## **Q1** Association Rules

12 Points

Check all that apply.

- [ ] Deriving association rules from frequent itemsets requires scanning the dataset.
- [x] The bottleneck in finding strong association rules is in finding frequent itemsets.
- [ ] The search space of frequent itemsets is a lattice of size $2^{numberoftransaction}$.
- [x] The search space of frequent itemsets is a lattice of size $2^{numberofitems}$.
- [x] Extracting quantitative association rules is an optimization problem, because it is not possible to do a systematic search of association rules involving numerical variables.
- [ ] In association rules, if an itemset is frequent, then all its supersets are frequent.

## **Q2** Local Search

15 Points

The following statements are about Local Search in general. Check all true statements.

- [x] Hill-climbing moves to the best successor of the current state.
- [x] Local search keep only one/few states in memory and therefore use less memory than systematic search.
- [x] Hill-Climbing cannot escape from local minima.
- [ ] All Local Search algorithms are optimal, i.e., guaranteed to find a global optima.
- [x] Local Search encounters many problems in the state space landscape, such local minima/maxima, plateaus, and shoulders.
- [ ] Simulated Annealing cannot escape from local minima.
- [ ] In Simulated Annealing, the neighbor selected is always discarded if it is worse than the current state.
- [x] In a finite state space, if we run Hill climbing with random restarts, long enough, we are guaranteed to find the global optimum.
- [x] Simulated annealing is more likely to accept a bad move earlier in the search than later.
- [ ] Genetic algorithms are generally fast to converge to a solution

## **Q3** Arc consistency

5 Points

In checking arc consistency of $X \rightarrow Y$ , deleting one value from domain(X) may enable further reduction in the domains of other variables Z such that $Z \rightarrow X$.

Justify your answer.

- (•) True
- ( ) False

**For the justification, only do one of the submission options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

▾ HW 2 3.png Download

**The question:** In checking arc consistency of $X \to Y$, deleting one value from domain(X) may enable further reduction in the domains of other variables $Z$ such that $Z \to X$.

**Solution:** This is a **TRUE** statement. We may provide such an example where $X$, $Y$ and $Z$ denote NSW (New South Wales), SA (South Australia) and V (Victoria), respectively. In the arc consistency check of $X \to Y$, we delete **blue** from the domain of $X$ to make $X \to Y$ arc consistent. Meanwhile, we notice that this enables further reduction in the domain of $Z$, where **red** must be deleted from $Z$, as the arc consistency check of $Z \to X$ indicates that there is no valid value for $X$ if we set $Z$ to **red**.

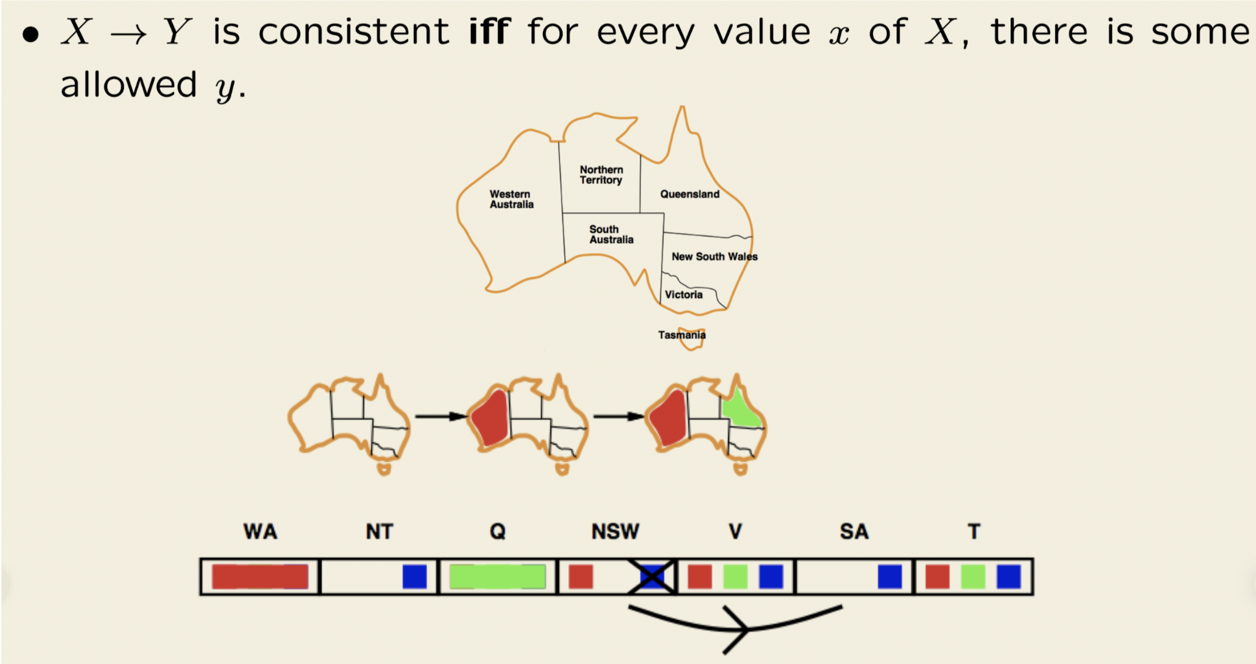
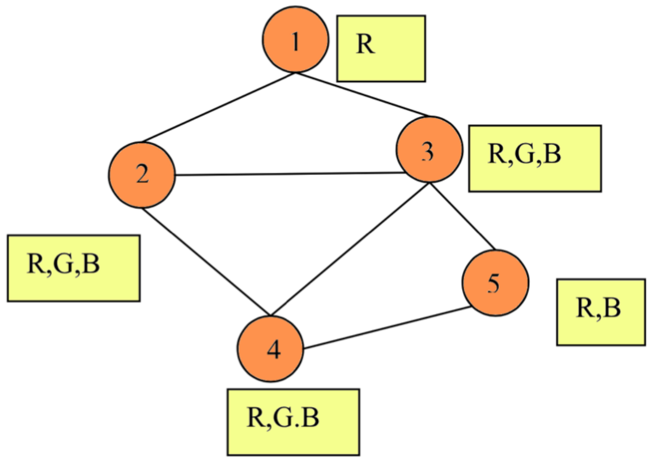



