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1. In Euclidean geometry the fifth axiom might be true but once you get to a different space like hyperbolic geometry, the other 4 axioms hold but the 5th one does not.
2. Take for example, let $S = "S \text{ is not provable}"$
Then by proof by contradiction would be suppose the statement is false which would be S is provable then S is true but S cannot be true and false thus S is true which would mean S is not provable.
3. Instead of "does there exist an integer N such that the program halts in less than N steps" where N is anything over the "infinite" set of positive integers, let's use "with memory up to M " where M is finite.
Now the question is "does it halt in less than N steps?"

4I) A: B is a lie-teller

B: A is a lie-teller

$$[A, B] = [F, F], [T, T]$$

4II) A: B is Truth-teller

B: A is a lie-teller

$$[A, B] = [F, F], [T, T]$$

4III) A: B is a lie-teller

B: C is a lie-teller

C: A is a lie-teller

$$[A, B, C] = [F, F, F], [T, T, T]$$

4IV) A: B is a lie-teller

B: C is a lie-teller

C: D is a lie-teller

D: A is a lie-teller

$$[A, B, C, D] = [F, F, F, F], [T, T, T, T]$$