

# **INTELIGENTNI TUTORSKI SISTEMI**

**DOC. DR. MATEJ GUID**

Laboratorij za umetno inteligenco  
Fakulteta za računalništvo in informatiko  
Univerza v Ljubljani

april 2013

# O POMENU BESEDE „TUTOR“ – MALO ZA ŠALO MALO ZARES ;)

*„In the United States, the term tutor is generally associated with one who gives professional instruction in a given topic or field.“*

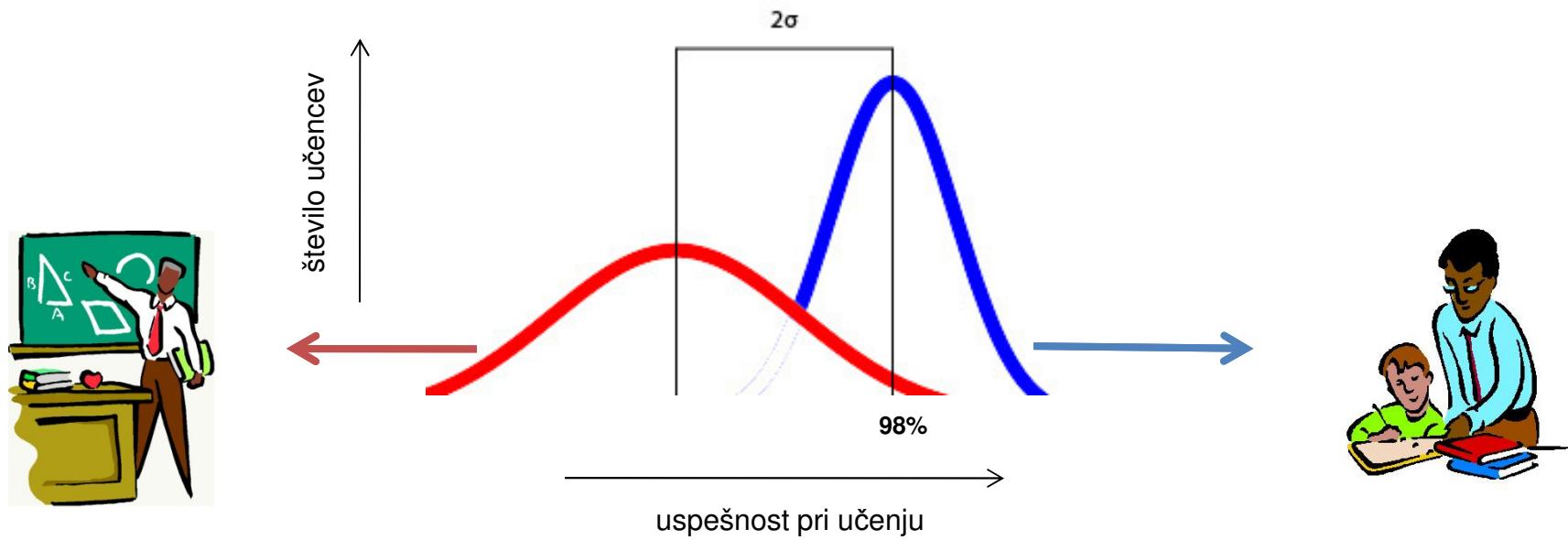
-- Wiki Answers

1. **tútor** -ja m (ū) knjiž. *varuh, skrbnik*: postaviti mladoletniku tutorja; pren. tutor življenja ♪
2. **tútorski** -a -o prid. (ū) knjiž. *varuški, skrbniški*: tutorske dolžnosti ♪
3. **tútorstvo** -a s (ū) knjiž. *varuštvo, skrbništvo*: sprejeti tutorstvo / lastiti si tutorstvo nad kom; idejno, politično tutorstvo ♪

-- SSKJ

# POUČEVANJE ENA NA ENA

Poučevanje ena na ena je veliko bolj učinkovito kot poučevanje v razredu.



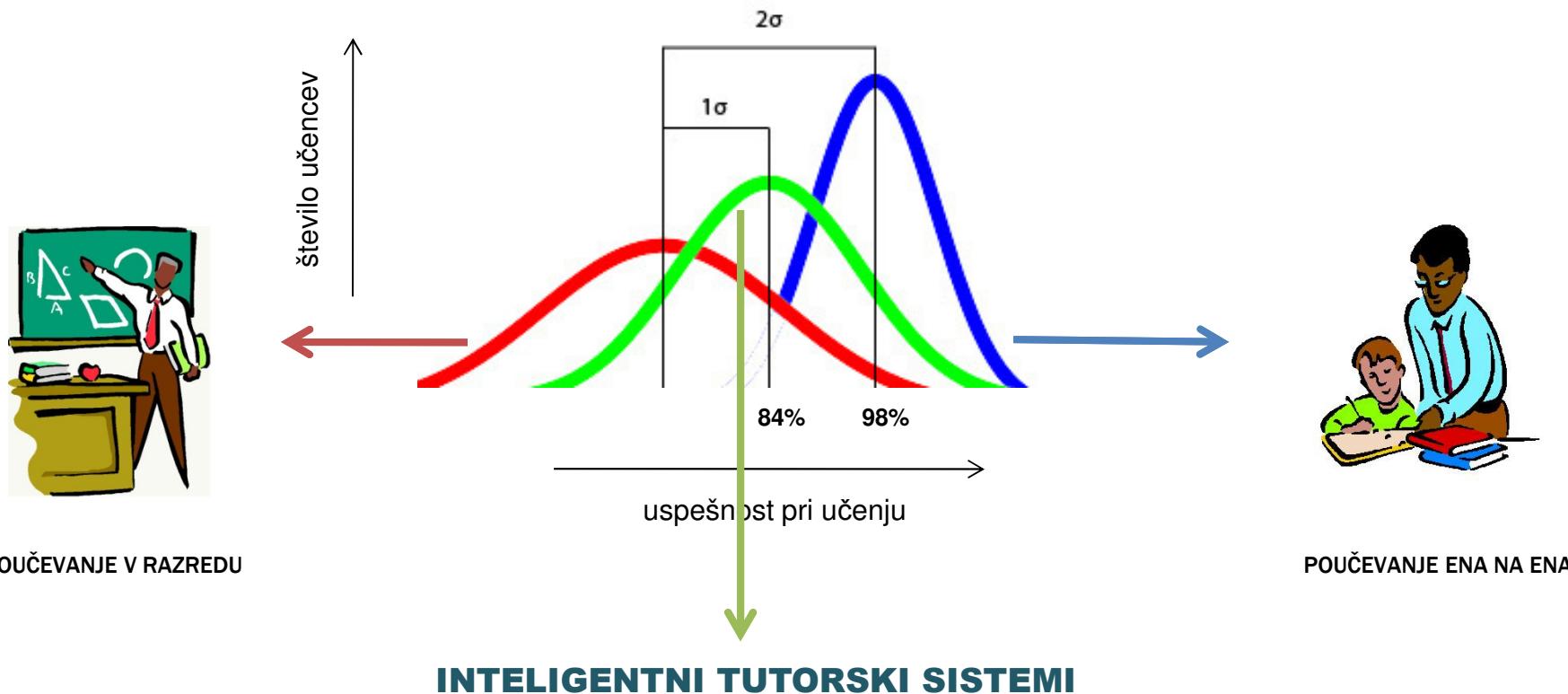
POUČEVANJE V RAZREDU

POUČEVANJE ENA NA ENA

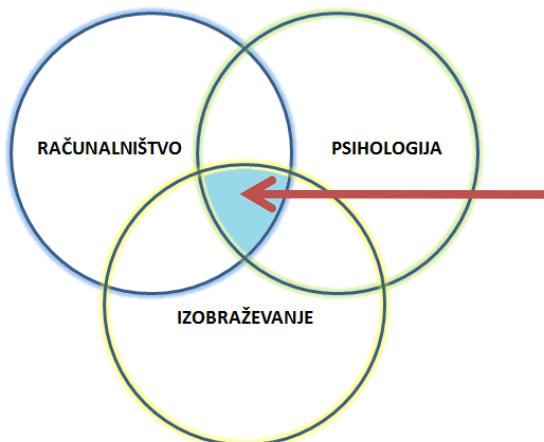
Ali lahko izdelamo računalniške sisteme za poučevanje, ki bodo podajali instrukcije, prilagojene individualnim potrebam in sposobnostim vsakega posameznika?

# INTELIGENTNI SISTEMI ZA POUČEVANJE

Inteligentni sistemi za poučevanje so po učinkovitosti na pol poti med učenjem v razredu in poučevanjem ena na ena.