Figure 1: A scenario of the Map Colouring problem discussed in the lectures.

## Q4 CSPs

21 Points

Consider the following constraint graph for a graph coloring problem (the constraints indicate that connected nodes cannot have the same color). The domains are shown in the boxes next to each variable node.




### Q4.1

5 Points

What are the variable domains after a full constraint propagation?

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

1. (R)
2. (G, B)
3. (G, B)
4. (R, G, B)
5. (R, B)

No files uploaded

## Q4.2
8 Points

Show the sequence of variable assignments during a pure backtracking search (do not assume that the propagation above has been done), assume that the variables are examined in numerical order and the values are assigned in the order shown next to each node. Show assignments by writing the variable number and the value, e.g. 1R.

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

1R,
2G,
3B,
4R,
5 (backtracking),
4 (backtracking),
3 (backtracking),
2B,
3G,
4R,
5B.

Final result: 1R, 2B, 3G, 5R, 5B

No files uploaded

## Q4.3
8 Points

Show the sequence of variable assignments during backtracking with forward checking, assume that the variables are examined in numerical order and the values are assigned in the order shown next to each node. Show assignments by writing the variable number and the value, e.g. 1R.

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

1R,
2G,
No possible value for 5
2B,
3G,
4R,
5B.

Final result: 1R, 2B, 3G, 5R, 5B

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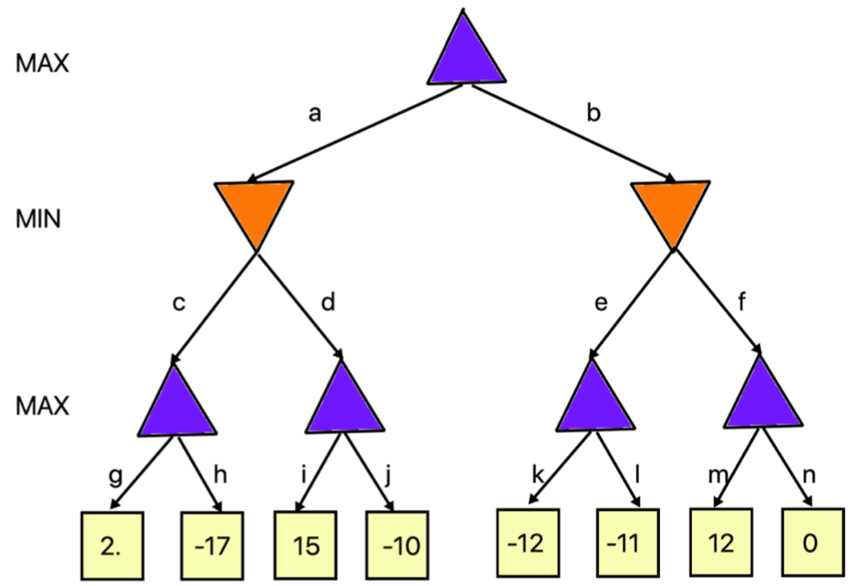
## **Q5** Minimax Algorithm

24 Points

Consider the following game tree.




### **Q5.1**

12 Points

What is the value of Max at the root?

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

2

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## Q5.2

12 Points

Using alpha beta pruning, what branches are cut? Justify your answer. Give all branches even if you gave their parents.

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

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Answer: $j$, $f$, $m$ and $n$ are cut.

