DESTATIS
Statistisches Bundesamt

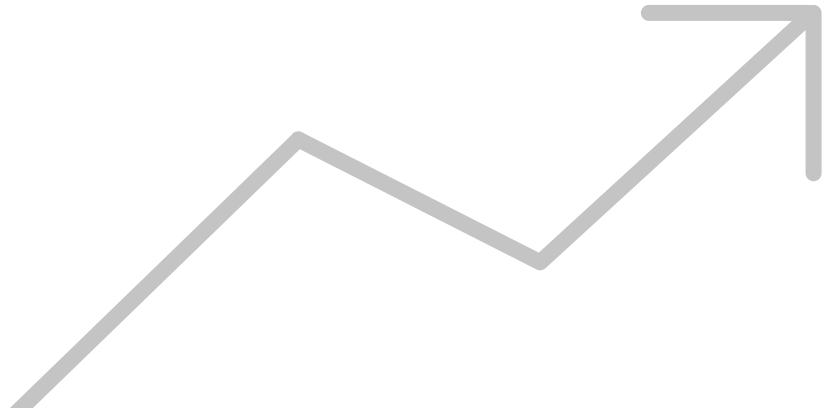
An approach to resolve feasibility problems due to the frozen cell problem in τ-Argus Modular

SDC User Workshop 2022

20th of September 2022, Paris

Michel REIFFERT*, Sarah Giessing*

*Destatis



Agenda

- Example and motivation for the Frozen Cell Problem (FCP)
- Definition of the (FCP)
- Approach to deal with the (FCP)
- Implementation
- Development and future work
- Discussion

Frozen Cell Problem (FCP) - Motivation

- Table T_{orig} with already disseminated cells $(C21, BC), (D212, BC)$ and $(D211, BC)$:

	I	A	O	BC
D211	-	105	-	105
D212	-	890	-	890
C21	0	995	0	995

- Protected or frozen
- (temporarily) primary unsafe

- T_{orig} is infeasible and the latest version of τ-Argus (4.2.2 build 1) returns an error message: *„Error in modular suppression procedure“*.
- If T_{orig} is a subtable of a much larger hierarchical table, there is no suppression pattern for the complete table.

Simplified version of the (CSP)

- In order to obtain the suppression pattern $SUP_{T_{Orig}}$ the cell suppression problem (CSP) needs to be solved to optimality.

- Parameters (CSP):
  - Status ↪ $x_i \in \{0,1\}$
  - Costs ↪ $\omega_i \geq 0$
  - Protection levels ↪ lpl, upl

$$\min \sum_{i=1}^{n} \omega_i x_i \qquad (CSP)$$

$$s.t. \quad SUP \text{ satisfies the protection level requirements} \quad , \forall \text{ sensitive cells}$$

$$\vdots$$

$$x \in \{0,1\}^n$$

Auxiliary problems $(Unfrozen)$ and $(Minpl)$

$(Orig)$

- Status: According to T_{Orig}
- Costs: proportional to size of cell value
- Protection levels: standard τ-Argus

$(Unfrozen)$

- Status: all protected (non-zero) cells set to safe
- Costs: All safe cells cost $:= 1$; All protected cells cost $:= \#cells\ in\ T_{Orig}$
- Protection levels: standard τ-Argus

$(Minpl)$

- Status: all protected (non-zero) cells set to safe
- Costs: All safe cells cost $:= 1$; All protected cells cost $:= \#cells\ in\ T_{Orig}$
- Protection levels: $\mathrm{upl} := \mathrm{lpl} \leq \min(cell\ value(T_{Orig}))$

Definition of the Frozen Cell Problem (FCP)

Definition FCP

A table T_{Orig} induces a frozen cell problem (FCP), if all feasible solutions of the auxiliary problem $(Unfrozen)$ contain at least one cell that is logically identical to a protected cell in T_{Orig}.

- Note, that it is possible to change $(Unfrozen)$ to $(Minpl)$ in the definition, depending on the accepted level of risk.
- The feasible set of $(Minpl)$ is greater or equal than the feasible set of $(Unfrozen)$, i.e. $(Minpl)$ can yield a feasible SUP, whereas $(Unfrozen)$ is infeasible due to FCP.

