WARP Shoes Project Report

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1.0 Abstract:

This report outlines the optimization methods, assumptions, and results formulated using provided project descriptions. The optimization problem is centered around the WARP shoe company when the demand for February 2006 is anticipated to double. The model focuses on optimal profit based on production amounts of 557 types of shoes. Restrictions include budget, raw material availability, machine time, and warehouse capacity constraints. The optimal profit found is $11415800. Due to long run times, the IP model is loosened to LP model, which yields decimal results instead of integer, with significantly shorter runtime. Results are rounded to integers, which are less accurate.

2.0 Introduction:

This optimization problem is based off of a shoe company, WARP, having its competitor go into bankruptcy. Due to this, their demand for February of 2006 is expected to double the usual amount. The usual amount is calculated by averaging the given February demands over the past six years, details will be included in sections 3 and 4 (methodology and results). The company requires a model that optimizes its production for that month while satisfying all constraints. The profit comes from the production of shoes and their respective prices.

A database is given with numerous tables that includes information needed for this model. Tables that are used include the Product_Master, Product_Demand, Machine_Master, RM_Master, Warehouse_Master, BOM, and Machine_Assign tables.

Restrictions that needed to be considered for this problem includes a budget for raw materials which are used to create shoes, working hours of all machines, total warehouse capacity, and raw material availability.

In addition to these strict restrictions, the model also needed to take into account the reduction of $10 per pair of shoes that did not meet the demand. This rule also indicates that the monthly demand for February is not a forced constraint. Other reductions in total profit includes raw material price, workers pay, and machine use cost.

3.0 Methodology:

Our model aims to provide an optimal production plan for 557 types of shoes. The goal is to maximize profit while adhering to the constraints outlined in the sections above. The complete code for the model is provided in Appendix A. Below, we outline the model components and the assumptions made, along with justifications.

3.1 Components of the Model:

1. **Sets Defined**

   1) **`S`** (Shoes):
      The set of 557 shoe types, each corresponding to a unique product number (e.g., SH001) that requires production planning.

   2) **`R`** (Raw Materials):
      The set of 165 raw materials used in the production of shoes. Each raw material has an associated cost and available quantity.

   3) **`M`** (Machines):
      The set of 72 machines used for manufacturing shoes. Each machine has an associated operational cost.

2. **Parameters Defined**

   1) `price {S}:`
      The selling price of one unit of shoe type `s`. This parameter determines the revenue generated for each shoe type.

   2) `demand {S}:`
      The estimated demand for shoe type `s` in February

   3) `raw_mat_cost {R}:`
      The cost per unit of raw material `r`. This determines the raw material expenses based on production.

   4) `raw_mat_avail {R}`:
      The total available quantity of raw material `r`. This parameter restricts how much of each raw material can be used in production.

   5) `raw_mat_use {S,R}:`
      The amount of raw material `r` required to produce one unit of shoe type `s`.

6) `oper_cost {M}:`
   The operational cost per minute for machine `m`. This parameter contributes to the machine operation cost in the objective function.

7) `duration {S, M}`
   The time (in seconds) required to produce one unit of shoe type `s` on machine `m`. This determines the machine time required for production.

3. **Decision Variable:**
   The only decision variable is `x[s]`, an integer variable representing the number of shoes of type s to produce, where `s ∈ S`.

   Due to run time reduction purposes, the model is relaxed to an LP which means the removal of the integer definition when defining `x`, more details are included in section 4.0.

4. **Objective Function**
   The objective is to maximize profit, defined as:

$$
\begin{aligned}
\text{Profit} = &\sum_{s \in S} \text{price}[s] \cdot x[s] && \text{(Revenue)} \\
&- \sum_{s \in S, r \in R} \text{raw\_mat\_use}[s, r] \cdot \text{raw\_mat\_cost}[r] \cdot x[s] && \text{(Raw Material Costs)} \\
&- \sum_{s \in S, m \in M} \text{duration}[s, m] \cdot \frac{\text{oper\_cost}[m]}{60} \cdot x[s] && \text{(Machine Operating Costs)} \\
&- \sum_{s \in S, m \in M} \text{duration}[s, m] \cdot \frac{25}{3600} \cdot x[s] && \text{(Labor Costs)} \\
&- \sum_{s \in S} 10 \cdot \max(0, \text{demand}[s] - x[s]) && \text{(Penalty for Unmet Demand)}
\end{aligned}
$$