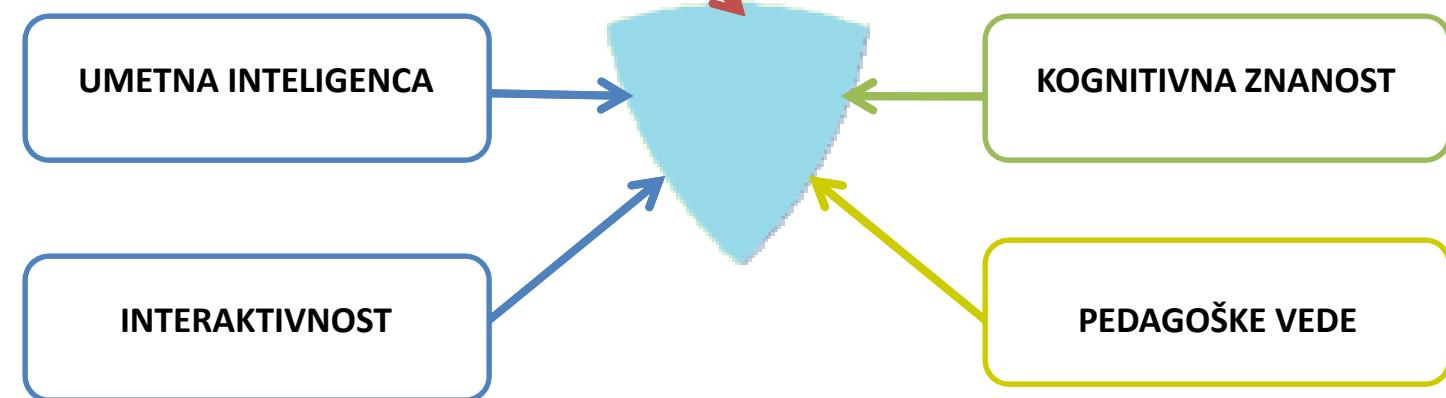


# PODROČJE: UMETNA INTELIGENCA V IZOBRAŽEVANJU

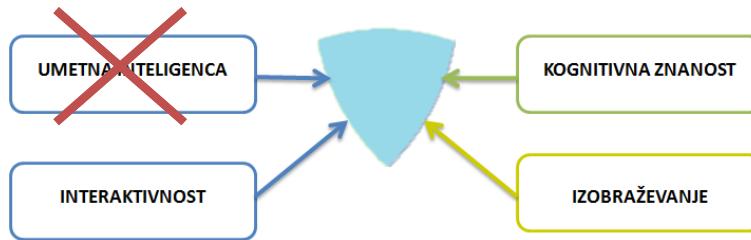


## INTELIGENTNI TUTORSKI SISTEMI

- računalniška orodja, namenjena individualnemu poučevanju učencev
- avtonomno in inteligentno prilagajanje njihovim specifičnim potrebam



# PREDHODNIKI INTELIGENTNIH TUTORSKIH SISTEMOV



## RAČUNALNIŠKO PODPRTO POUČEVANJE

Speed Game



Speed Match  
Information Processing

Play Now

Feeling like your reaction time could use some improvement? Race against the clock and put your reaction speed to the test.

Memory Game



Memory Matrix  
Spatial Recall

Play Now

Challenge yourself to remember patterns that grow bigger and more complex as you improve.

Flexibility Game

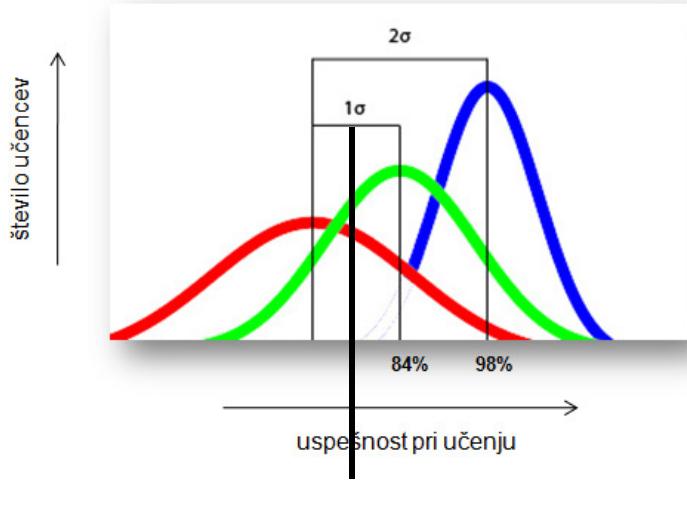


Word Bubbles  
Verbal Fluency

Play Now

Our most popular game! Come up with as many words as you can that begin with the three letters provided.

primer: [www.lumosity.com](http://www.lumosity.com)



0.5σ

Problem Solving Game



Raindrops  
Arithmetic

Play Now

We can't all be naturally good with numbers, but we can get better! Play this to improve your arithmetic skills.



Glavna pomanjkljivost: statično, togo obnašanje.  
Niso se zmožni prilagoditi specifičnim potrebam učencev.

## Chess Tempo

To Play: 00:37 ✓

White Castling: None  
Black Castling: None  
Problem #: 41377

Upgrade Membership to have a convenient button to play the current position against the computer, and see common problem mistakes. Gold members also see details of the chess game the problem was taken from, and get a link to explore the full game in the [game database](#).

Problem Blitz Rating: 1907.6  
Blitz Av Seconds: 00:43  
Blitz Attempts: 700  
Blitz Success Rate: 50.29%

Problem Standard Rating: 1769.9  
Standard Av Seconds: 03:17  
Standard Attempts: 1961  
Standard Success Rate: 52.22%

18 comments ( 2 hidden ) [Show](#) [Show All](#)

Tags: [Mate Threat](#), [Capturing Defender](#), [Exposed King](#), [Extra Move](#) (2.cxd5)

[+ Tag](#) [- Tag](#)

Please read the [tag descriptions](#) and [Tagging Guidelines](#) before tagging problems.

Quality: (click on star to vote)

Choose the best move(s). For help see the [Tactics FAQ](#).  
The best move usually ends up at least 2 pawns worth of material.  
Moves that win a pawn or less will likely fail the problem.

Last Problem: Correct  
User: 2102 (+16.7)  
Problem: 1769.8 (-0.3)

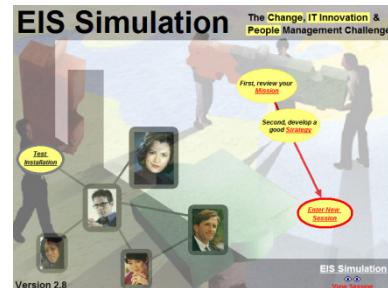
1... Rxd5

( 1... Rxd5 2. Qf4+ Qxf4 3. gxf4 Rd3 4. Kf2 Rxb3 5. Re5 Bg4 6. Rxc5 Rf3+ 7. Ke1 Rxf4 8. Ra5 Rxc4 9. Rxa6 b3 10. Rb6 Rc1+ 11. Kd2 Rc2+ 12. Kd3 ) \*

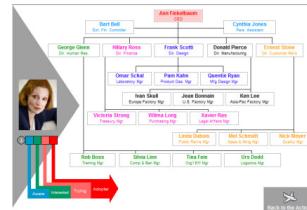
Next Problem Give Up ⏪ ⏩ ⏴ ⏵ ⏶ ⏷ ⏸ ⏹

Problem Set: Standard ( 43183 in set)  
Correct: 1 Incorrect: 0  
Last Problem For Session ■

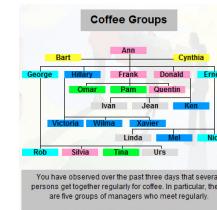
# RAČUNALNIŠKO PODPRTO POUČEVANJE: EIS SIMULATION



*EIS Simulation: The Change, IT Innovation & People Management Challenge*



organizacijska struktura



neformalne organizacije

Control Panel (People & Progress)  
Org. Chart  
Org. Networks

	Aware	Interested	Trying	Adopter
Ann Finkelbaum				
Bart Bell				
Cynthia Jones				
Donald Pierce				
Ernest Stone				
Frank Scotti				
George Glenn				
Hillary Ross				
Ivan Skull				
Jean Bonnain				
Ken Lee				
Linda Dubois				
Mel Schmidt				
Nick Meyer				
Omar Sohal				
Pam John				
Quentin Ryan				
Rob Boss				
Silvia Linn				
Tina Fein				
Urs Dodd				
Victoria Strong				
Wilma Long				
Xavier Ras				

INITIATIVES

- SEEK ADVICE
- PERSONAL PROFILE
- WORKSHOP
- FACE-TO-FACE MEETING
- INTERNAL MAGAZINE
- COVERT LOBBYING
- MEMORANDUM
- DIRECTIVE
- ELECTRONIC MAIL
- PILOT TEST
- STAFF DISCUSSION
- QUESTIONNAIRE
- EXTERNAL SPEAKER
- NETWORKS
- DIRECTORS MEETING

Click on any initiative for a short description!

Detailed Descriptions      Implement it!  
Mission Score      Print      Quit      EIS Simulation  
Click on any bubble to see access more      View Other Session

