



O optimizaciji programskoga kôda iteriranoga Ritzova postupka

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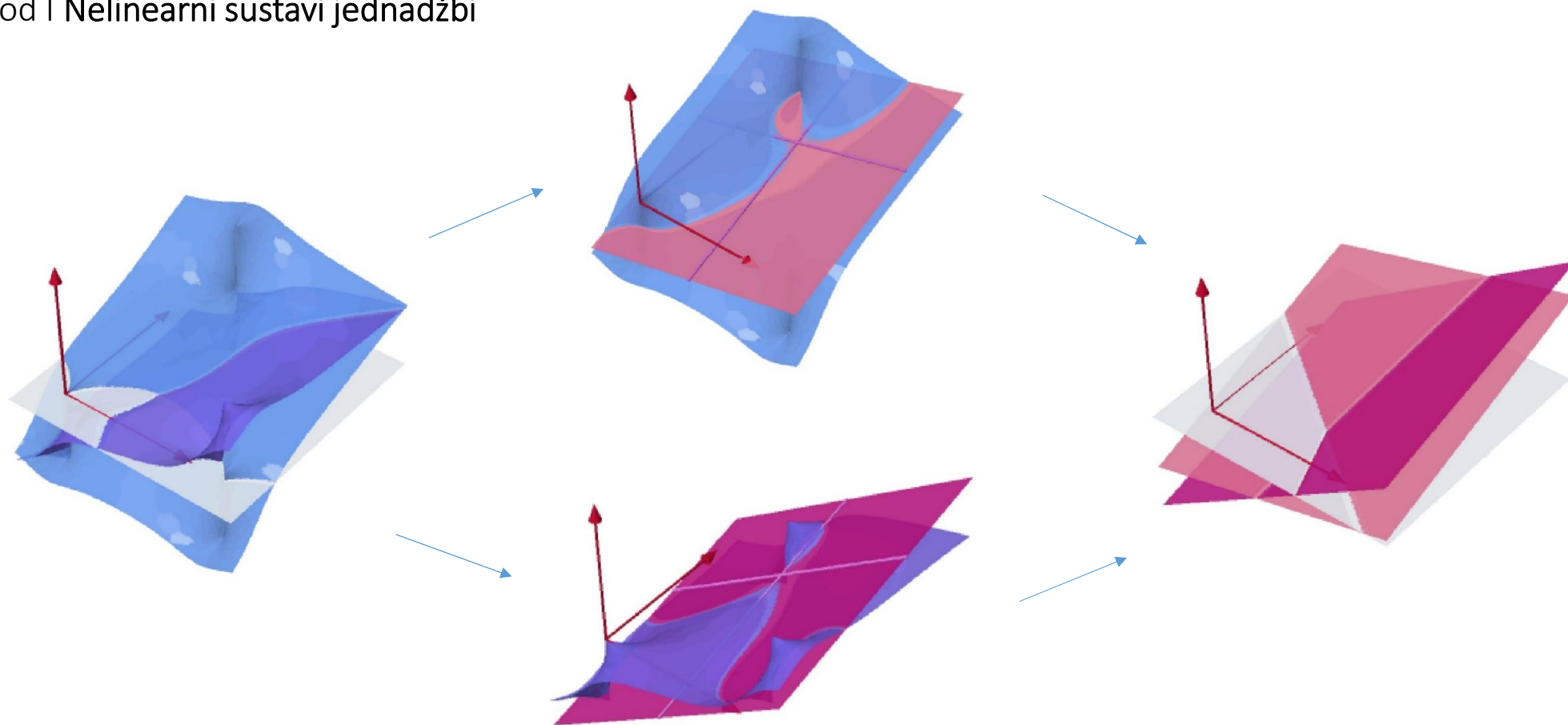
Katedra za statiku, dinamiku i stabilnost konstrukcija