   This function includes:

1) Revenue earned from the sale of shoes

$$\text{Revenue} = \sum_{s \in S} \text{price}[s] \cdot x[s]$$

2) Raw material costs

$$\text{Raw Material Costs} = \sum_{s \in S} \sum_{r \in R} \text{raw\_mat\_use}[s, r] \cdot \text{raw\_mat\_cost}[r] \cdot x[s]$$

3) Machine operating costs based on operation time. It is divided by 60 to match the time unit for duration (in seconds).

$$\text{Machine Operating Costs} = \sum_{s \in S} \sum_{m \in M} \text{duration}[s,m] \cdot \frac{\text{oper\_cost}[m]}{60} \cdot x[s]$$

4) Labor costs (worker's wages) of $25 per hour. It is divided by 3600 to match the time unit for duration (in seconds).

$$\text{Labor Costs} = \sum_{s \in S} \sum_{m \in M} \text{duration}[s,m] \cdot \frac{25}{3600} \cdot x[s]$$

5) Penalty of $10 per unit of unmet demand for each shoe type. If production meets/exceeds demand, the penalty is zero. If production is less than demand, the penalty is applied.

$$\text{Unmet Demand Penalty} = \sum_{s \in S} 10 \cdot \max(0, \text{demand}[s] - x[s])$$

5. Constraints

The following 4 constraints were considered:

1) **Raw Material Budget:** Total spending on raw materials must not exceed $10M.

$$\sum_{s \in S} \sum_{r \in R} \text{raw\_mat\_use}[s,r] \cdot \text{raw\_mat\_cost}[r] \cdot x[s] \leq 10{,}000{,}000$$

2) **Raw Material Availability:** The amount of raw materials used cannot exceed the available quantities.

$$\sum_{s \in S} \text{raw\_mat\_use}[s,r] \cdot x[s] \leq \text{raw\_mat\_avail}[r], \quad \forall r \in R$$

3) **Machines Time Capacity:** Each machine can operate for a maximum of 12 hours per day for 28 days.

$$\sum_{s \in S} \text{duration}[s,m] \cdot x[s] \leq 3600 \cdot 12 \cdot 28, \quad \forall m \in M$$

4) **Warehouse Capacity:** The total number of shoes produced must not exceed the storage capacity of all warehouses, which is 140,000.

$$\sum_{s \in S} x[s] \leq 140,000$$

3.2 Assumptions

To simplify the model and make it computationally efficient, the following assumptions were made.

1) The closing inventory of January 2006 was zero for all types of shoes.
2) All sales happen at the end of the month.
3) The setup times and costs for machines are negligible.
4) Transportation costs, warehouse operations costs, and manufacturing sequence are ignored.
5) Sale prices and all costs associated with production are fixed as in the databases provided.
6) The demand for each type of shoe for the month of February is estimated solely based on the historical February's demand from the past 6 years (1997-2003) and the predictions from market analysts.

4.0 Results

Our model was implemented using AMPL as the modeling language and Gurobi as the solver. It was originally designed as an IP problem. However, due to the long computational time required to solve the model, we relaxed it to a LP problem by removing the integer requirements for the decision variable x[s]. This significantly reduced the computation time. After solving the relaxed LP, the values of the decision variables were rounded to the nearest integer to provide a practical production plan. The optimization process involved 2509 simplex iterations and 1 branching node, as reported in the AMPL console.

The model yielded a maximized profit of **$11,415,800**. This profit reflects the revenue generated from selling the shoes, minus the costs of raw materials, machine operation, labor, and any penalties for unmet demand. The complete list of optimal production quantities for each shoe type (after rounding) can be found in Appendix B. The rest of Section 4.0 provides answers to the questions listed in the project instruction.

