow \neg lying(marchHare) \vee \neg lying(\text{Mad}Hare)$

(b)

$lying$ (marchHare) $\vee$ $lying$ $(doormouse)$

$= stole(marchHare,jam) \vee (lying(marchHare)\ \ \wedge lying(\text{Mad}Hare))$

$= stole(marchHare,jam) \vee (stole(marchHare,jam)\ \ \wedge lying(\text{Mad}Hare))$

Because $lying(\text{Mad}Hare)$ means madHare stole the jam and marchHare did not stole the jam, $stole(marchHare,jam)\ \ \wedge lying(\text{Mad}Hare)$ will not occur.

AS a result, $marchHare$ stole the jam.

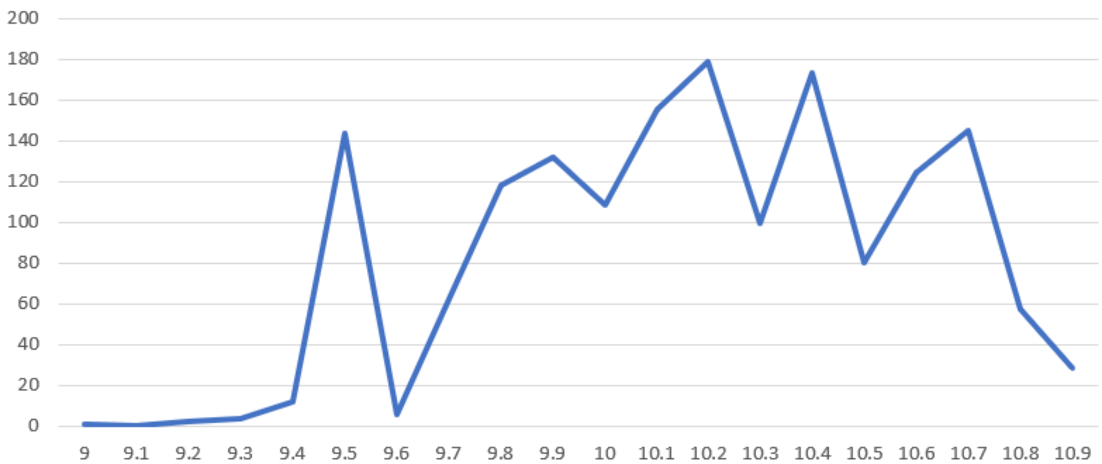
(c)

(d)

3.

easy-hard-easy pattern exists.

In experiment, if c is less than 9 or c large than 11, it takes little time to run the program. Because of clauses is generated randomly, the cpu time is different even using same c value.



As the result show, c=10.2, the cpu time is largest

4.production system
a) A production system classifies the common characteristics shared by a class of reasoning problems, and has the following components:
1. Collection of states
Example: Start or initial state,Goal state
2. Collection of productions: rules or moves
Example: If it is raining outside, then an umbrella will be bring
3. Control system: decides which production to apply next

b)
1.Compute the set of possible instantiations of the rules
2 selects the best instantiation by the control system. Strategy may be the order of rule, the frequency of rule executed, the more general rule ,or priority.
3 Rule execution

Deductive, forward chaining, data driven reasoning
Evidences, symptoms, facts ⇒ conclusions, hypothesis Inductive,
backward chaining (BC), goal driven
reasoning Conclusions, hypothesis ⇒ evidences, symptoms, facts Hybrid chaining

c)
advantage
1.The structure of each sentence in a production system is unique and uniform as they use "IF-THEN" structure. This structure provides simpli city in knowledge representation. This feature of production system improves the readability of production rules. 2Information can be treated as a collection of independent facts which may be added or deleted from the system with essentially no deletetious side effects.

Disvantage:
1As the rules of the production system are large in number and they are hardly written in hierarchical manner.2The rules in a production system should not have any type of conflict operations. When a new rule is added to a database, it should ensure that it does not have any conflicts with the existing rules.