Zavod za tehničku mehaniku

Građevinski fakultet Sveučilišta u Zagrebu

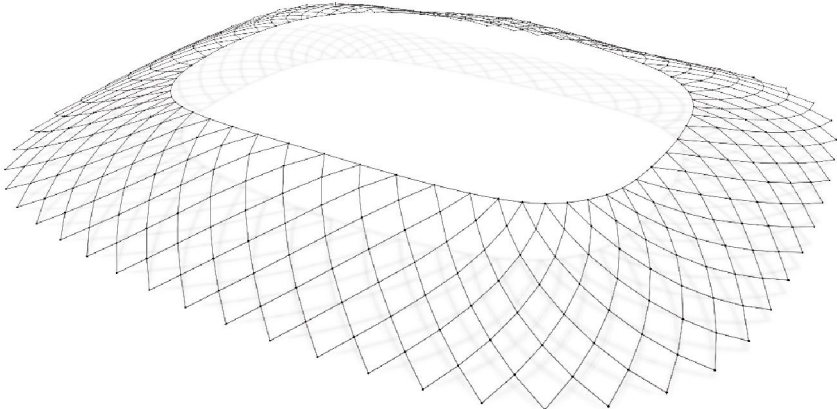


Uvod I Nelinearni sustavi jednadžbi



Geometrijska interpretacija Newton Raphson postupka - hiperplohe, koje su grafovi nelinearnih funkcija, zamjenjuju se dirnim hiperravninama