Base table - Example

Base Table	BC								
		I				A			O
			LI	MI	SI		LA	SA	
R	1645	90	80	5	5	1000	995	5	555
P1	550	50	50	-	-	-	-	-	500
P2	1080	30	20	5	5	1000	995	5	50
C21	995	-	-	-	-	995	995	-	-
D211	105	-	-	-	-	105	105	-	-
D212	890	-	-	-	-	890	890	-	-
C22	85	30	20	5	5	5	-	5	50
P3	15	10	10	-	-	-	-	-	5
C31	5	-	-	-	-	-	-	-	5
C32	10	10	10	-	-	-	-	-	-

- Protected or frozen
- (temporarily) primary unsafe

Approach – Step 1 ($Unfrozen$)

T_{Orig}

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

solve ($Orig$)

„Error in modular suppression procedure“

Is a protected cell from T_{Orig} suppressed?

$T_{Unfrozen}$

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

solve ($Unfrozen$)

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

$SUP_{Unfrozen}$

- with: $\mathrm{pl}(\mathrm{P2}, \mathrm{A}) = 10$

Approach – Step 1 ($Unfrozen$)

- If $SUP_{Unfrozen}$ contains an originally protected cell, it follows that $(Orig)$ is infeasible due to FCP.

  ➡ Continue with the approach.

- If $SUP_{Unfrozen}$ does not contain an originally protected cell, it follows that $(Orig)$ has at least one feasible solution including only non-protected cells.

  ➡ Return subtable to Modular.

Approach – Step 2 (*Minpl*) [optional]

T_{Orig}

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

solve $(Orig)$

„Error in modular suppression procedure“

Is a protected cell from T_{Orig} suppressed?

T_{Minpl}

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

solve $(Minpl)$

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

SUP_{Minpl}

- with: $\mathrm{pl}(\mathrm{P2}, \mathrm{A}) = 1$

Approach – Step 2 (*Minpl*) [optional]

- If SUP_{Minpl} contains an originally protected cell, it follows that $(Orig)$ is infeasible due to FCP.

  ➡ Continue with the approach.

- If SUP_{Minpl} does not contain an originally protected cell, it follows that $(Orig)$ with adjusted protection levels has at least one feasible solution including only non-protected cells.

  ➡ Return subtable to Modular.

Approach – Step 3 (*last resort*)

- All interior cells of the subtable receive the status ‚*frozen*', i.e. they get suppressed.

	I	A	O	BC
C21	-	995	-	995
C22	30	5	50	85
P2	30	1000	50	1080

$$SUP_{Frozen}$$

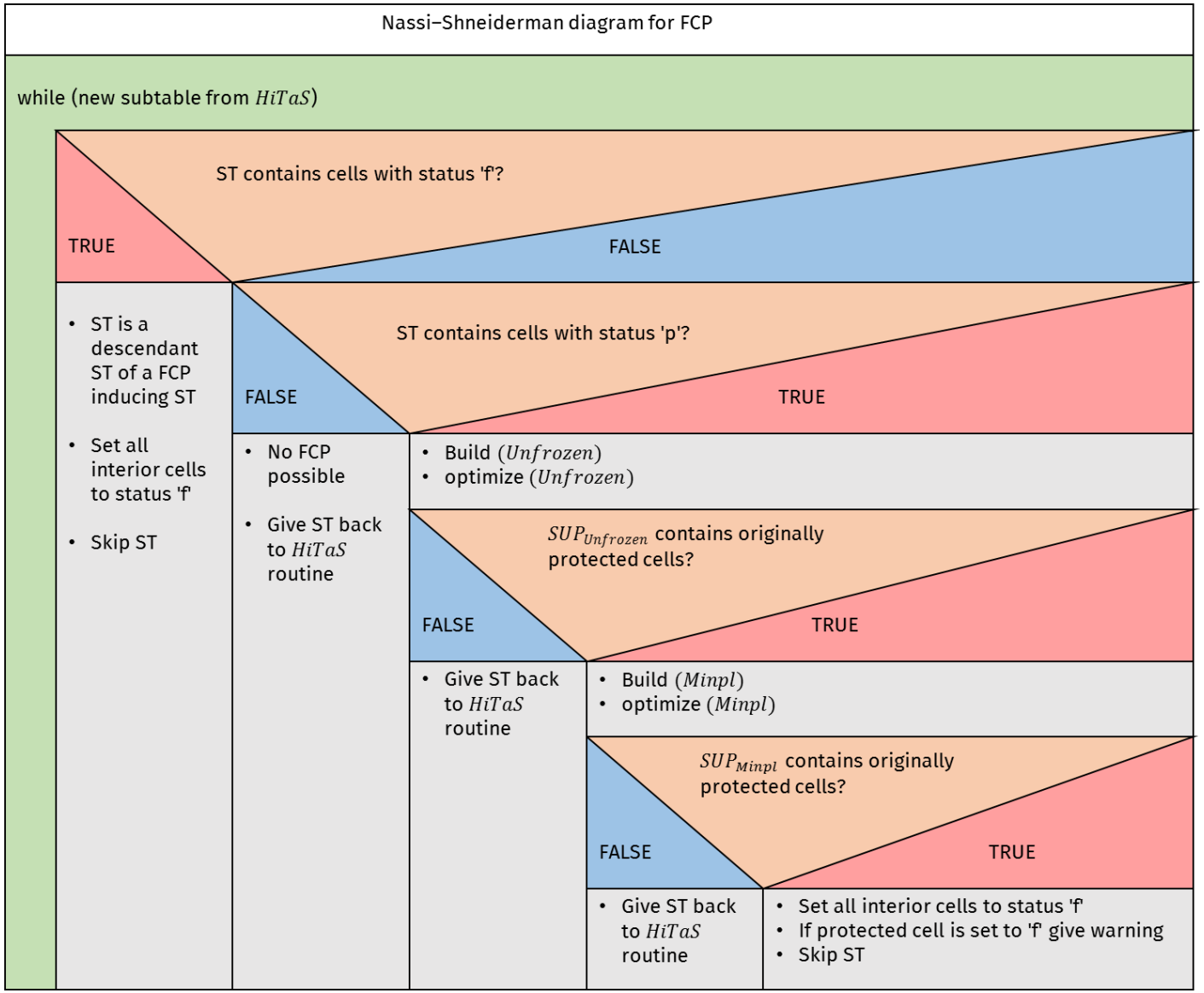
- For consistency reasons all subtables that contain at least one of the ‚*frozen*' cells have to be completely suppressed.