4.1 How should you estimate the demand for the month of February?

Using SQL, we calculated the average demand (sum and then divide by 6) for each type of shoe in February based on data from the past six years (1997–2003). Then, we double these demands to reflect the market analysts' prediction. Below is the code:

```
table demandTab "ODBC" "./WARP2011W.mdb" "SQL=SELECT Product_Num,
SUM(Demand)/6 * 2 as Pdemand FROM Product_Demand WHERE Month=2 GROUP BY
Product_Num":
S <- [Product_Num], demand~Pdemand;
      read table demandTab;
```

4.2 How many variables and constraints do you have?

1 variable:

- x{S}: number of shoes of type s to be produced

4 constraints:

- Raw material budget <= 10000000
- Amount of each raw material used <= its available quantity
- Machine time capacity <= 12 hrs * 28 days
- Total warehouse capacity <= 140000

4.3 If you had to relax your integer program to an LP, how many constraints were violated after rounding the LP solution to the closest integer solution?

After rounding LP solutions to the nearest integer solutions, those who reach 0.5 in the tens digit are rounded up while the others are rounded down (e.g. 1.5 is rounded to 2 while 1.4 is rounded to 1). This means that the raw material availability constraints will be violated, specifically those who are binding. In Q4, the list provided is the list of all binding constraints, in which case no additional materials are available. However, when we round up production numbers, we are theoretically producing a fraction more of shoes (e.g. rounding 1.5 to 2 means we are producing 0.5 more shoes in theory). This is not possible due to the limitations of availability in the binding constraint.

Therefore, the raw material availability constraints are violated when we round up decimal results to integer results in production numbers.

4.4 Which constraints are binding, and what is the real-world interpretation of those binding constraints?

The following constraints for raw material availability are binding, indicating that the available supply of these raw materials is fully utilized (no slack). Since there is no remaining supply, any increase in production or demand for shoes requiring these raw materials cannot be met without increasing the supply.

availability for raw material 2 availability for raw material 3 availability for raw material 5	availability for raw material 106 availability for raw material 107 availability for raw material 108

availability for raw material 6	availability for raw material 111
availability for raw material 9	availability for raw material 113
availability for raw material 12	availability for raw material 114
availability for raw material 13	availability for raw material 115
availability for raw material 16	availability for raw material 116
availability for raw material 17	availability for raw material 117
availability for raw material 31	availability for raw material 118
availability for raw material 32	availability for raw material 120
availability for raw material 36	availability for raw material 121
availability for raw material 37	availability for raw material 122
availability for raw material 38	availability for raw material 124
availability for raw material 39	availability for raw material 125
availability for raw material 41	availability for raw material 127
availability for raw material 55	availability for raw material 129
availability for raw material 57	availability for raw material 131
availability for raw material 60	availability for raw material 132
availability for raw material 61	availability for raw material 133
availability for raw material 65	availability for raw material 136
availability for raw material 66	availability for raw material 137
availability for raw material 67	availability for raw material 138
availability for raw material 68	availability for raw material 139
availability for raw material 73	availability for raw material 140
availability for raw material 75	availability for raw material 141
availability for raw material 76	availability for raw material 142
availability for raw material 79	availability for raw material 143
availability for raw material 81	availability for raw material 145
availability for raw material 82	availability for raw material 146
availability for raw material 83	availability for raw material 147
availability for raw material 84	availability for raw material 148
availability for raw material 85	availability for raw material 149
availability for raw material 86	availability for raw material 150
availability for raw material 88	availability for raw material 151
availability for raw material 91	availability for raw material 152
availability for raw material 94	availability for raw material 156
availability for raw material 96	availability for raw material 157
availability for raw material 98	availability for raw material 158
availability for raw material 99	availability for raw material 159
availability for raw material 102	availability for raw material 161
availability for raw material 103	availability for raw material 163
availability for raw material 104	availability for raw material 164

4.5 Assume that some additional warehouse space is available at the price of $10/box of shoes. Is it economical to buy it? What is the optimal amount of space to buy in this situation?

No, it's not economical to buy any additional warehouse space, because the current constraint for warehouse capacity is not binding, meaning we still have unused storage space for shoes.

4.6 Imagine that machines were available for only 8 hours per day. How would your solution change? Which constraints are binding now? Does the new solution seem realistic to you?

