Bayesian Estimation of Student Placement Readiness and Risk

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Chapter 1

Bayesian Network Architecture

1.1 Overview

The Bayesian Network constructed for the estimation of student placement readiness is a probabilistic model capturing technical, psychological, and resume–related factors. It contains a total of **7 nodes**, divided into:

- **4 Evidence Nodes** (observed)

- **2 Hidden Nodes** (latent)

- **1 Target Node** (final prediction)

1.2 Nodes

1.2.1 Evidence Nodes

- **MockPerformance**: {Excellent, Good, Average, Poor}

- **Consistency**: {HighlyConsistent, Moderate, Irregular, Rare}

- **Rejections**: {None, 1–2, 3–5, MoreThan5}

- **ResumeQuality**: {High, Medium, Low}

1.2.2 Hidden Nodes

- **SkillLevel**: {High, Medium, Low} Parents: MockPerformance, Consistency

- **ConfidenceState**: {Confident, Neutral, Anxious, Frustrated} Parents: SkillLevel, Rejections

1.2.3   Target Node

- **PlacementReadiness**: {WellPrepared, ModeratelyPrepared, Underprepared, HighRisk} Parents: SkillLevel, ConfidenceState, ResumeQuality

1.3   Causal Relationships

The Bayesian Network is structured based on the following causal dependencies:

Causal Edge	Reason
MockPerformance → SkillLevel	Better mock scores indicate stronger technical ability.
Consistency → SkillLevel	Regular and disciplined practice develops stronger skills.
Rejections → ConfidenceState	More rejections reduce confidence and increase anxiety/frustration.
SkillLevel → ConfidenceState	Higher skill boosts confidence; low skill creates self-doubt.
SkillLevel → PlacementReadiness	Strong technical foundations directly improve placement success.
ConfidenceState → PlacementReadiness	Confident students perform better in interviews than anxious ones.
ResumeQuality → PlacementReadiness	Strong resumes increase shortlisting probability and overall readiness.

Table 1.1: Causal edges and their interpretations in the Bayesian Network

1.4 Graphical Structure
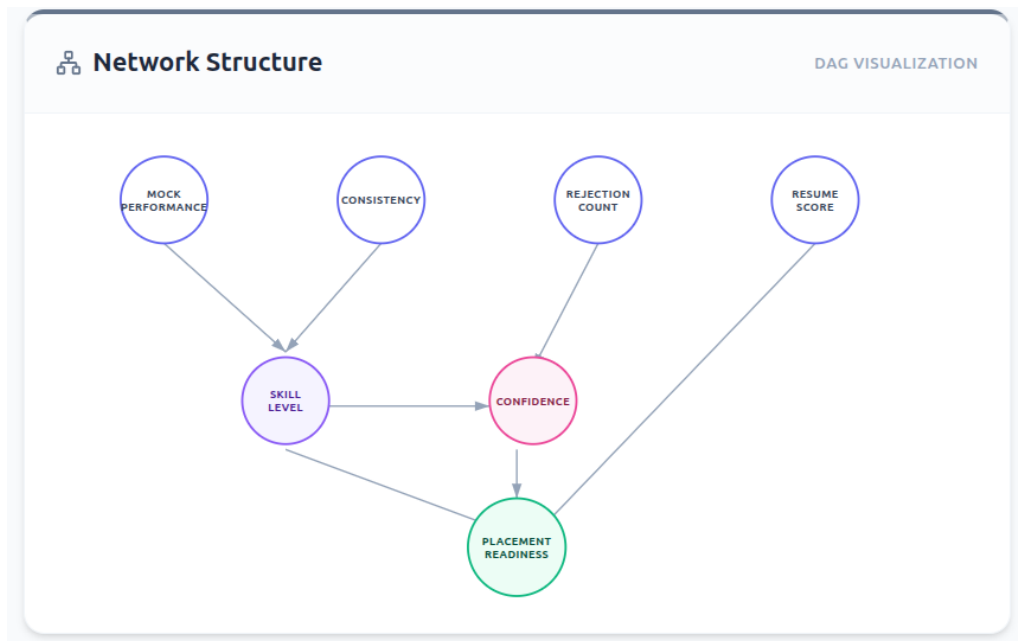
Figure 1.1: Bayesian Network Structure (DAG) for Placement Readiness

Chapter 2

Conditional Probability Tables (CPTs)

All CPTs are stored in `cpt_data.json` and loaded by the Python implementation. For completeness, the tables used in the final model are presented below.