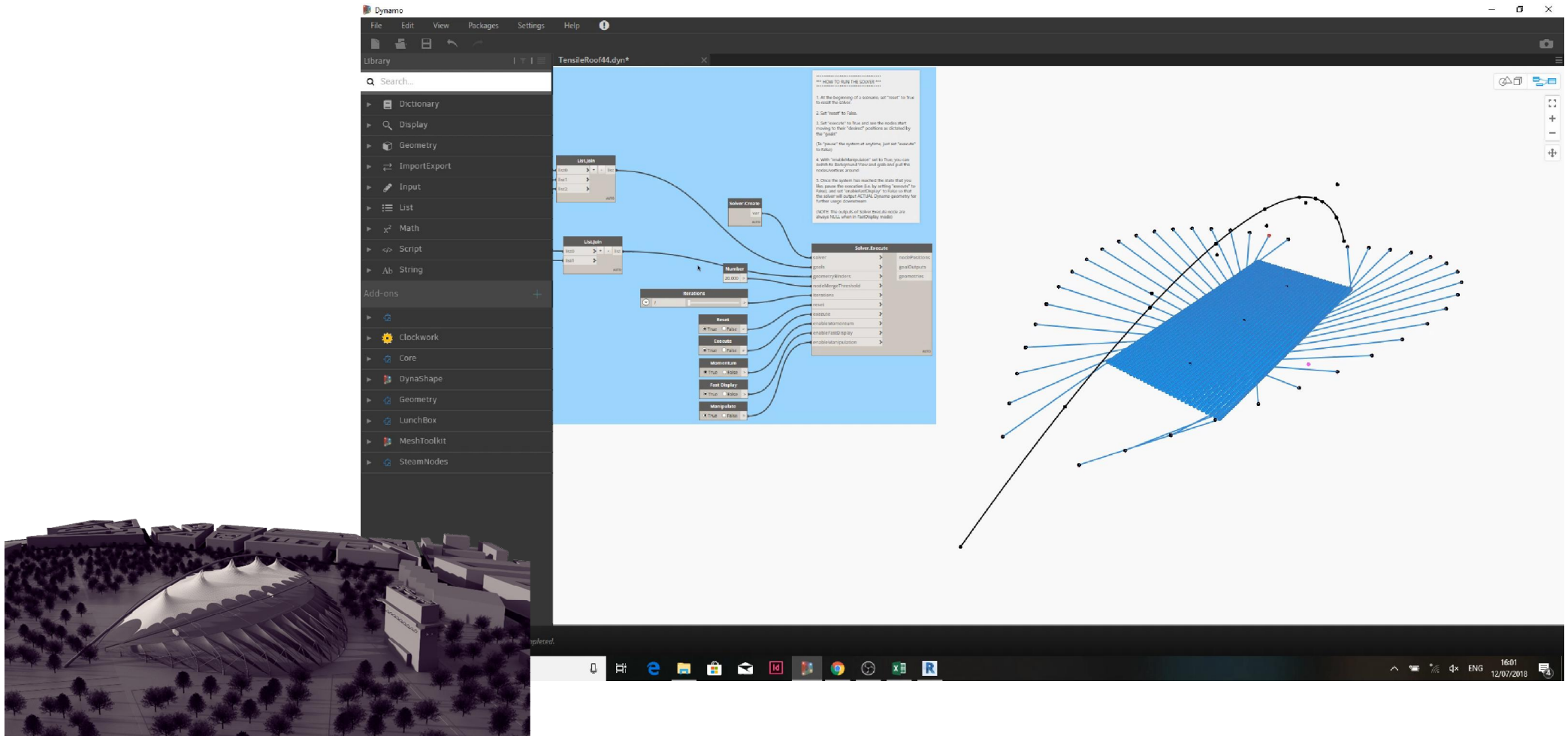
Uvod I Problem pronalaska oblika



Broj koraka vanjske i unutarnje petlje

	CG	IRM-CG	IRM (2)	IRM (3)	IRM (4)	IRM (5)	IRM (6)
Outer	7 943	7 943	7 943	7 943	7 944	7 945	7 946
Inner	49 730	49 706	49 493	20 975	17 170	16 088	15 501