→ Subtables with ‚frozen' cells are descendant-subtables of T_{Orig}.

SUP for example table

Base Table	BC								
		I				A			O
			LI	MI	SI		LA	SA	
R	1645	90	80	5	5	1000	995	5	555
P1	550	50	50	-	-	-	-	-	500
P2	1080	30	20	5	5	1000	995	5	50
C21	995	-	-	-	-	995	995	-	-
D211	105	-	-	-	-	105	105	-	-
D212	890	-	-	-	-	890	890	-	-
C22	85	30	20	5	5	5	-	5	50
P3	15	10	10	-	-	-	-	-	5
C31	5	-	-	-	-	-	-	-	5
C32	10	10	10	-	-	-	-	-	-

$$SUP_{Basetable}$$


Nassi–Shneiderman diagram for FCP
while (new subtable from $HiTaS$)
ST contains cells with status 'f'?
TRUE
FALSE
• ST is a descendant ST of a FCP inducing ST
• Set all interior cells to status 'f'
• Skip ST
ST contains cells with status 'p'?
FALSE
TRUE
• No FCP possible
• Give ST back to $HiTaS$ routine
• Build $(Unfrozen)$
• optimize $(Unfrozen)$
$SUP_{Unfrozen}$ contains originally protected cells?
FALSE
TRUE
• Give ST back to $HiTaS$ routine
• Build $(Minpl)$
• optimize $(Minpl)$
SUP_{Minpl} contains originally protected cells?
FALSE
TRUE
• Give ST back to $HiTaS$ routine
• Set all interior cells to status 'f'
• If protected cell is set to 'f' give warning
• Skip ST

Development and future work

Development:

- The approach is fully implemented into the existing $HiTaS$ method in C++.
- The approach was tested with several (small) real-life examples.

Future work:

- Further testing with higher dimensional and larger instances.
- Integration into the latest version of τ-Argus, once all tests are completed successfully.

Discussion

General:

- How do you treat tables with potential FCPs at the moment?
- Is the FCP a common situation in your experience?

Argus GUI (once FCP approach is available):

- Offer FCP as an option inside “Modular”? Always check for FCP?
- How to deal with the new status ‘f’ in the τ-Argus GUI?
- How to inform the user about the case of suppressed (interior) protected cells?

DESTATIS
Statistisches Bundesamt

Contact

Statistisches Bundesamt
Statistische Geheimhaltung
65180 Wiesbaden

Michel Reiffert
Michel.Reiffert@destatis.de
phone: +49 611 75-3715

www.destatis.de

www.destatis.de/kontakt