spremljanje napredka

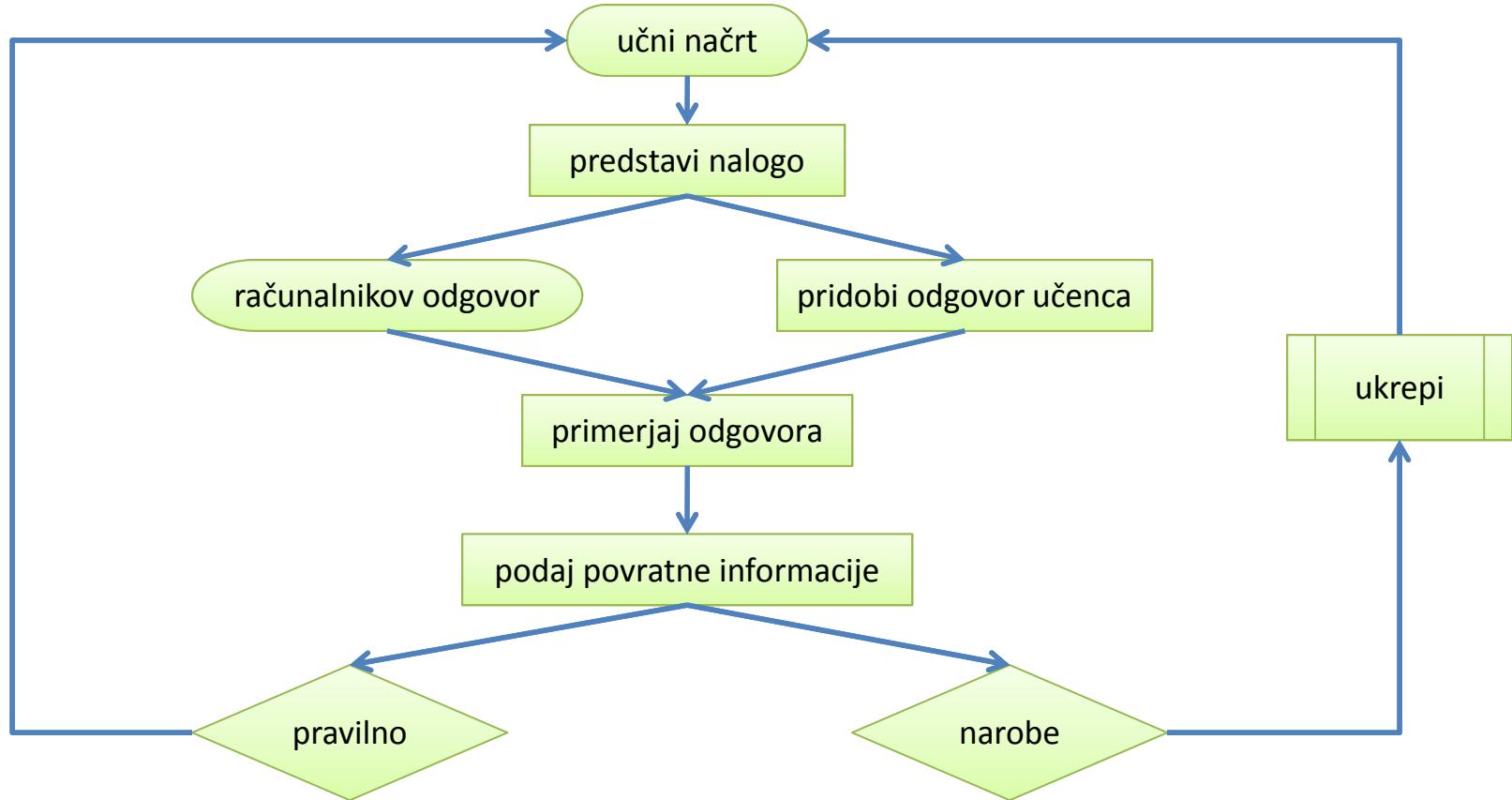
Hillary Ross  
Dir. Finance

Seen as responsible for the cost controls of recent years. Came to position with lots of business school credentials and later seen as another MBA, "Master of Brutal Action". Strong believes that the business requires real transformation but only in cost savings.

izbira odločitve (20 opcij)

časovnica: 120 dni

# SISTEMI ZA RAČUNALNIŠKO PODPRTO POUČEVANJE

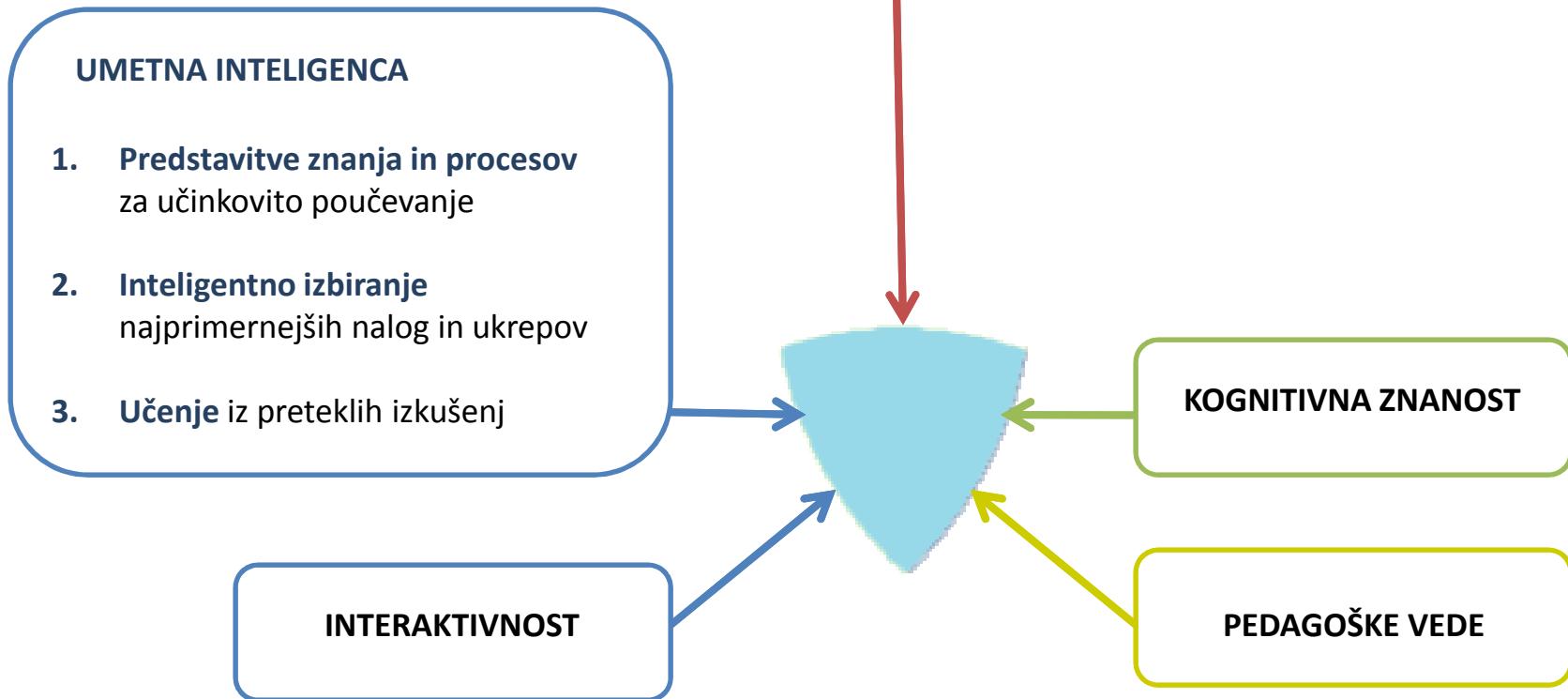


Vse odločitve v programu so vnaprej določene.

Ni obravnave notranjega procesa, ki je učenca vodil do rešitve.

CAI

## INTELIGENTNI TUTORSKI SISTEMI



ITS

# INTELIGENTNI TUTORSKI SISTEMI: V PRAKSI

## Carnegie Learning: Cognitive Tutor poučevanje matematike

**Carnegie Learning's Cognitive Tutor**

**A1 Rock-Climber**

**Worksheet:**

Quantity Name	CLIMBING TIME	HEIGHT ABOVE GROUND
Unit	MINUTES	FEET
Expression	T	$2.5T + 67$
Question 1	10	92
Question 2	20	117
Question 3	1.25	70.125
Question 4	-10	42

**Transformation ▾ Simplification ▾ =**

Solve the equation for T

$$2.5T + 67 = 92$$

$$2.5T + 67 - 67 = 92 - 67 \quad \text{Subtract 67 from both sides}$$

$$\frac{2.5T}{2.5} = \frac{25}{2.5}$$

$$T = 10 \quad \text{Divide both sides by 2.5}$$

**A2 Unit07 YGTX I**

Graph the inequality  $y > x - 7$  to find its solution set.

Choose a graphing method for  $y > x - 7$

**GRAPHSETUP**

**Slope-Intercept**

Slope: 1

Y Intercept: (0, -7)

Graph Shade

X Interval: 1 Y Interval: 1.0

Dependent Independent

**ANDES Physics Workbench - [s2e-Solution]**

**Variables**

Name	Definition	Dir
T0	the instant depicted	
m=2 kg	mass of ball	$\theta x=0^\circ$
x	axis	$\theta Fg...$
Fg	magnitude of the Weight Force on...	$\theta F1...$
F1	magnitude of the Normal Force on...	
a	magnitude of the instantaneous A...	

**Answer:**

**T:** There is a force acting on the ball at T0 that you have not yet drawn.  
Explain further OK

**T:** Notice that the ball is supported by a surface: wall2.  
Explain further OK

**T:** When an object is supported by a surface, the surface exerts a normal force on it. The normal

For Help, press F1

00:09:16 SCORE: 20

*The Andes Physics Tutor*  
poučevanje fizike

ITS

# PRIMER IZ ALGEBRE

*20 ljudi gre na koncert. Otrok je osem  
več kot odraslih.*

*otroci = ?*

*odrasli = ?*

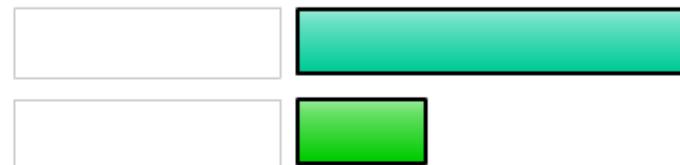
Twenty people are going to a concert. There are eight more children than adults.

Which bar represents the children and which bar represents the adults?  
Please drag the names down to the boxes below.

**children**

**adults**

How many children and adults were at the concert?



Number of children =

Number of adults =



Hint

← Previous

Next →



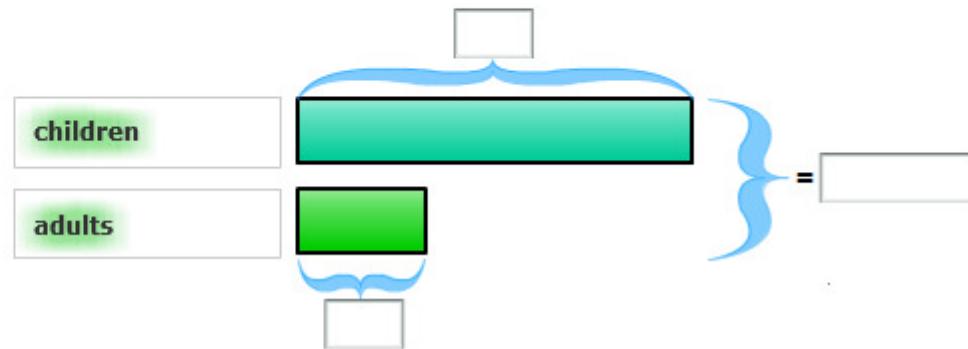
Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

Now which box is for the TOTAL number of people? Please enter the number you find in the introduction text in that box.



Number of children =

Number of adults =

?