Uvod | Interaktivni alat za pronalazak oblika

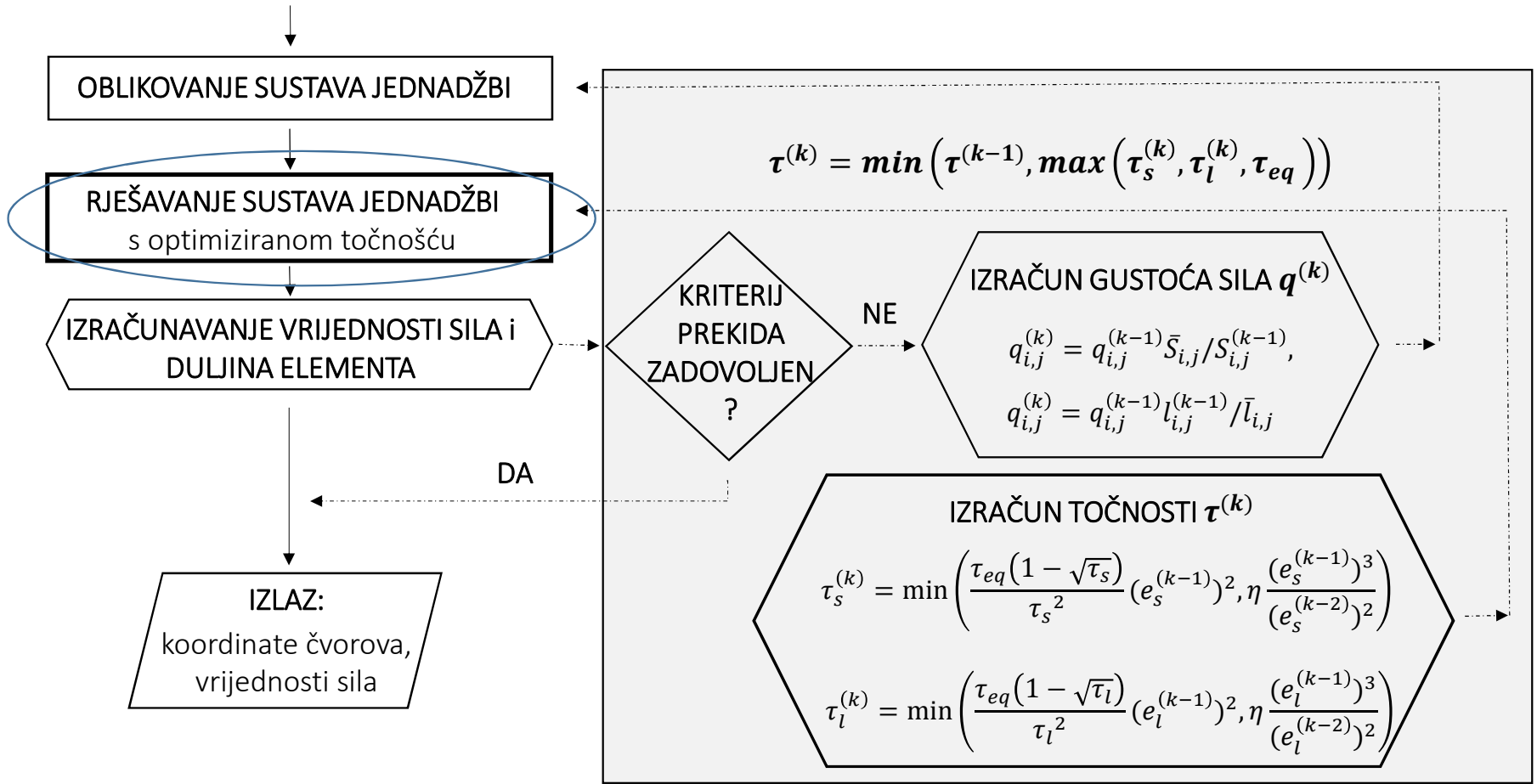


C. Alexandru, I. Balaban, D. Chernyshova and E. Šamec: PHEONIX STADIUM, Augarten park, Vienna, concept design, 2018.

Uvod I Dosadašnja istraživanja

ULAZ: OBJ. file/JSON. file
 topologija mreže, ležajevi, početne vrijednosti gustoća sila tražene sile i duljine, kriterij prekida ($\tau_s, \tau_l, \tau_{eq}$)

Netočna iteracijska primjena metode gustoća sila



Uvod I „Usko grlo” IRM algoritma

Require: \mathbf{A} , \mathbf{b} , $\mathbf{x}_{(0)}$, ε , n_{\max} {usually $\mathbf{x}_{(0)} \leftarrow \mathbf{0}$ }

Ensure: $\mathbf{x}_{(i+1)}$ {close to \mathbf{x} }

- (1) $i \leftarrow 0$ {initialisation: steepest descent}
- (2) $\mathbf{r}_{(0)} \leftarrow \mathbf{b} - \mathbf{A}\mathbf{x}_{(0)}$
- (3) $q \leftarrow \mathbf{r}_{(0)}^T \mathbf{r}_{(0)} / (\mathbf{r}_{(0)}^T \mathbf{A} \mathbf{r}_{(0)})$
- (4) $\mathbf{p}_{(0)} \leftarrow q \mathbf{r}_{(0)}$
- (5) **while** ($\|\mathbf{r}_{(i)}\|_2 > \varepsilon \|\mathbf{r}_{(0)}\|_2$) \wedge ($i \leq n_{\max}$) **do** {iterated Ritz method}
- (6) $\mathbf{x}_{(i+1)} \leftarrow \mathbf{x}_{(i)} + \mathbf{p}_{(i)}$
- (7) $\mathbf{r}_{(i+1)} \leftarrow \mathbf{b} - \mathbf{A}\mathbf{x}_{(i+1)}$
- (8) **generate** $[\phi_{1,(i)}, \phi_{2,(i)}, \dots, \phi_{m,(i)}]$
- (9) $\bar{\mathbf{A}}_{(i)} \leftarrow [\phi_{1,(i)}, \phi_{2,(i)}, \dots, \phi_{m,(i)}]^T \mathbf{A} [\phi_{1,(i)}, \phi_{2,(i)}, \dots, \phi_{m,(i)}]$
- (10) $\bar{\mathbf{r}}_{(i)} \leftarrow [\phi_{1,(i)}, \phi_{2,(i)}, \dots, \phi_{m,(i)}]^T \mathbf{r}_{(i+1)}$
- (11) $\mathbf{a}_{(i)} \leftarrow \bar{\mathbf{A}}_{(i)}^{-1} \bar{\mathbf{r}}_{(i)}$
- (12) $\mathbf{p}_{(i+1)} \leftarrow [\phi_{1,(i)}, \phi_{2,(i)}, \dots, \phi_{m,(i)}] \mathbf{a}_{(i)}$
- (13) $i \leftarrow i + 1$
- (14) **end while** {end iterated Ritz method}

J. Dvornik, D. Lazarević, A. Jaguljnjak Lazarević, M. Demšić: Nonrecursive Equivalent of the Conjugate Gradient Method without the Need to Restart, 2019.

Scheme pohranjivanja rijetko popunjenih matrica I Koordinatni zapis

$$\begin{bmatrix} 10. & 0. & -2. & -3. & 0. \\ 0. & 40. & 0. & -5. & 0. \\ 2. & 0. & 60. & 0. & 0. \\ 3. & 0. & 0. & 80. & 0. \\ 0. & 0. & 7. & 0. & 90. \end{bmatrix}$$