AMPL Code Changed:

```
subject to machine_time_capacity {m in M}:
	sum{s in S} duration[s,m] * x[s] <= 3600*8*28;
```

Profit remains the same (11415800).

Raw material availability constraints changed

From non-binding to binding	From binding to non-binding
1, 10, 15, 22, 27, 30, 42, 44, 45, 47, 48, 50, 51, 53, 56, 58, 69, 77, 80, 92, 97, 110, 128, 135, 144, 153, 154	2, 3, 12, 13, 17, 38, 39, 61, 65, 67, 68, 73, 84, 96, 99, 106, 107, 108, 115, 116, 129, 131, 138, 140, 143, 150, 156, 164.

4.7 If in addition there were a $7,000,000 budget available to buy raw materials, what would you do? Change your formulation and solve again.

AMPL code changed:

```
subject to raw_mat_budget:
	sum {s in S, r in R} raw_mat_use[s,r] * x[s] * raw_mat_cost[r]
	<= 7000000;
```

Profit remains the same (11415800).

Raw material availability constraints changed

From non-binding to binding	From binding to non-binding
1, 10, 11, 24, 25, 27, 40, 42, 46, 50, 51, 52, 56, 59, 64, 69, 77, 78, 97, 101, 126, 128, 134, 135, 153, 154.	5, 9, 12, 13, 16, 17, 36, 39, 67, 68, 73, 81, 82, 94, 99, 106, 107, 108, 115, 116, 126, 131, 140, 143, 148, 156, 157, 164.

5.0 Conclusion

In summary, using the model following all rules given in the WARP Shoe company description, the model gave a maximum profit of $11415800, with binding variables as listed in section 4 results. Modifications to certain constraints will change the binding variables but will not change the overall profit. However, the loosening of integer programming to linear programming will result in a violation of constraints of the raw material availability as explained in section 4.3. The optimal solution shoe production amounts are provided in Appendix B.

Appendix A

.mod file

```
#Beichen_Du_dubeiche_1009971407

#Cindy_Zhao_zhaocin3_1010078185

#sets

set S; #set of shoes (557)

set M; #machine number (72)

set R; #raw material number (165)

set W; #set of warehouses (8)

#parameters

param price{S}; #sale price of shoes[s]

param demand{S}; #demand of shoes[s]

param oper_cost{M}; #cost of operating machine[m] in min

param duration{S,M} default 0; #duration to produce shoes[s] on mach[m] in sec

param raw_mat_cost{R};

param raw_mat_avail{R}; #raw material[r] available

param raw_mat_use{S,R} default 0; #amount raw_mat[r] used to produce shoes[s]

param warehouse_cost{W}; #operation cost of warehouse[w]

param warehouse_cap{W}; #capacity of warehouse[w]

#decision var

var x{S} >= 0; #number of shoes[s] produced

#objective function

maximize profit:

	sum{s in S} price[s] * x[s] #revenue

	- sum{s in S, r in R} raw_mat_use[s,r] * x[s] * raw_mat_cost[r] #raw
material cost

	- sum{s in S, m in M} duration[s,m] * x[s] * (oper_cost[m]/60) #duration
in sec * cost per sec
```

```
	- sum{s in S, m in M} duration[s,m] * x[s] * (25/3600) #duration in sec * 
paid per sec

	- sum{s in S} 10 * max(0, demand[s] - x[s]); #penalty for unmet demand (0 
if produced > demand)


#constraints

subject to raw_mat_budget:

	sum {s in S, r in R} raw_mat_use[s,r] * x[s] * raw_mat_cost[r] <= 
10000000;


subject to raw_mat_availability {r in R}:

	sum {s in S} raw_mat_use[s,r] * x[s] <= raw_mat_avail[r];

subject to machine_time_capacity {m in M}:

	sum{s in S} duration[s,m] * x[s] <= 3600*12*28;


subject to total_warehouse_capacity:

	sum{s in S} x[s] <= 140000; #sum of all warehouses' capacities
```