Hint

← Previous      Next →

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

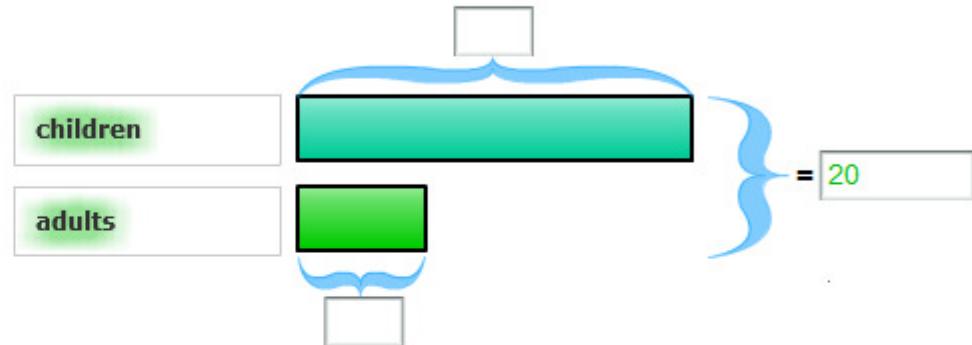
✓

Done

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

The top bar only shows the total children. Please drag-and-drop a piece from the bottom bar onto the top bar to cut it.



Number of children =

Number of adults =

?

Hint

← Previous

Next →

✓

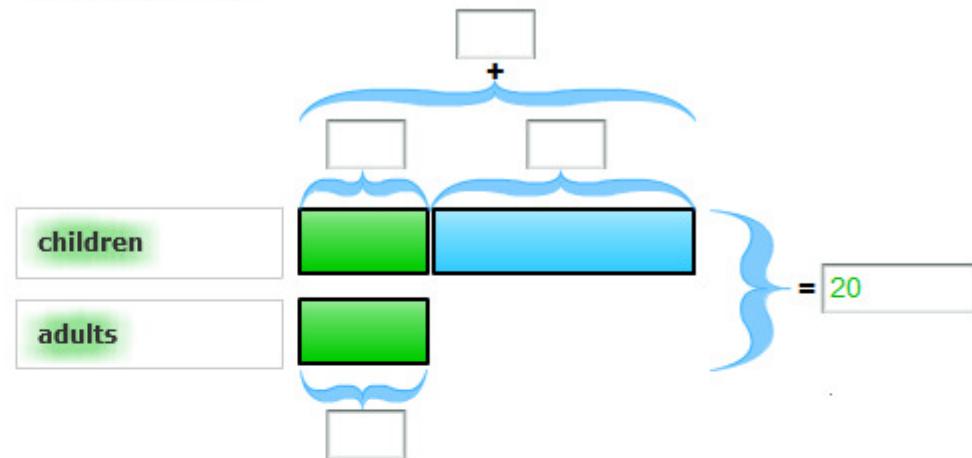
Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

Great! Now find the box for 'how many more children there are than adults' and fill it in.



Number of children =

Number of adults =

?

Hint

← Previous

Next →

✓

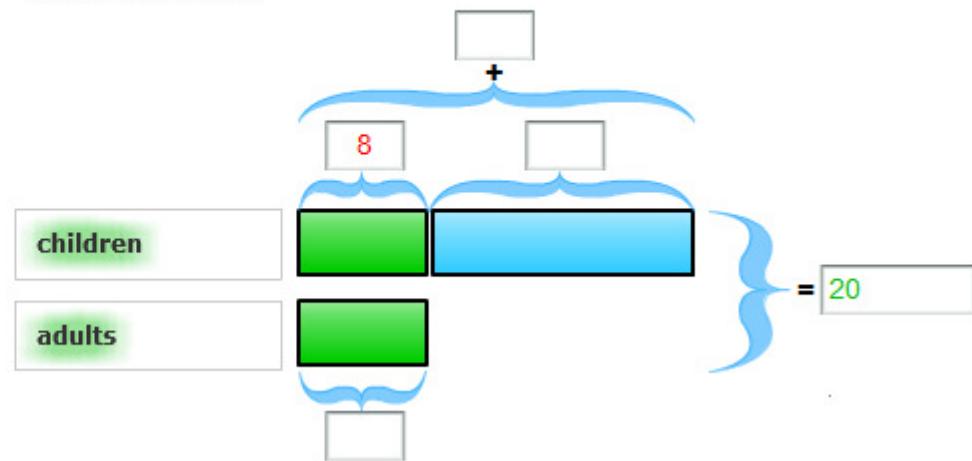
Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

Great! Now find the box for 'how many more children there are than adults' and fill it in.



Number of children =

Number of adults =

?

Hint

No, this part is still UNKNOWN. Please enter the known values first.

← Previous

Next →

✓

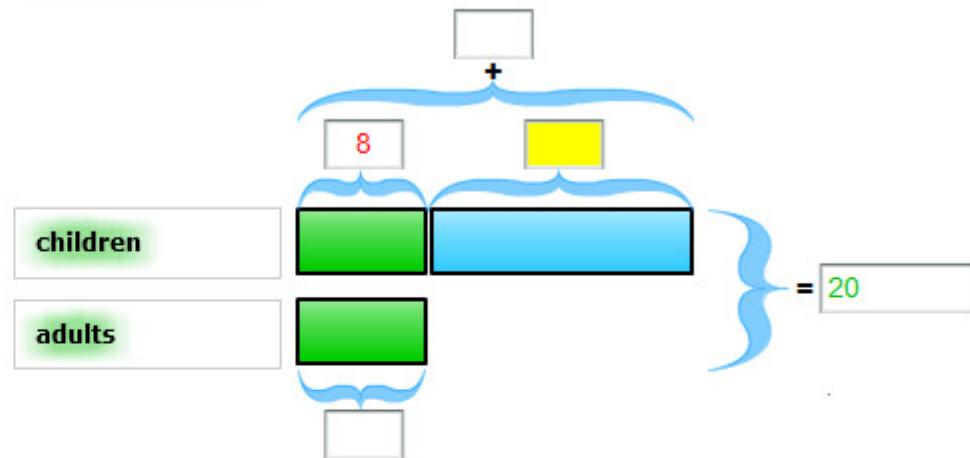
Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

Great! Now find the box for 'how many more children there are than adults' and fill it in.



Number of children =

Number of adults =

Hint  
Hint

Now that you've cut the upper bar, you need to find how many more children there are than adults.

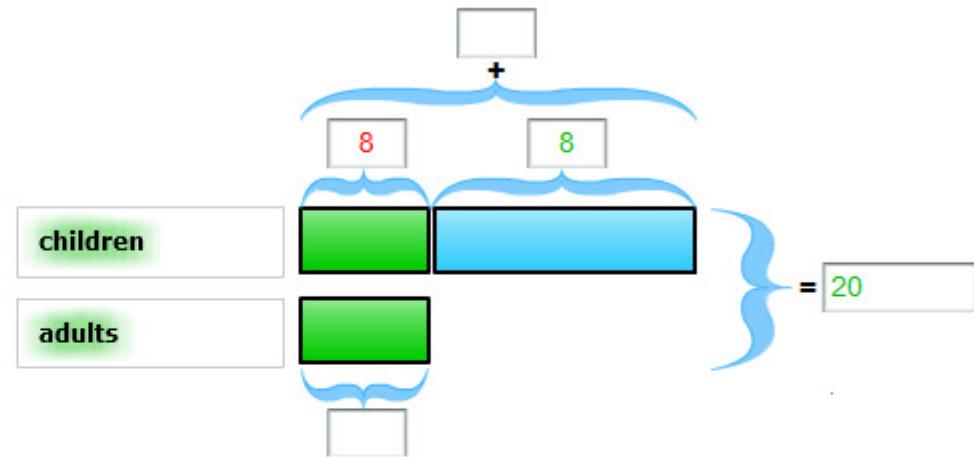
[← Previous](#) [Next →](#)

Done  
Done

- |                          |                           |
|--------------------------|---------------------------|
| <input type="checkbox"/> | Find Sum of Parts         |
| <input type="checkbox"/> | Identify Given Values     |
| <input type="checkbox"/> | Identify Unknown Part     |
| <input type="checkbox"/> | Interpret Representations |
| <input type="checkbox"/> | Set-up Equation           |
| <input type="checkbox"/> | Solve Equation            |

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



Good. Now to find the unknown part, please drag one of the unknowns to the box below.

Number of children =

x

Number of adults =



Hint

← Previous

Next →

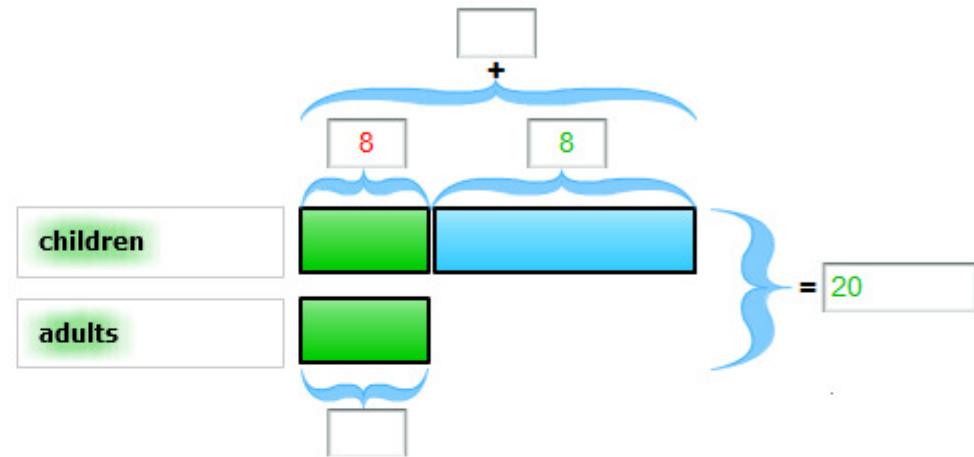


Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



How many unknown parts are there in the bars above?