2.1 Prior Probabilities

2.1.1 MockPerformance

State	Probability
Excellent	0.15
Good	0.30
Average	0.40
Poor	0.15

2.1.2 Consistency

State	Probability
HighlyConsistent	0.20
Moderate	0.35
Irregular	0.30
Rare	0.15

2.1.3 Rejections

State	Probability
None	0.25
1–2	0.35
3–5	0.25
MoreThan5	0.15

2.1.4 ResumeQuality

State	Probability	ATS Range
High	0.25	71–100
Medium	0.50	41–70
Low	0.25	0–40

2.2 CPT: SkillLevel

$P(SkillLevel \mid MockPerformance, Consistency)$

MockPerf	Consistency	High	Medium	Low
Excellent	HighlyConsistent	0.85	0.13	0.02
Excellent	Moderate	0.75	0.20	0.05
Excellent	Irregular	0.55	0.35	0.10
Excellent	Rare	0.35	0.45	0.20
Good	HighlyConsistent	0.70	0.25	0.05
Good	Moderate	0.55	0.35	0.10
Good	Irregular	0.35	0.45	0.20
Good	Rare	0.20	0.45	0.35
Average	HighlyConsistent	0.45	0.45	0.10
Average	Moderate	0.30	0.50	0.20
Average	Irregular	0.15	0.50	0.35
Average	Rare	0.08	0.37	0.55
Poor	HighlyConsistent	0.20	0.50	0.30
Poor	Moderate	0.10	0.40	0.50
Poor	Irregular	0.05	0.25	0.70
Poor	Rare	0.02	0.18	0.80

2.3 CPT: ConfidenceState

$P(ConfidenceState \mid Rejections, SkillLevel)$

Rejections	Skill	Confident	Neutral	Anxious	Frustrated
None	High	0.70	0.25	0.04	0.01
None	Medium	0.50	0.40	0.08	0.02
None	Low	0.25	0.45	0.25	0.05
1–2	High	0.50	0.35	0.12	0.03
1–2	Medium	0.30	0.40	0.25	0.05
1–2	Low	0.10	0.30	0.45	0.15
3–5	High	0.30	0.35	0.28	0.07
3–5	Medium	0.15	0.30	0.40	0.15
3–5	Low	0.05	0.15	0.45	0.35
MoreThan5	High	0.15	0.25	0.40	0.20
MoreThan5	Medium	0.08	0.17	0.45	0.30
MoreThan5	Low	0.03	0.07	0.40	0.50

2.4 CPT: PlacementReadiness

$P(PlacementReadiness \mid SkillLevel, ConfidenceState, ResumeQuality)$

Skill	Confidence	Resume	WP	MP	UP	HR
High	Confident	High	0.90	0.08	0.01	0.01
High	Confident	Medium	0.75	0.20	0.04	0.01
High	Confident	Low	0.55	0.30	0.12	0.03
High	Neutral	High	0.75	0.20	0.04	0.01
High	Neutral	Medium	0.60	0.30	0.08	0.02
High	Neutral	Low	0.40	0.35	0.20	0.05
High	Anxious	High	0.55	0.30	0.10	0.05
High	Anxious	Medium	0.40	0.35	0.20	0.05
High	Anxious	Low	0.25	0.35	0.30	0.10
High	Frustrated	High	0.30	0.45	0.20	0.05
High	Frustrated	Medium	0.20	0.40	0.30	0.10
High	Frustrated	Low	0.10	0.30	0.40	0.20
Medium	Confident	High	0.50	0.40	0.08	0.02
Medium	Confident	Medium	0.30	0.50	0.17	0.03
Medium	Confident	Low	0.15	0.40	0.35	0.10

Medium	Neutral	High	0.35	0.45	0.17	0.03
Medium	Neutral	Medium	0.25	0.45	0.25	0.05
Medium	Neutral	Low	0.10	0.35	0.40	0.15
Medium	Anxious	High	0.15	0.40	0.35	0.10
Medium	Anxious	Medium	0.10	0.35	0.40	0.15
Medium	Anxious	Low	0.03	0.20	0.52	0.25
Medium	Frustrated	High	0.05	0.30	0.45	0.20
Medium	Frustrated	Medium	0.03	0.25	0.47	0.25
Medium	Frustrated	Low	0.01	0.15	0.45	0.39
Low	Confident	High	0.25	0.45	0.25	0.05
Low	Confident	Medium	0.20	0.40	0.30	0.10
Low	Confident	Low	0.10	0.30	0.40	0.20
Low	Neutral	High	0.15	0.40	0.35	0.10
Low	Neutral	Medium	0.10	0.35	0.40	0.15
Low	Neutral	Low	0.01	0.09	0.45	0.45
Low	Anxious	High	0.10	0.30	0.40	0.20
Low	Anxious	Medium	0.05	0.20	0.45	0.30
Low	Anxious	Low	0.02	0.10	0.40	0.48
Low	Frustrated	High	0.05	0.25	0.40	0.30
Low	Frustrated	Medium	0.03	0.15	0.40	0.42
Low	Frustrated	Low	0.00	0.02	0.28	0.70