Koordinatni zapis

→	A	10.	40.	2.	60.	-5.	3.	80.	7.	-3.	90.	-2.
→	I	0	1	2	2	1	3	3	4	0	4	0
→	J	0	1	0	2	3	0	3	2	3	4	2

Koordinatni zapis sa svrstavanjem po stupcima

A	10.	3.	2.	40.	60.	-2.	7.	80.	-5.	-3.	90.
I	0	3	2	1	2	0	4	3	1	0	4
J	0	0	0	1	2	2	2	3	3	3	4

Koordinatni zapis sa svrstavanjem po stupcima i poretkom u svakom stupcu

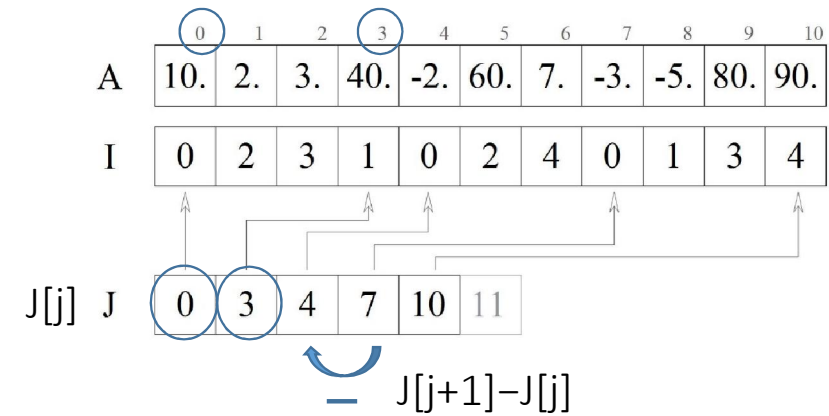
A	10.	2.	3.	40.	-2.	60.	7.	-3.	-5.	80.	90.
I	0	2	3	1	0	2	4	0	1	3	4
J	0	0	0	1	2	2	2	3	3	3	4



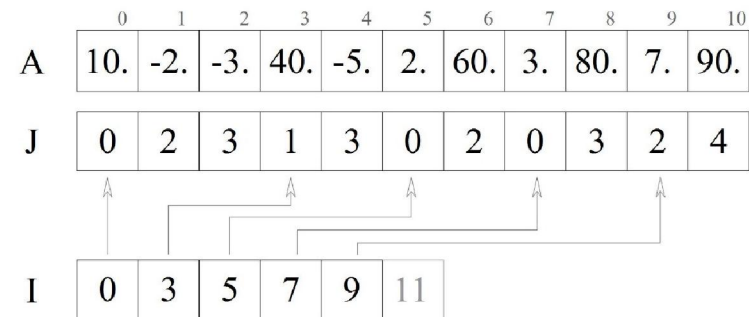
Scheme pohranjivanja rijetko popunjenih matrica I Sažeti zapis

$$\begin{bmatrix} 10. & 0. & -2. & -3. & 0. \\ 0. & 40. & 0. & -5. & 0. \\ 2. & 0. & 60. & 0. & 0. \\ 3. & 0. & 0. & 80. & 0. \\ 0. & 0. & 7. & 0. & 90. \end{bmatrix}$$

Sažeti zapis po stupcima



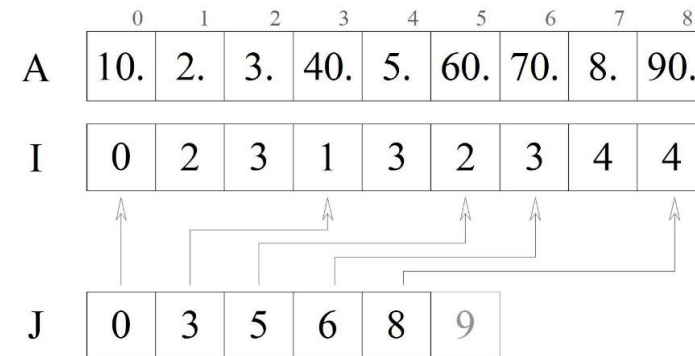
Sažeti zapis po redcima



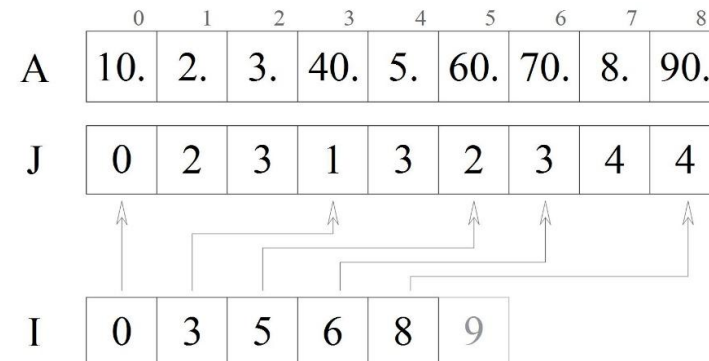
Scheme pohranjivanja rijetko popunjenih matrica I Primjer – simetrična matrica

$$\begin{bmatrix} 10. & 0. & 2. & 3. & 0. \\ 0. & 40. & 0. & 5. & 0. \\ 2. & 0. & 60. & 0. & 0. \\ 3. & 5. & 0. & 70. & 8. \\ 0. & 0. & 0. & 8. & 90. \end{bmatrix}$$

