PDB - Review

- How do we build/represent PDB in practice
  - Goal state on queue
  - Put all neighbors on back of queue and update costs in PDB to 1+parent
  - Neighbors represented as regular states
    - Hash/ranking function ignores states which have been abstracted away

- Size of PDB

Better Sliding Tile Heuristic

- Manhattan distance
  - What’s wrong?
  - Doesn’t represent linear conflicts

- New heuristic:
  - MD + Linear conflicts
  - If two tiles are in the same row and out of order, add 2 to the heuristic

Heuristic operations?

- Max?
- Sum?
- Other?
Pattern Databases Enhancements

- Multiple PDBs
- Symmetry
- Additive PDBs
- Compression
- Duality

Using PDBs in practice

- What happens if we just build a single PDB with half the tiles in it (sliding tile puzzle)
  - Other tiles aren’t taken into account
  - Worse heuristic than Manhattan distance
- What if we build two PDBs?
  - max of two heuristics

What is better?

- Are few large PDBs better than lots of small ones?
  - It depends on the distribution of values seen during the search
  - Lots of low values is bad
    - Most of the search will focus on states with low heuristic values

Holte et al, 2006

![Graph showing the distribution of heuristic values for the 15-puzzle.](image)
Holte et al, 2006

Compression

- Can take sets of values in one domain abstraction and take the min over them to compress down into another abstraction
- Works best if PDB values are stored as the incremental difference above and beyond manhattan distance
- Can also compress away the blank
- Is admissible but not necessarily consistent

Additivity

- Normally, the moves of all tiles ‘count’
- What if we only count the moves of some tiles in the domain abstraction?
  - Given two PDBs without overlaps, the values can be added
  - Imagine 1 tile per PDB -- Manhattan Distance
  - Imagine 2 tiles per PDB -- MD + Linear

Symmetry

- Regular PDB
- Random state (solution length = 54)
- Reflect the original state
  - Look up PDB positions
  - (Look in inverted PDB)
- Relabel positions to look up in original PDB

![Graph showing distributions of heuristic values](image)

![Symmetry examples](image)