.dat file

```
#Beichen_Du_dubeiche_1009971407

#Cindy_Zhao_zhaocin3_1010078185

table shoePrice "ODBC" "./WARP2011W.mdb" "Product_Master":

S <- [Product_Num], price ~ Sales_Price;

	read table shoePrice;

table demandTab "ODBC" "./WARP2011W.mdb" "SQL=SELECT Product_Num, SUM(Demand)/6 
* 2 as Pdemand FROM Product_Demand WHERE Month=2 GROUP BY Product_Num":

	S <- [Product_Num], demand~Pdemand;

	read table demandTab;


table machineTab "ODBC" "./WARP2011W.mdb" "Machine_Master":
```

```
    M <- [Machine_Num], oper_cost ~ OpCost_per_min;
    read table machineTab;


table rawMatTab "ODBC" "./WARP2011W.mdb" "RM_Master":
    R <- [RM_Num], raw_mat_cost ~ Cost, raw_mat_avail ~ S_Quantity;
    read table rawMatTab;

table warehouseTab "ODBC" "./WARP2011W.mdb" "Warehouse_Master":
    W <- [Warehouse_Num], warehouse_cost ~ Op_Cost, warehouse_cap ~ Capacity;
    read table warehouseTab;

table rawMatShoe "ODBC" "./WARP2011W.mdb" "BOM":
    [Product_Num, RM_Num], raw_mat_use ~ Quantity;
    read table rawMatShoe;
table avgDurTab "ODBC" "./WARP2011W.mdb" "Machine_Assign":
    [Product_Num,Machine_Num], duration ~ Avg_Duration;
    read table avgDurTab;
```

.run file

```
#Beichen_Du_dubeiche_1009971407
#Cindy_Zhao_zhaocin3_1010078185
reset;
model dubeiche_zhaocin3.mod;
data dubeiche_zhaocin3.dat;
option solver gurobi;
solve;
display profit > dubeiche_zhaocin3.out;
for {s in S} {
```

```
        printf "%s: %d\n", s, round(x[s]) > dubeiche_zhaocin3.out;
}
printf "\nBinding Constraints: \n" > dubeiche_zhaocin3.out;
if raw_mat_budget.slack == 0 then
        printf "\traw mat budget is binding\n" > dubeiche_zhaocin3.out;
for {r in R} {

        if raw_mat_availability[r].slack == 0 then
                printf "\tavailability for raw material %s\n", r >
dubeiche_zhaocin3.out;

        }
for {m in M} {
        if machine_time_capacity[m].slack == 0 then
                printf "\ttime capacity for machine %s\n", m >
dubeiche_zhaocin3.out;
        }
if total_warehouse_capacity.slack == 0 then
        printf "\ttotal warehouse capacity\n" > dubeiche_zhaocin3.out;
```

Appendix B

```
profit = 11415800
```

Solutions:

SH001: 0

SH002: 524

SH003: 0

SH004: 88

SH005: 111

SH006: 0

SH007: 0

SH008: 0

SH009: 0

SH010: 0

SH011: 506

SH012: 211

SH013: 496

SH014: 0

SH015: 0

SH016: 0

SH017: 0

SH018: 68

SH019: 41

SH020: 0

SH021: 0

SH022: 0

SH023: 0

SH024: 155

SH025: 346

SH026: 0

SH027: 446

SH028: 0

SH029: 454

SH030: 0

SH031: 252

SH032: 573

SH033: 0

SH034: 435

SH035: 0

SH036: 0

SH037: 0

SH038: 558

SH039: 428

SH040: 505

SH041: 284

SH042: 209

SH043: 0

SH044: 516

SH045: 187

SH046: 0

SH047: 479

SH048: 185

SH049: 0

SH050: 505

SH051: 0

SH052: 0

SH053: 0

SH054: 0

SH055: 0

SH056: 0

SH057: 101

SH058: 317

SH059: 0

SH060: 209

SH061: 330

SH062: 535

SH063: 346

SH064: 0

SH065: 451

SH066: 0

SH067: 0

SH068: 0

SH069: 0

SH070: 0

SH071: 371

SH072: 0

SH073: 37

SH074: 0

SH075: 0

SH076: 38

SH077: 159

SH078: 396

SH079: 0

SH080: 478

SH081: 160

SH082: 259

SH083: 10

SH084: 0

SH085: 0

SH086: 0

SH087: 484

SH088: 494

SH089: 0

SH090: 554

SH091: 0

SH092: 108

SH093: 99

SH094: 304

SH095: 493

SH096: 516

SH097: 0

SH098: 0

SH099: 0

SH100: 0

SH101: 0

SH102: 0

SH103: 0

SH104: 0

SH105: 488

SH106: 51

SH107: 0

SH108: 0

SH109: 0

SH110: 387

SH111: 0

SH112: 0

SH113: 530

SH114: 0

SH115: 0

SH116: 199

SH117: 0

SH118: 300

SH119: 39

SH120: 0

SH121: 593

SH122: 0

SH123: 0

SH124: 0

SH125: 0

SH126: 6

SH127: 106

SH128: 0

SH129: 0

SH130: 57

SH131: 0

SH132: 0

SH133: 0

SH134: 457

SH135: 0

SH136: 0

SH137: 0

SH138: 0

SH139: 0

SH140: 0

SH141: 0

SH142: 447

SH143: 0

SH144: 524

SH145: 43

SH146: 201

SH147: 184

SH148: 0

SH149: 29

SH150: 496

SH151: 0

SH152: 0

SH153: 0

SH154: 370

SH155: 0

SH156: 0

SH157: 0

SH158: 0

SH159: 0

SH160: 0

SH161: 0

SH162: 0

SH163: 0

SH164: 0

SH165: 537

SH166: 0
SH167: 0
SH168: 126
SH169: 0
SH170: 0
SH171: 0
SH172: 0
SH173: 398
SH174: 0
SH175: 0
SH176: 525
SH177: 0
SH178: 69
SH179: 0
SH180: 0
SH181: 0
SH182: 0
SH183: 0
SH184: 0
SH185: 192
SH186: 0
SH187: 106
SH188: 224
SH189: 0
SH190: 0
SH191: 0
SH192: 18
SH193: 0

SH194: 217
SH195: 488
SH196: 0
SH197: 510
SH198: 0
SH199: 0
SH200: 0
SH201: 556
SH202: 0
SH203: 584
SH204: 0
SH205: 456
SH206: 0
SH207: 0
SH208: 0
SH209: 483
SH210: 0
SH211: 0
SH212: 0
SH213: 510
SH214: 0
SH215: 0
SH216: 0
SH217: 285
SH218: 0
SH219: 0
SH220: 0
SH221: 546

SH222: 0
SH223: 477
SH224: 346
SH225: 442
SH226: 489
SH227: 239
SH228: 0
SH229: 0
SH230: 0
SH231: 0
SH232: 369
SH233: 438
SH234: 473
SH235: 514
SH236: 419
SH237: 0
SH238: 354
SH239: 124
SH240: 0
SH241: 415
SH242: 0
SH243: 0
SH244: 274
SH245: 0
SH246: 0
SH247: 85
SH248: 148
SH249: 473

SH250: 0
SH251: 0
SH252: 0
SH253: 445
SH254: 452
SH255: 32
SH256: 507
SH257: 0
SH258: 0
SH259: 85
SH260: 0
SH261: 477
SH262: 480
SH263: 0
SH264: 0
SH265: 386
SH266: 0
SH267: 0
SH268: 0
SH269: 501
SH270: 44
SH271: 0
SH272: 0
SH273: 113
SH274: 0
SH275: 0
SH276: 273
SH277: 493
SH278: 0
SH279: 12
SH280: 0
SH281: 345
SH282: 484
SH283: 0
SH284: 381
SH285: 0
SH286: 407
SH287: 479
SH288: 18
SH289: 362
SH290: 5
SH291: 0
SH292: 0
SH293: 0
SH294: 0
SH295: 471
SH296: 0
SH297: 0
SH298: 0
SH299: 362
SH300: 499
SH301: 0
SH302: 0
SH303: 0
SH304: 0
SH305: 0
SH306: 0
SH307: 92
SH308: 289
SH309: 0
SH310: 0
SH311: 0
SH312: 556
SH313: 564
SH314: 456
SH315: 0
SH316: 187
SH317: 479
SH318: 0
SH319: 0
SH320: 539
SH321: 0
SH322: 82
SH323: 0
SH324: 0
SH325: 554
SH326: 24
SH327: 0
SH328: 46
SH329: 467
SH330: 0
SH331: 0
SH332: 0
SH333: 0