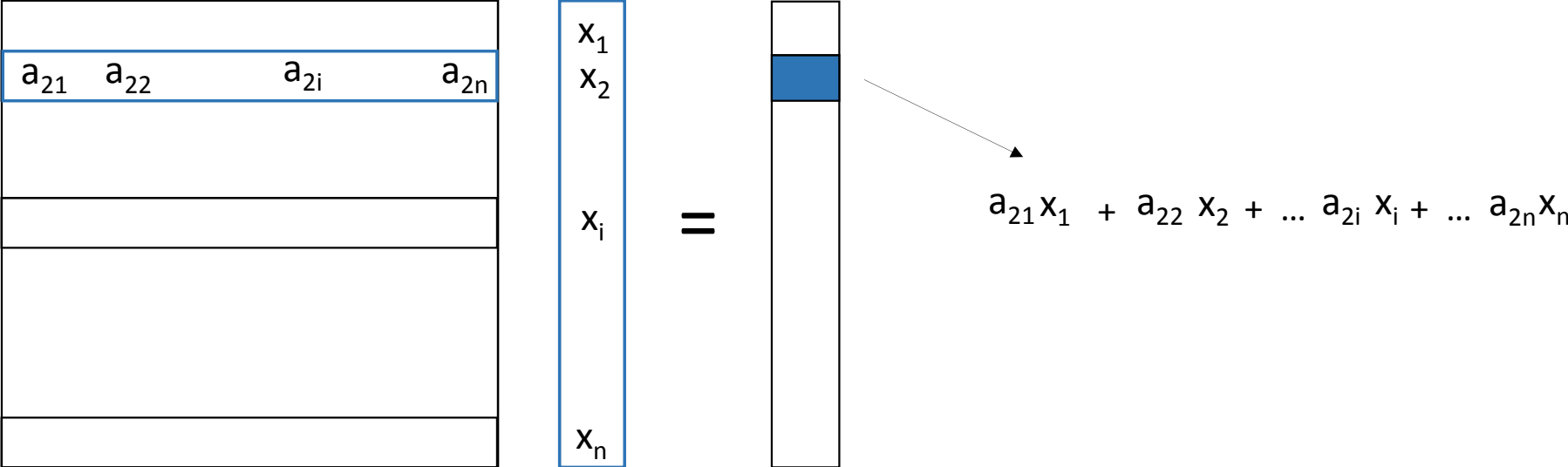
Sažeti zapis po stupcima donjeg trokutastog dijela simetrične matrice



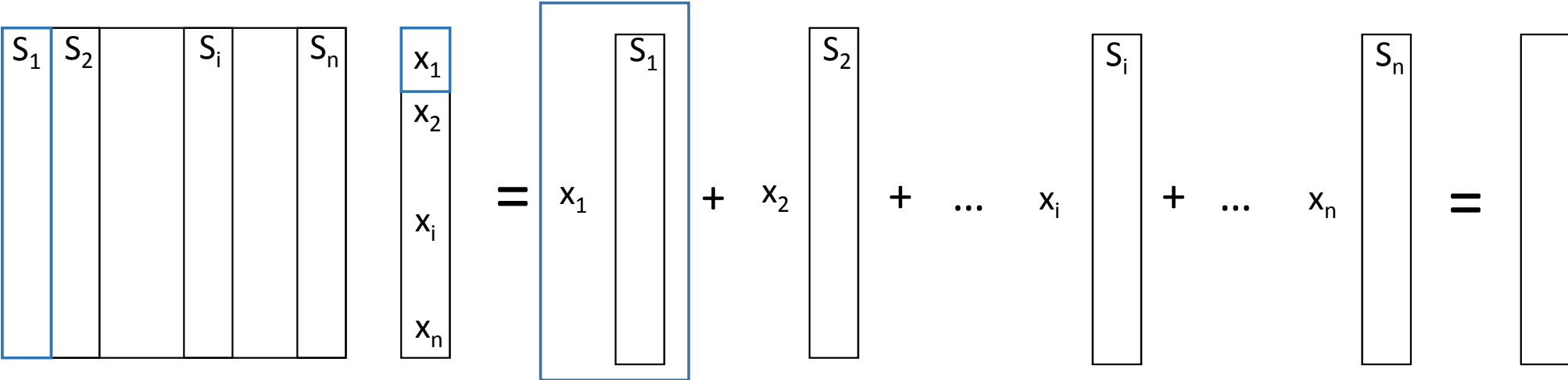
Sažeti zapis po redcima gornjeg trokutastog dijela simetrične matrice