Number of children =



Number of adults =



Hint

[← Previous](#) [Next →](#)

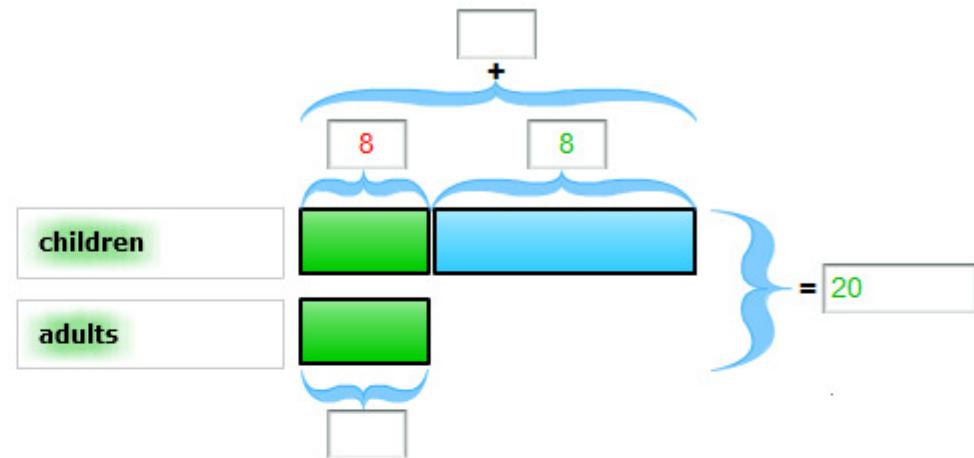
- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation



Done

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



Now for a little calculation: how many people are the two unknown parts together?

Number of children =

Number of adults =

$$2 \times \boxed{\text{green box}} = \boxed{\text{answer}}$$



Hint

[← Previous](#) [Next →](#)

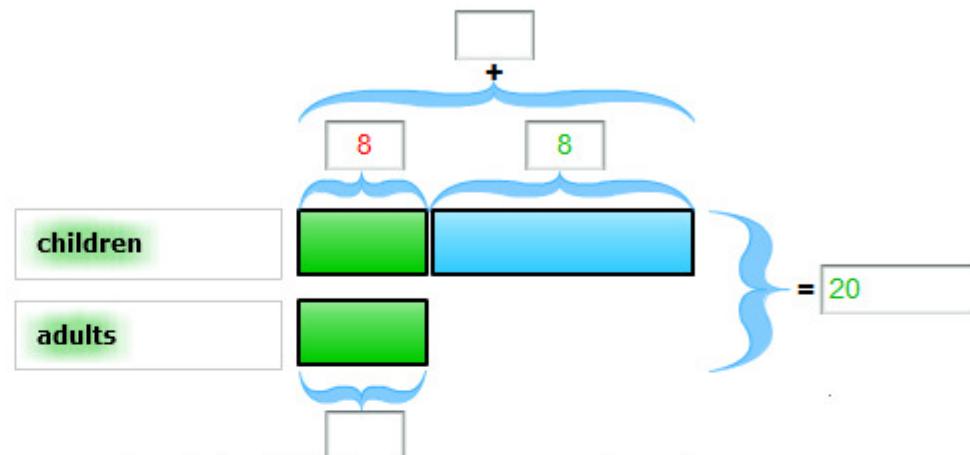
- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation



Done

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



Now for a little calculation: how many people are the two unknown parts together?

Number of children =

$$2 \times \boxed{?} = 2 \times 8$$

Number of adults =



**Hint**

You know the total number of people: 20. You know the difference between children and adults (the blue piece): 8. How many are left for the two green pieces?

← Previous

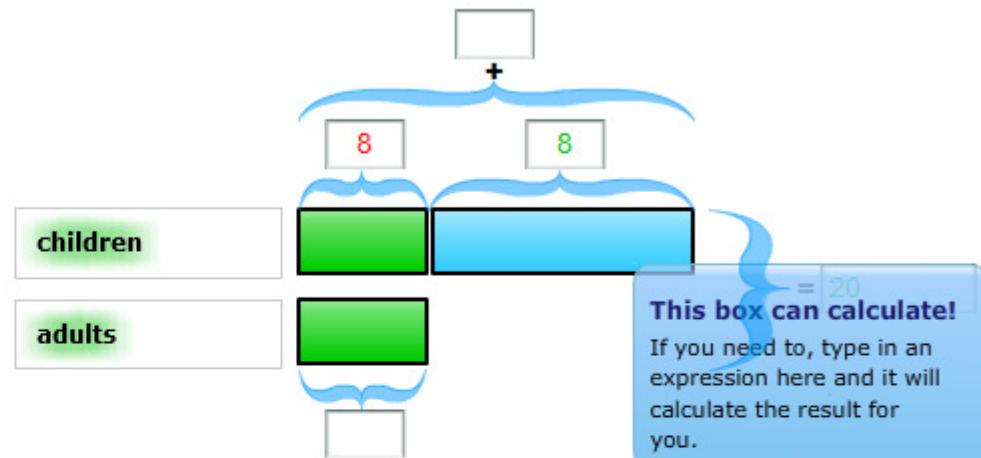
Next →

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

**Done**

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



Now for a little calculation: how many people are the two unknown parts together?

Number of children =

Number of adults =

$$2 \times \boxed{8} = 20 - 8$$

**Hint Hint**

You know the total number of people: 20. You know the difference between children and adults (the blue piece): 8. How many are left for the two green pieces?

← Previous

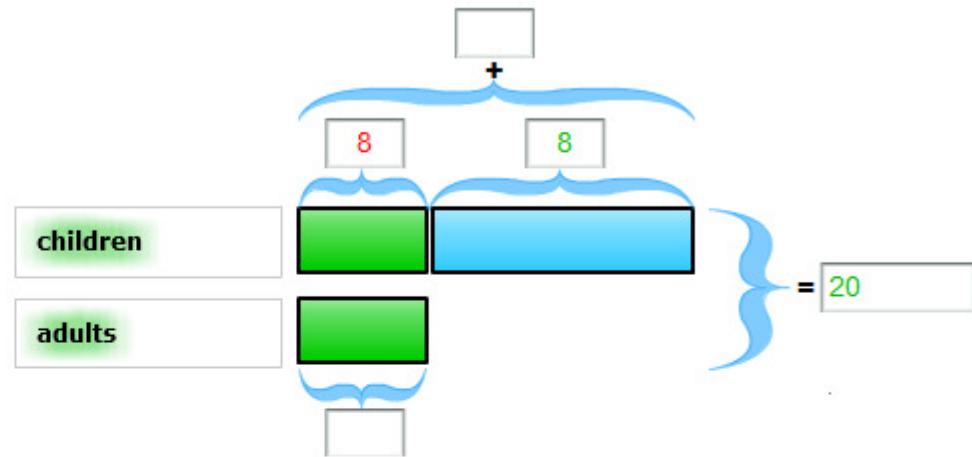
Next →

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

**Done Done**

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?



Yes, indeed! So how many people is ONE unknown part?

Number of children =

$$2 \times \boxed{\phantom{00}} = 12$$

Number of adults =

$$1 \times \boxed{\phantom{00}} = 12/2$$

?

Hint

← Previous

Next →

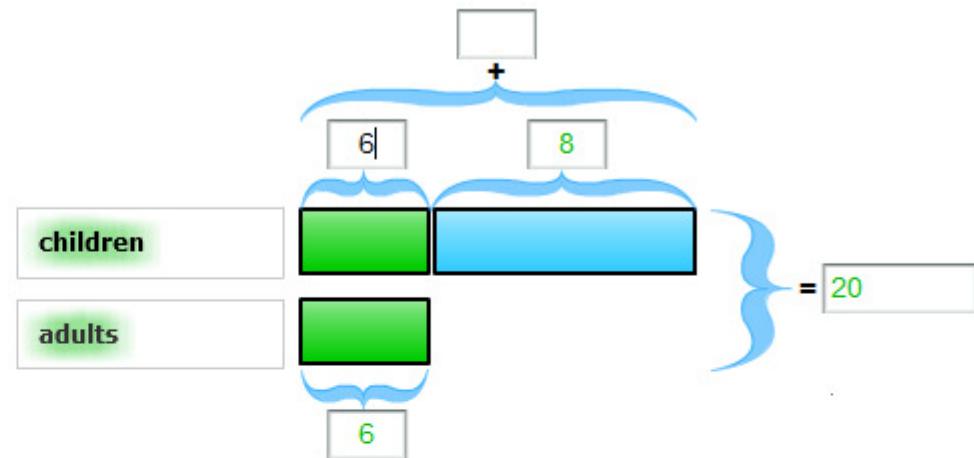
✓ Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.

How many children and adults were at the concert?

Please fill in the remaining textboxes with what you just found out.



Number of children =

$$2 \times \boxed{\phantom{00}} = 12$$

Number of adults =

$$1 \times \boxed{\phantom{00}} = 6$$

?

Hint

← Previous

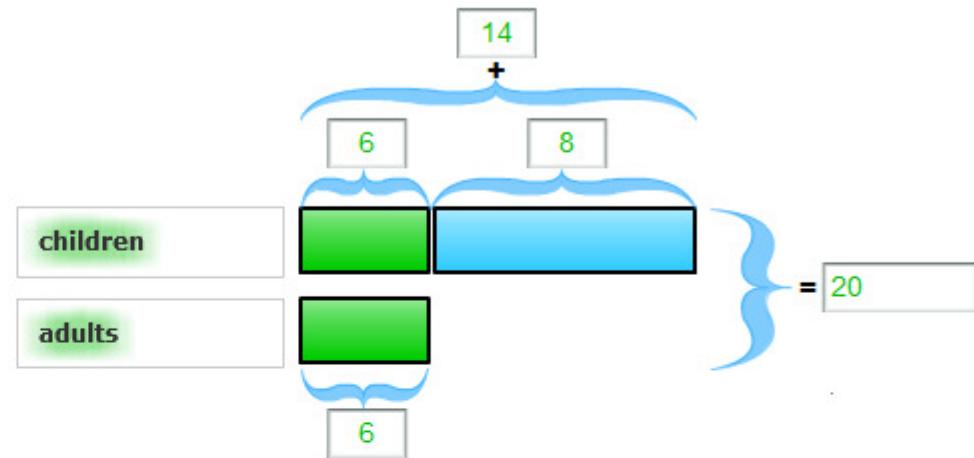
Next →

✓

Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.



