Austin Smothers

CISP 430

Assignment 9

\* Turned in late due to being sick

## Part 1: Hashing with Collision Resolution

H(key) = key % 10 | Data: 22, 3, 12, 1, 18, 36, 33, 9

Method A (Chaining):

Action: Insert 22

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 |  |  |  |  |  |  |  |

Action: Insert 3

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  |  |  |  |  |  |

Action: Insert 12 – Requires link for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  |  |  |  |  |  |
|  |  | 12 |  |  |  |  |  |  |  |

Action: Insert 1

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  |  |  |  |  |  |
|  |  | 12 |  |  |  |  |  |  |  |

Action: Insert 18

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  |  |  |  | 18 |  |
|  |  | 12 |  |  |  |  |  |  |  |

Action: Insert 36

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  |  | 36 |  | 18 |  |
|  |  | 12 |  |  |  |  |  |  |  |

Action: Insert 33 – Requires link for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  |  | 36 |  | 18 |  |
|  |  | 12 | 33 |  |  |  |  |  |  |

Action: Insert 9

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  |  | 36 |  | 18 | 9 |
|  |  | 12 | 33 |  |  |  |  |  |  |

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Method B (Linear Rehashing – step by 1):

Action: Insert 22

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 |  |  |  |  |  |  |  |

Action: Insert 3

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  |  |  |  |  |  |

Action: Insert 12 – Requires stepping for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 | 12 |  |  |  |  |  |

Action: Insert 1

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  |  |  |  |  |

Action: Insert 18

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  |  |  | 18 |  |

Action: Insert 36

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  | 36 |  | 18 |  |

Action: Insert 33 – Requires stepping for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 | 33 | 36 |  | 18 |  |

Action: Insert 9

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 | 33 | 36 |  | 18 | 9 |

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Method C (Generalized Linear rehashing – step by 3):

Action: Insert 22

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 |  |  |  |  |  |  |  |

Action: Insert 3

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  |  |  |  |  |  |

Action: Insert 12 – Requires stepping by 3 for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  | 12 |  |  |  |  |

Action: Insert 1

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  | 12 |  |  |  |  |

Action: Insert 18

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  | 12 |  |  | 18 |  |

Action: Insert 36

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  | 12 | 36 |  | 18 |  |

Action: Insert 33 – Requires stepping by 3 for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 |  | 12 | 36 |  | 18 | 33 |

Action: Insert 9 – Requires stepping by 3 for collision resolution

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 9 | 12 | 36 |  | 18 | 33 |

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Method D (Double Hashing with h2(key) = (key % 3) + 2):

Action: Insert 22

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 |  |  |  |  |  |  |  |

Action: Insert 3

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 |  |  |  |  |  |  |

Action: Insert 12 – Requires second hash for stepping. Second hash value is 2, step 2

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  | 22 | 3 | 12 |  |  |  |  |  |

Action: Insert 1

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  |  |  |  |  |

Action: Insert 18

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  |  |  | 18 |  |

Action: Insert 36

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 |  | 36 |  | 18 |  |

Action: Insert 33 – Requires second hash for stepping. Second hash value is 2. Step 2

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 | 33 | 36 |  | 18 |  |

Action: Insert 9

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 1 | 22 | 3 | 12 | 33 | 36 |  | 18 | 9 |

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## Part 2: Perfect Hashing

Hash Function:

h(key) = ( g[first\_letter\_of\_key] + g[last\_letter\_of\_key] + length\_of\_key) %10

Lookup table G:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Value | 0 | 5 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 2 | 2 | 3 |
| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Char |  | a | b | c | d | e | f | g | h | i | j | k | l | m |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Value | 4 | 5 | 6 | 7 | 8 | 6 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Index | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Char | n | o | p | q | r | s | t | u | v | w | x | y | z |

Keys:

auto, break, case, const, for, switch, struct, while, static, continue

Final Data Table: Tinker Table:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Index | Key |  | Key | Size | First char | Last char | Value | H(key) |
| 0 | switch |  | auto | 4 | 5 | 5 | 14 | 4 |
| 1 | struct |  | break | 5 | 2 | 2 | 9 | 9 |
| 2 | case |  | case | 4 | 3 | 5 | 12 | 2 |
| 3 | while |  | const | 5 | 3 | 0 | 8 | 8 |
| 4 | auto |  | for | 3 | 6 | 8 | 17 | 7 |
| 5 | static |  | switch | 6 | 6 | 8 | 20 | 0 |
| 6 | continue |  | struct | 5 | 6 | 0 | 11 | 1 |
| 7 | for |  | while | 5 | 3 | 5 | 13 | 3 |
| 8 | const |  | static | 6 | 6 | 3 | 15 | 5 |
| 9 | break |  | continue | 8 | 3 | 5 | 16 | 6 |