Chapter 3

Results with Analysis

This chapter presents representative non-trivial test cases generated by the Python implementation of the Bayesian Network (`bayesian_network.py`). Each case consists of a specific set of observed evidence, followed by the inferred posteriors and qualitative analysis.

The following subsections show the actual terminal reports for four carefully chosen test cases.

3.1 Test Case 1 – Well-Prepared Student with Strong Resume

```
========================================================================
STUDENT PLACEMENT READINESS ASSESSMENT REPORT
========================================================================


INPUT EVIDENCE:
------------------------------------------------------------------------

  MockPerformance          : Excellent
  Consistency              : HighlyConsistent
  Rejections               : None
  ResumeQuality            : High (ATS Score: 71-100)

INFERRED SKILL LEVEL:
------------------------------------------------------------------------

  Most Likely State: High (85.00%)
  Probability Distribution:
    High           :  85.00%
    Medium         :  13.00%
```

```
   Low              :   2.00%


INFERRED CONFIDENCE STATE:
----------------------------------------------------------------------
  Most Likely State: Confident (66.50%)
  Probability Distribution:
    Confident      :  66.50%
    Neutral        :  27.35%
    Anxious        :   4.94%
    Frustrated     :   1.21%


PLACEMENT READINESS ASSESSMENT:
======================================================================
  PRIMARY ASSESSMENT: WellPrepared (76.46%)

  Detailed Probability Distribution:
    WellPrepared       :  76.46%
    ModeratelyPrepared :  17.21%
    Underprepared      :   4.64%
    HighRisk           :   1.68%


RECOMMENDED ACTIONS:
----------------------------------------------------------------------
    • Continue current preparation strategy
    • Focus on mock interviews with top companies
    • Work on advanced problem-solving


======================================================================
```

Analysis: This case corresponds to an ideal candidate with excellent performance, high consistency, no rejections and a strong resume. The model very strongly favours the *WellPrepared* state, with negligible risk.

3.2 Test Case 2 – Average Student with Pressure and Weak Resume

```
======================================================================
STUDENT PLACEMENT READINESS ASSESSMENT REPORT
======================================================================
```

```
INPUT EVIDENCE:
--------------------------------------------------------------------------
  MockPerformance         : Average
  Consistency             : Irregular
  Rejections              : 3-5
  ResumeQuality           : Low (ATS Score: <40)


INFERRED SKILL LEVEL:
--------------------------------------------------------------------------
  Most Likely State: Medium (50.00%)
  Probability Distribution:
    Medium        :  50.00%
    Low           :  35.00%
    High          :  15.00%


INFERRED CONFIDENCE STATE:
--------------------------------------------------------------------------
  Most Likely State: Anxious (39.95%)
  Probability Distribution:
    Anxious       :  39.95%
    Neutral       :  25.50%
    Frustrated    :  20.80%
    Confident     :  13.75%


PLACEMENT READINESS ASSESSMENT:
==========================================================================
  PRIMARY ASSESSMENT: Underprepared (41.57%)

  Detailed Probability Distribution:
    Underprepared       :  41.57%
    HighRisk            :  32.49%
    ModeratelyPrepared  :  18.58%
    WellPrepared        :   7.36%


IDENTIFIED RISK FACTORS:
--------------------------------------------------------------------------
  1. High rejection count affecting psychological state
  2. Inconsistent preparation pattern detected
```

```
   3. Technical skills need significant improvement
   4. Resume quality below ATS threshold (ATS score < 40)
   5. High probability of stress/frustration detected
   6. CRITICAL: Requires immediate intervention and support


RECOMMENDED ACTIONS:
----------------------------------------------------------------------

   • URGENT: Develop structured preparation plan
   • Daily practice schedule needed
   • Consider placement coaching/mentorship
   • Focus on fundamental concepts
   • Resume rewrite required (current ATS score insufficient)


======================================================================
```

Analysis: Here, the student exhibits moderate skill but suffers from irregular preparation, several rejections and a weak resume. The model classifies the student as primarily *Underprepared*, with a significant *HighRisk* component, emphasizing the need for early intervention.