How many children and adults were at the concert?

Number of children =

$$2 \times \boxed{6} = 12$$

Number of adults =

$$1 \times \boxed{6} = 6$$

?

Hint

← Previous

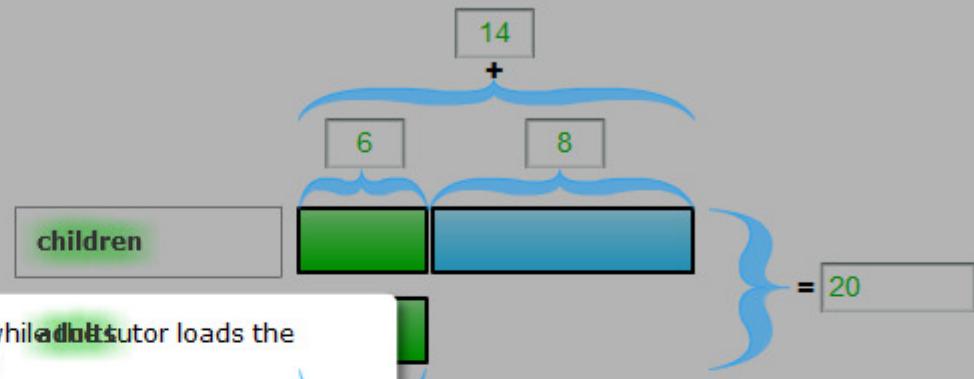
Next →

✓

Done

- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

Twenty people are going to a concert. There are eight more children than adults.



Please wait while MathTutor loads the next problem

How many children and adults were at the concert?

Number of children =

Number of adults =



=  

$1 \times$  

=  



Hint

← Previous

Next →



Done

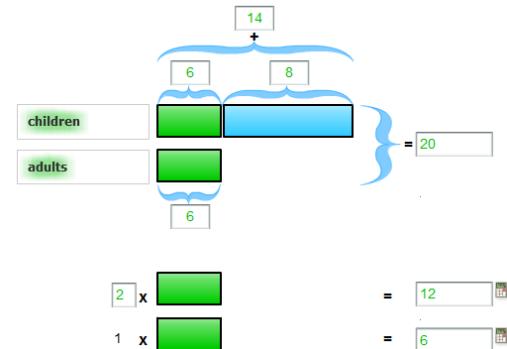
- Find Sum of Parts
- Identify Given Values
- Identify Unknown Part
- Interpret Representations
- Set-up Equation
- Solve Equation

# PRIMER IZ ALGEBRE (NADALJEVANJE)

20 ljudi gre na koncert. Otrok je osem več kot odraslih.

$$\text{otroci} = ?$$

$$\text{odrasli} = ?$$



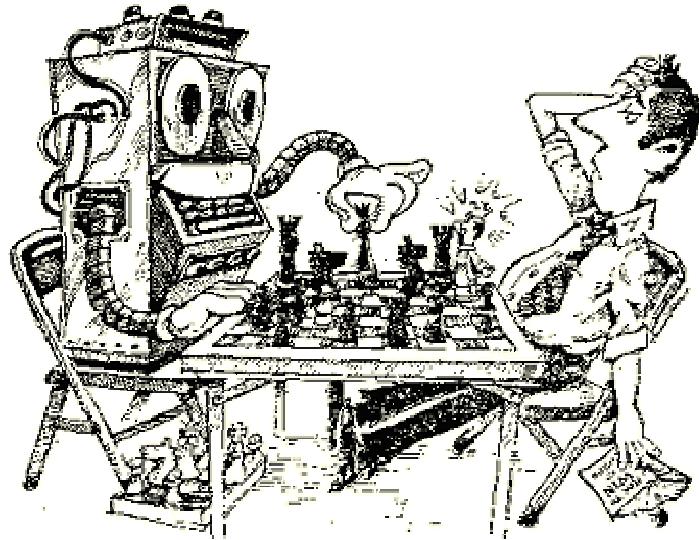
$$\begin{aligned}\text{otroci} &= x + 8 = 6 + 8 = \underline{\underline{14}} \\ \text{odrasli} &= x = \underline{6}\end{aligned}$$

$$\text{otroci} + \text{odrasli} = 20$$

$$\begin{aligned}x + 8 + x &= 20 \\ 2x &= 20 - 8 \\ 2x &= 12 \\ x &= 6\end{aligned}$$

CAI?

ITS?



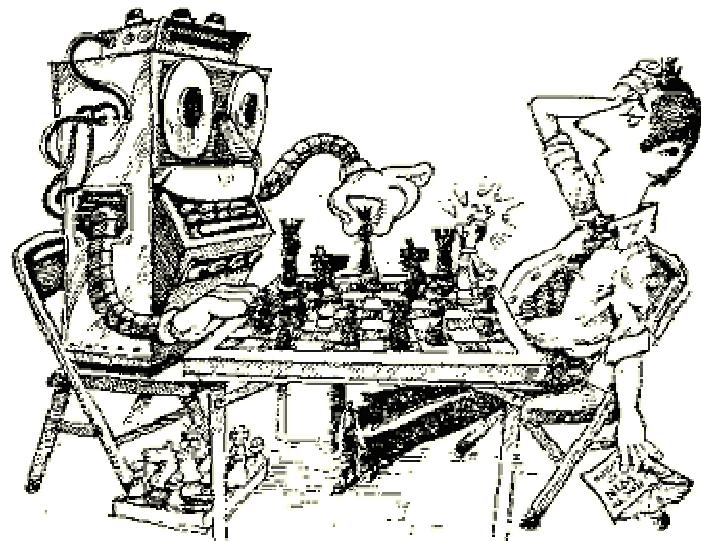
# KOMPONENTE INTELIGENTNIH TUTORSKIH SISTEMOV

EKSPERTNO ZNANJE O DOMENI

model domene

PEDAGOŠKO ZNANJE

model učitelja



MODELIRANJE UČENCA

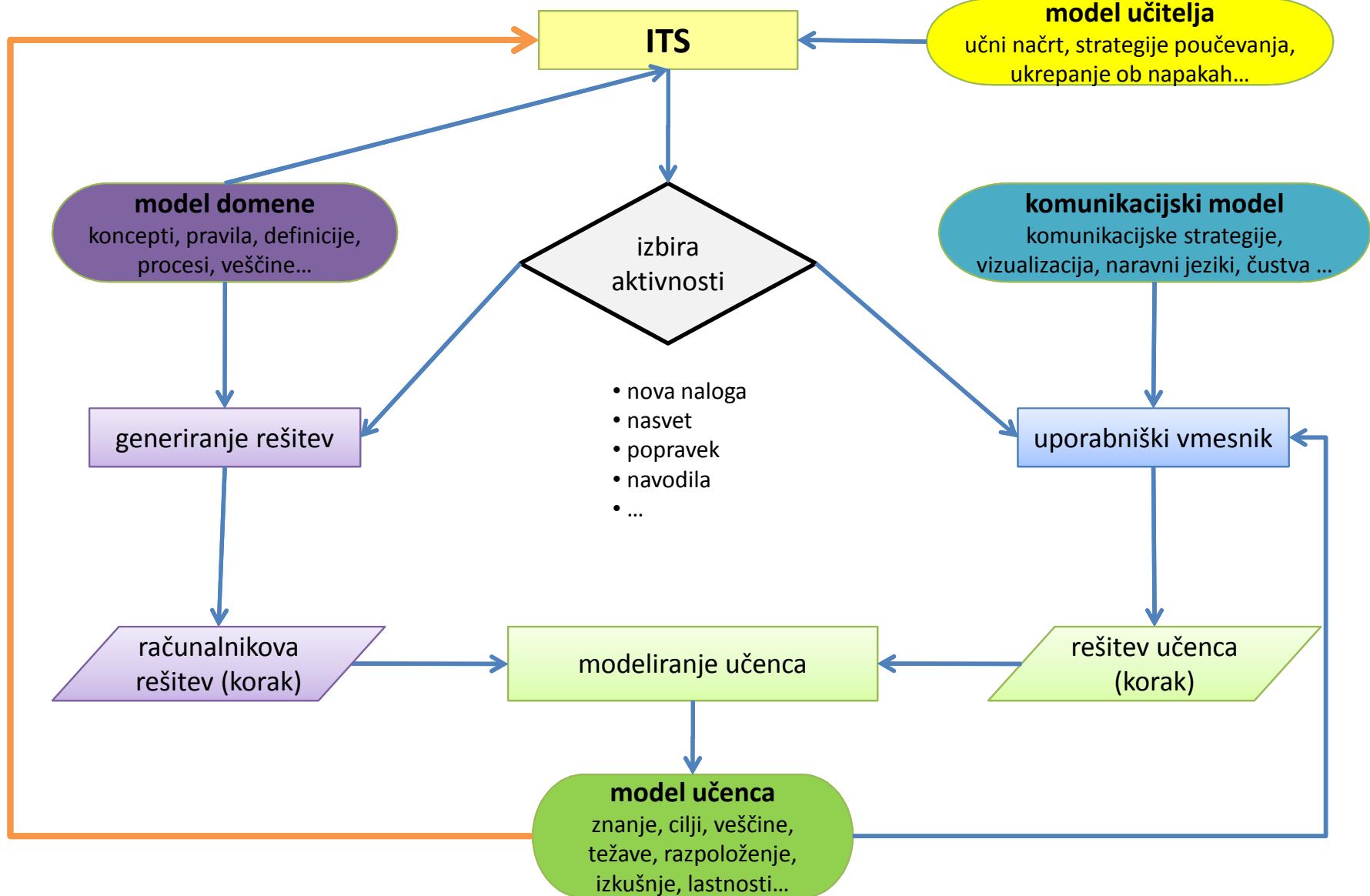
model učenca

KOMUNIKACIJSKE VEŠČINE

komunikacijski model

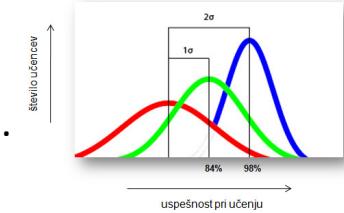
ITS

# DELovanje INTELIGENTNEGA SISTEMA ZA POUČEVANJE

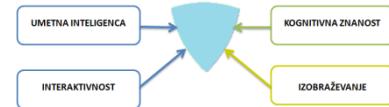


# POVZETEK

- Motivacija za razvoj inteligentnih sistemov za poučevanje:  
**učinkovitost poučevanja ena na ena** v primerjavi s poučevanjem v razredu.