Umnožak rijetko popunjene matrice i vektora | Po redcima



Umnožak rijetko popunjene matrice i vektora | Po stupcima



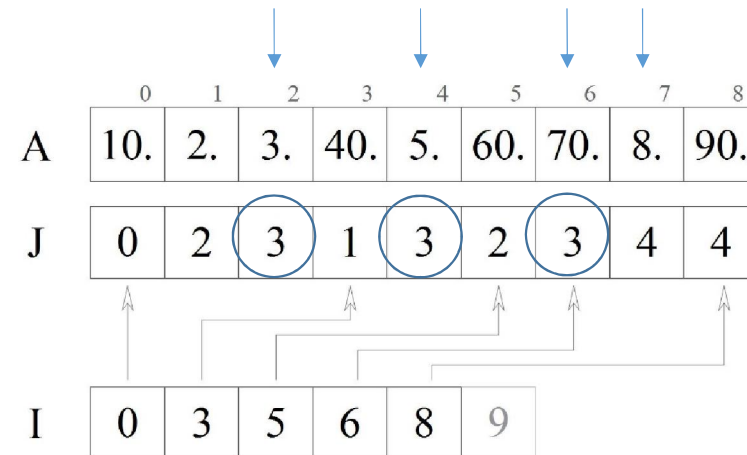
Umnožak rijetko popunjene matrice i vektora | Simetrične matrice

$$\begin{bmatrix} 10. & 0. & 2. & 3. & 0. \\ 0. & 40. & 0. & 5. & 0. \\ 2. & 0. & 60. & 0. & 0. \\ \textcircled{3.} & \textcircled{5.} & 0. & \textcircled{70.} & \textcircled{8.} \\ 0. & 0. & 0. & 8. & 90. \end{bmatrix}$$

Svojstvo distributivnosti:

$$\mathbf{Ar} = (\mathbf{L} + \mathbf{D} + \mathbf{U})\mathbf{r} = \mathbf{Lr} + \mathbf{Dr} + \mathbf{Ur}$$

Sažeti zapis po redcima gornjeg trokutastog dijela simetrične matrice



Umnožak rijetko popunjene matrice i vektora | Simetrične matrice

$$\mathbf{Ar} = \mathbf{U}^T \mathbf{r} + \mathbf{Dr} + \mathbf{Ur}$$

$$\begin{bmatrix}
 10. & 0. & 2. & 3. & 0. \\
 0. & 40. & 0. & 5. & 0. \\
 2. & 0. & 60. & 0. & 0. \\
 3. & 5. & 0. & 70. & 8. \\
 0. & 0. & 0. & 8. & 90.
 \end{bmatrix}
 \begin{bmatrix}
 a \\
 b \\
 c \\
 d \\
 e
 \end{bmatrix}
 =
 \begin{bmatrix}
 10. a \\
 40. b \\
 60. c \\
 70. d \\
 90. e
 \end{bmatrix}
 +
 \begin{bmatrix}
 2. c + 3. d \\
 5. d \\
 0 \\
 8. e \\
 0
 \end{bmatrix}
 +
 \underbrace{
 \begin{bmatrix}
 0. \\
 2. \\
 3. \\
 0.
 \end{bmatrix}
 a
 +
 \begin{bmatrix}
 0. \\
 5. \\
 0.
 \end{bmatrix}
 b
 +
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 0. \\
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 \end{bmatrix}
 c
 +
 d
 \begin{bmatrix}
 8.
 \end{bmatrix}
 }_{\mathbf{U}^T \mathbf{r}}$$



Umjesto zaključka...



Hvala na pažnji!

Unidentified funicular objects