3.3   Test Case 3 – High-Risk Student (Critical Intervention Needed)

```
======================================================================
STUDENT PLACEMENT READINESS ASSESSMENT REPORT
======================================================================


INPUT EVIDENCE:
----------------------------------------------------------------------

   MockPerformance          : Poor
   Consistency              : Rare
   Rejections               : MoreThan5
   ResumeQuality            : Low (ATS Score: <40)


INFERRED SKILL LEVEL:
----------------------------------------------------------------------

   Most Likely State: Low (80.00%)
   Probability Distribution:
     Low              :   80.00%
```

```
  Medium           :  18.00%
  High             :   2.00%


INFERRED CONFIDENCE STATE:
-------------------------------------------------------------------------
  Most Likely State: Frustrated (45.80%)
  Probability Distribution:
    Frustrated     :  45.80%
    Anxious        :  40.90%
    Neutral        :   9.16%
    Confident      :   4.14%


PLACEMENT READINESS ASSESSMENT:
=========================================================================
  PRIMARY ASSESSMENT: HighRisk (54.28%)

  Detailed Probability Distribution:
    HighRisk            :  54.28%
    Underprepared       :  37.42%
    ModeratelyPrepared  :   6.83%
    WellPrepared        :   1.47%


IDENTIFIED RISK FACTORS:
-------------------------------------------------------------------------
  1. High rejection count affecting psychological state
  2. Inconsistent preparation pattern detected
  3. Technical skills need significant improvement
  4. Resume quality below ATS threshold (ATS score < 40)
  5. High probability of stress/frustration detected
  6. Low skill level requires intensive training
  7. CRITICAL: Requires immediate intervention and support


RECOMMENDED ACTIONS:
-------------------------------------------------------------------------
  • CRITICAL: Immediate intervention required
  • Meet with placement officer/counselor
  • Consider stress management support
  • Intensive skill development program needed
  • Professional resume writing service recommended
```

- Explore alternative career paths if needed

==

Analysis: This is a clearly critical case: poor performance, almost no preparation, many rejections and a weak resume. The model justifiably classifies the student as predominantly *HighRisk*, and suggests multiple urgent interventions at both technical and psychological levels.

3.4 Test Case 4 – Good Skills Held Back by Poor Resume

```
========================================================================
STUDENT PLACEMENT READINESS ASSESSMENT REPORT
========================================================================


INPUT EVIDENCE:
------------------------------------------------------------------------

  MockPerformance          : Good
  Consistency              : Moderate
  Rejections               : 1-2
  ResumeQuality            : Low (ATS Score: <40)


INFERRED SKILL LEVEL:
------------------------------------------------------------------------

  Most Likely State: High (55.00%)
  Probability Distribution:
    High           :  55.00%
    Medium         :  35.00%
    Low            :  10.00%


INFERRED CONFIDENCE STATE:
------------------------------------------------------------------------

  Most Likely State: Confident (39.00%)
  Probability Distribution:
    Confident      :  39.00%
    Neutral        :  36.25%
    Anxious        :  19.85%
    Frustrated     :   4.90%
```

```
PLACEMENT READINESS ASSESSMENT:
======================================================================
  PRIMARY ASSESSMENT: Underprepared (30.94%)


  Detailed Probability Distribution:
    Underprepared       :  30.94%
    ModeratelyPrepared  :  29.66%
    WellPrepared        :  25.66%
    HighRisk            :  13.73%


IDENTIFIED RISK FACTORS:
----------------------------------------------------------------------
  1. Resume quality below ATS threshold (ATS score < 40)
  2. Skill level strong, but resume bottleneck significantly reduces readiness
  3. Mild psychological vulnerability detected (Anxious + Frustrated ~ 25%)


RECOMMENDED ACTIONS:
----------------------------------------------------------------------
  • Resume rewrite is the fastest high-impact improvement
  • Strengthen project descriptions and ATS keywords
  • Continue current preparation rhythm
  • Apply to companies that shortlist based on skills, not strict ATS thresholds
  • Improve competitive programming consistency


======================================================================
```

Analysis: This case illustrates how a strong skill profile can still translate into only *Underprepared* readiness due to a poor resume. The model identifies the resume as the primary bottleneck, suggesting that improving ATS alignment can significantly boost the student's prospects.