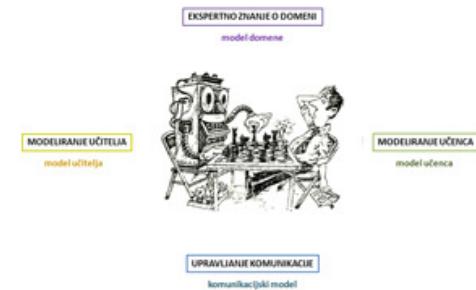


- Interdisciplinarno področje, kjer **umetna inteligenco** igra pomembno vlogo



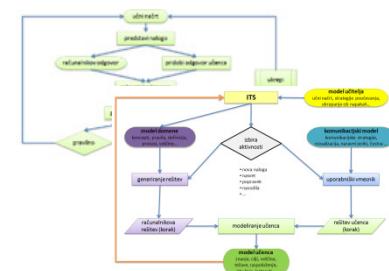
- Komponente inteligentnih sistemov za poučevanje so:

- model domene** -> *domain/expert model*
- model učenca** -> *student model*
- model učitelja** -> *teaching/pedagogical model*
- komunikacijski model** -> *communication model*



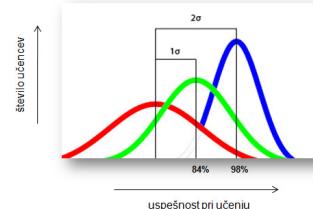
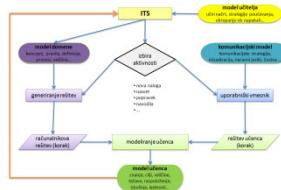
- Razlika med računalniško podprtим poučevanjem (*CAI*) in intelligentnimi sistemi za poučevanje (*ITS*) ob primerjavi med rešitvijo učenca in računalnika sproti samodejno:

- (1) ažurira svojo predstavo o znanju in veščinah učenca,
- (2) generira in izvrši ustrezne nadaljnje ukrepe.



avtonomno in inteligentno prilaganje specifičnim potrebam učencev

# POVZETEK: MALO DRUGAČE



avtonomno in inteligentno prilagajanje  
specifičnim potrebam učencev

učinkovitost poučevanja ena na ena

ITS  
↔  
CAI

INTELIGENTNI  
TUTORSKI SISTEMI



vloga umetne inteligence



model učitelja



MODELIRANIE UČITELJA  
model učitelja

UPRAVLJANIE KOMUNIKACIJE  
komunikacijski model

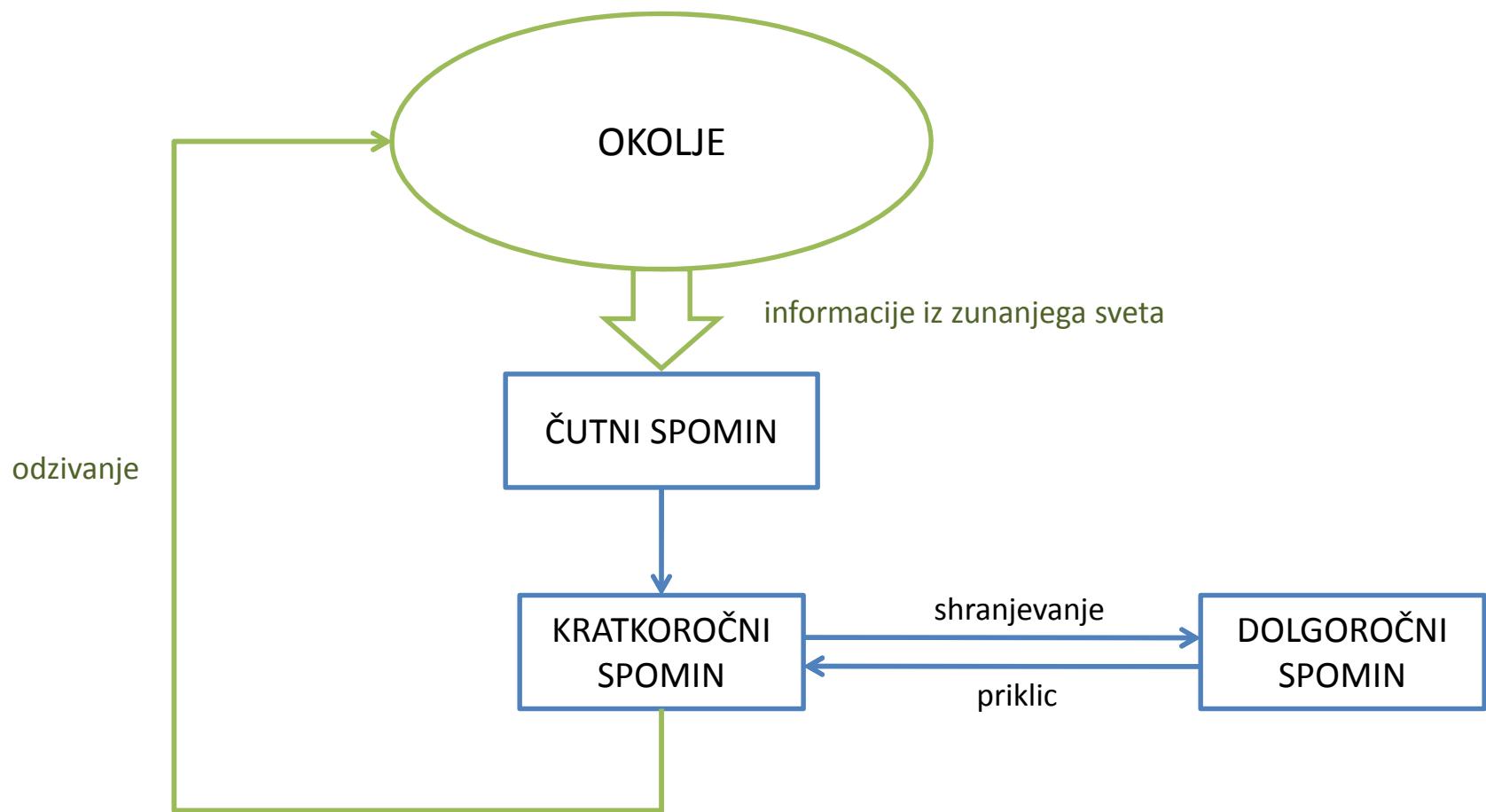
model domene

model učenca

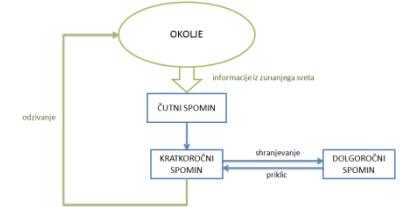


komunikacijski model

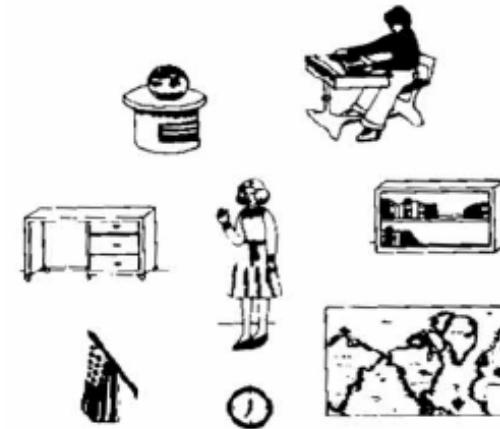
# ORGANIZACIJA SPOMINA



## KAJ JE NA SLIKI?



## KAJ SI LAŽJE ZAPOMNIMO?



**ČRKE ALI BESEDE?**

*chunks in declarative knowledge  
egdelwonk evitaralced ni sknuhc*

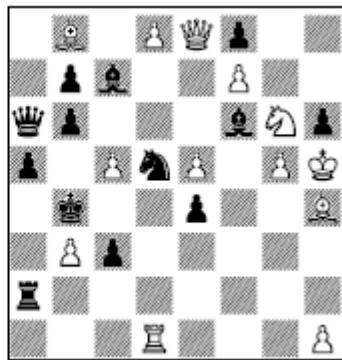
povezovanje informacij v **skupke** (angl. *chunks*)

# SKUPKIV DEKLARATIVNEM ZNANJU

povezovanje informacij v **skupke** (angl. *chunks*)