**Proof:** For the value of $a$, it can be calculated as

$$\mathrm{MIN}(c,d) = \mathrm{MIN}(\mathrm{MAX}(2,-17), \mathrm{MAX}(15,j)) = \mathrm{MIN}(2, \mathrm{MAX}(15,j)) = 2. \tag{1}$$

This is because $\mathrm{MAX}(15,j) \geq 15$, which does not change the value of $\mathrm{MIN}(2, \mathrm{MAX}(15,j))$. So we never consider the value of $j$ and it is cut.

As for the value of the root, we know that it is equal to

$$\mathrm{MAX}(a,b) = \mathrm{MAX}(\mathrm{MIN}(c,d), \mathrm{MIN}(e,f)) = \mathrm{MAX}(2, \mathrm{MIN}(e,f)). \tag{2}$$

Since $k = -12$ and $l = -11$, we have $e = -11$. So the value of the root can be further written as

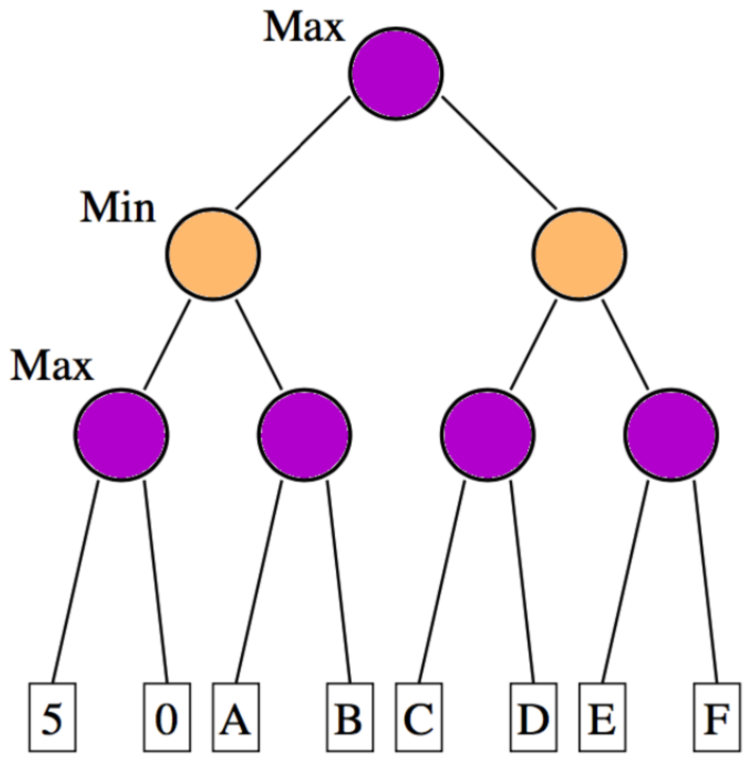
$$\mathrm{MAX}(2, \mathrm{MIN}(-11, f)), \tag{3}$$

with $\mathrm{MIN}(-11, f) \leq -11$, so the final result of $\mathrm{MAX}(2, \mathrm{MIN}(-11, f)) = 2$. We never need to consider the value of $j$ and therefore its children, $m$ and $n$. $\square$

## Q6 Alpha-Beta Pruning

23 Points

Consider the following game tree. Let A through F be real numbers. We explore the nodes with minimax and
$\alpha - \beta$ pruning.




### Q6.1
13 Points

Give a domain for A, so B is pruned.

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

B is pruned if A is larger than or equal to five.

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### Q6.2
10 Points

Let A = B = 5. Suggest values for C and D such as the subtree with children E and F is pruned.

**Only do one of the answer options, a text entry or a screenshot of latex, not both. (If you do both we will grade only the text entry.)**

An example can be C = D = 5.

In general, if MAX(C, D) is less than or equal to five, then the subtree is pruned.

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## Q7 Deadline

0 Points

Please make a note here if you received an extension from the teaching staff. If not, please leave this blank. We will use this question for early/late submission assignment adjustments.

# HW2 Conceptual

UNGRADED

**STUDENT**

Ziggy Chen

**TOTAL POINTS**

**- / 100 pts**

| | | |
|---|---|---|
| **QUESTION 1** | | |
| Association Rules | | 12 pts |
| **QUESTION 2** | | |
| Local Search | | 15 pts |
| **QUESTION 3** | | |
| Arc consistency | | 5 pts |
| **QUESTION 4** | | |
| CSPs | | 21 pts |
| 4.1 | (no title) | 5 pts |
| 4.2 | (no title) | 8 pts |
| 4.3 | (no title) | 8 pts |
| **QUESTION 5** | | |
| Minimax Algorithm | | 24 pts |
| 5.1 | (no title) | 12 pts |
| 5.2 | (no title) | 12 pts |

QUESTION 6

Alphа-Beta Pruning 23 pts

6.1 (no title) 13 pts

6.2 (no title) 10 pts

QUESTION 7

Deadline 0 pts