SH334: 451

SH335: 0

SH336: 0

SH337: 0

SH338: 504

SH339: 0

SH340: 547

SH341: 462

SH342: 408

SH343: 0

SH344: 0

SH345: 263

SH346: 0

SH347: 134

SH348: 570

SH349: 0

SH350: 0

SH351: 0

SH352: 463

SH353: 0

SH354: 0

SH355: 0

SH356: 212

SH357: 0

SH358: 0

SH359: 0

SH360: 0

SH361: 329

SH362: 463

SH363: 0

SH364: 0

SH365: 149

SH366: 238

SH367: 439

SH368: 0

SH369: 441

SH370: 0

SH371: 0

SH372: 298

SH373: 458

SH374: 0

SH375: 0

SH376: 0

SH377: 0

SH378: 493

SH379: 216

SH380: 0

SH381: 195

SH382: 0

SH383: 0

SH384: 589

SH385: 0

SH386: 0

SH387: 0

SH388: 0

SH389: 0

SH390: 0

SH391: 0

SH392: 0

SH393: 0

SH394: 0

SH395: 536

SH396: 0

SH397: 0

SH398: 0

SH399: 415

SH400: 50

SH401: 0

SH402: 0

SH403: 0

SH404: 0

SH405: 0

SH406: 0

SH407: 510

SH408: 0

SH409: 0

SH410: 157

SH411: 292

SH412: 0

SH413: 0

SH414: 0

SH415: 320

SH416: 0

SH417: 562

SH418: 244
SH419: 451
SH420: 51
SH421: 486
SH422: 0
SH423: 544
SH424: 0
SH425: 535
SH426: 17
SH427: 557
SH428: 0
SH429: 86
SH430: 502
SH431: 0
SH432: 0
SH433: 0
SH434: 0
SH435: 162
SH436: 0
SH437: 0
SH438: 56
SH439: 0
SH440: 0
SH441: 0
SH442: 0
SH443: 0
SH444: 145
SH445: 540
SH446: 0
SH447: 318
SH448: 0
SH449: 137
SH450: 0
SH451: 531
SH452: 0
SH453: 549
SH454: 0
SH455: 194
SH456: 502
SH457: 0
SH458: 0
SH459: 171
SH460: 0
SH461: 0
SH462: 379
SH463: 0
SH464: 364
SH465: 197
SH466: 514
SH467: 140
SH468: 37
SH469: 0
SH470: 396
SH471: 428
SH472: 89
SH473: 417
SH474: 281
SH475: 0
SH476: 486
SH477: 193
SH478: 395
SH479: 553
SH480: 0
SH481: 0
SH482: 0
SH483: 507
SH484: 0
SH485: 0
SH486: 0
SH487: 60
SH488: 0
SH489: 359
SH490: 571
SH491: 303
SH492: 92
SH493: 0
SH494: 24
SH495: 160
SH496: 0
SH497: 525
SH498: 398
SH499: 0
SH500: 496
SH501: 491

SH502: 0

SH503: 0

SH504: 0

SH505: 0

SH506: 0

SH507: 0

SH508: 389

SH509: 0

SH510: 0

SH511: 464

SH512: 335

SH513: 260

SH514: 463

SH515: 0

SH516: 496

SH517: 0

SH518: 0

SH519: 0

SH520: 114

SH521: 421

SH522: 0

SH523: 95

SH524: 0

SH525: 125

SH526: 0

SH527: 251

SH528: 0

SH529: 0

SH530: 0

SH531: 0

SH532: 519

SH533: 0

SH534: 389

SH535: 514

SH536: 361

SH537: 42

SH538: 0

SH539: 0

SH540: 68

SH541: 0

SH542: 0

SH543: 414

SH544: 0

SH545: 0

SH546: 262

SH547: 81

SH548: 0

SH549: 6

SH550: 0

SH551: 0

SH552: 46

SH553: 0

SH554: 0

SH555: 0

SH556: 456

SH557: 549