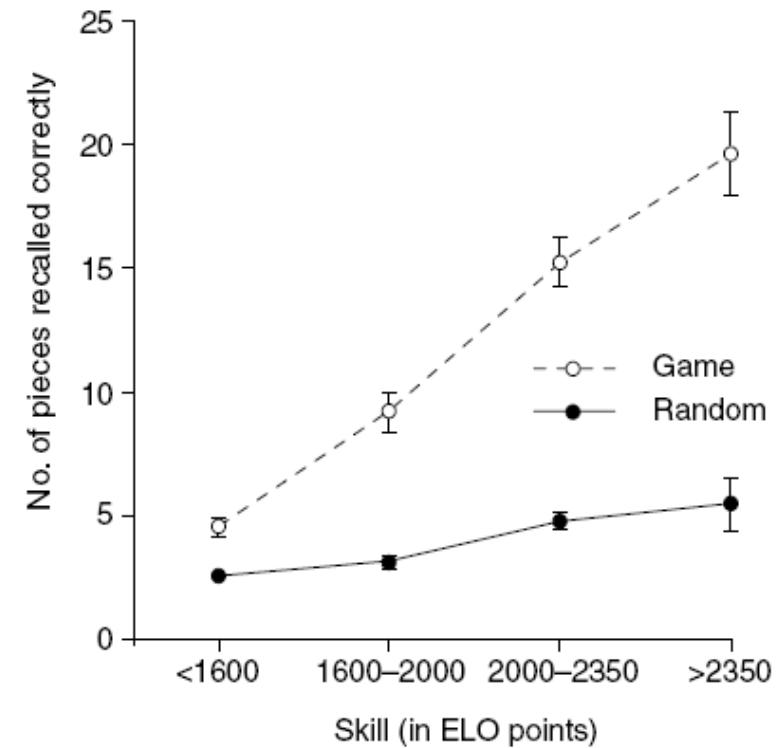


pozicija iz  
resnične partije

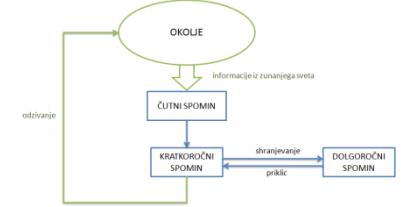


naključno  
pomešane figure

rekonstrukcija šahovskih pozicij  
*Gobet et al. (2001)*



## KAJ JE NA SLIKI?



# DEKLARATIVNO IN PROCEDURALNO ZNANJE

## DEKLARATIVNO ZNANJE

**KAJ?**

podatki in informacije  
(v obliki skupkov)



## PROCEDURALNO ZNANJE

**KAKO?**

nezavedna pravila  
(predelava in povezava informacij)

### KOGNITIVNA TEORIJA “ACT-R”:

Kognitivna spremnost je v tem, da znamo spremeniti deklarativno znanje v sistem produkcijskih pravil, ki predstavlja proceduralno znanje.

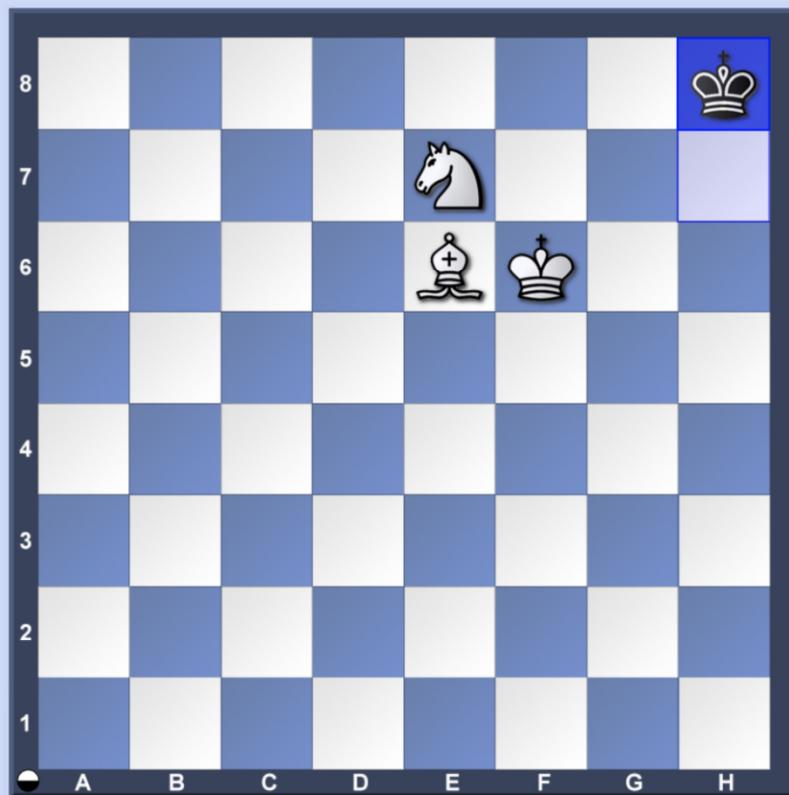
### KOGNITIVNI “TUTORJI”

osvajanje znanja	skozi reševanje problemov
predstavitev znanja	produkcijska pravila (ČE-POTEM)
interpretacija dejanj učencev	sledenje po poti rešitve problema ( <i>model tracing</i> )

# INTELIGENTNI SISTEM ZA POUČEVANJE ŠAHOVSKIH KONČNIC



Instructions

Example  
gamesPlay  
modeTime:  
**00:00:17**Moves:  
**1**

1.  $Kf5-f6$   $Kh7-h8$



## Block the Way to the Wrong Corner

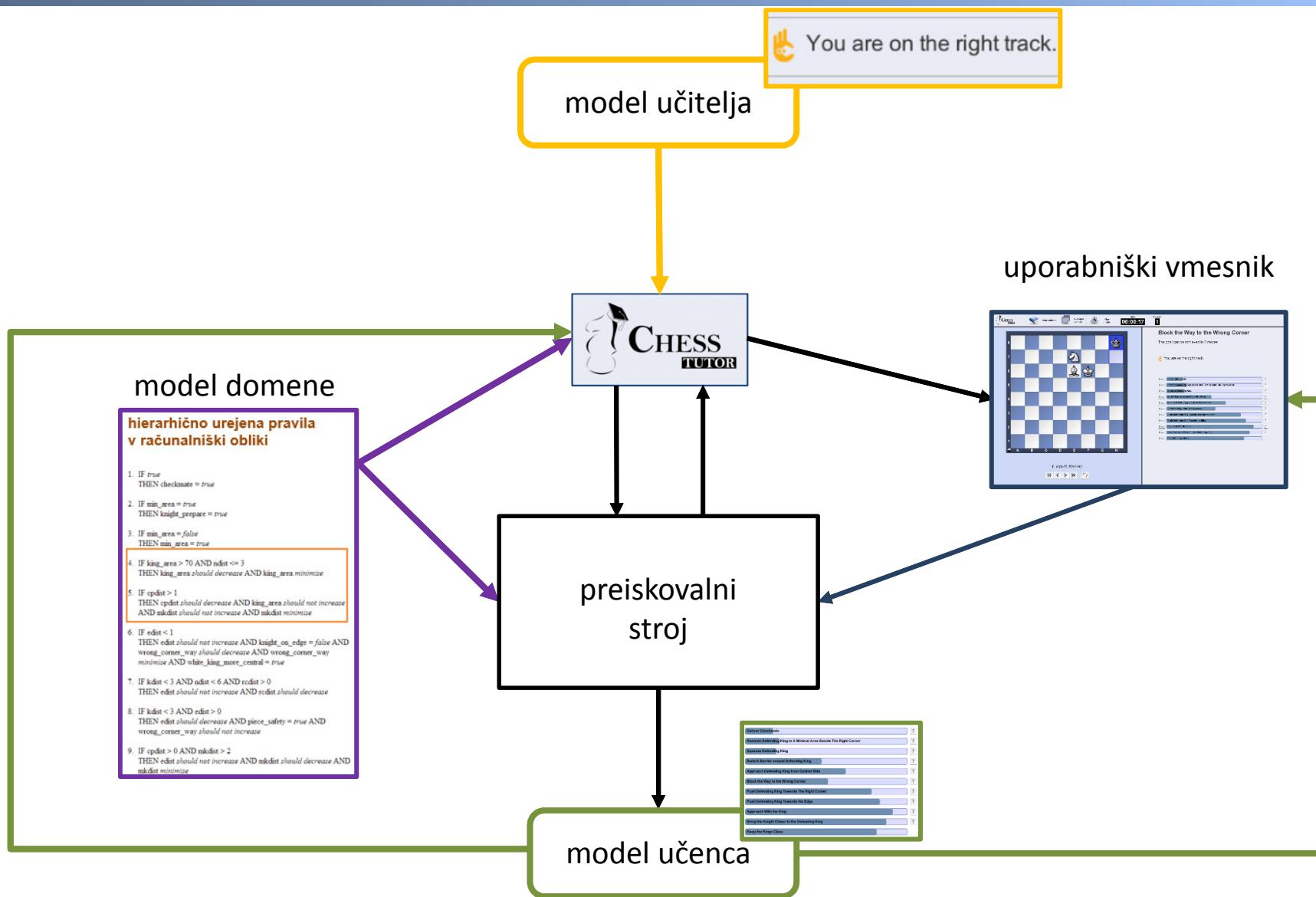
The goal can be achieved in 2 moves.



You are on the right track.

- New | Deliver Checkmate
- New | Restrain Defending King To A Minimal Area Beside The Right Corner
- New | Squeeze Defending King
- New | Build A Barrier around Defending King
- New | Approach Defending King from Central Side
- New | Block the Way to the Wrong Corner
- New | Push Defending King Towards The Right Corner
- New | Push Defending King Towards the Edge
- New | Approach With the King
- New | Bring the Knight Closer to the Defending King
- New | Keep the Kings Close

# INTELIGENTNI SISTEM ZA POUČEVANJE ŠAHOVSKIH KONČNIC



# KONCEPTUALIZACIJA DOMENSKEGA ZNANJA

## OSNOVNA TEORIJA

aksiomi  
zakoni  
formule  
pravila igre

...

pot: pogosto zelo dolga, za človeka težko izvedljiva

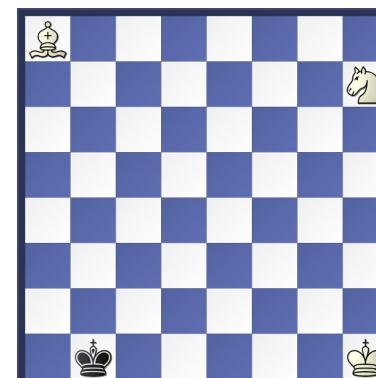
## REŠITEV PROBLEMA

## KONCEPTUALIZIRANA DOMENSKA TEORIJA

deklarativno znanje → proceduralno znanje

osnovna pravila igre  
premikanje figur  
pravilo 50-ih potez  
...  
mat v kotu barve lovca  
osnovna strategija

...



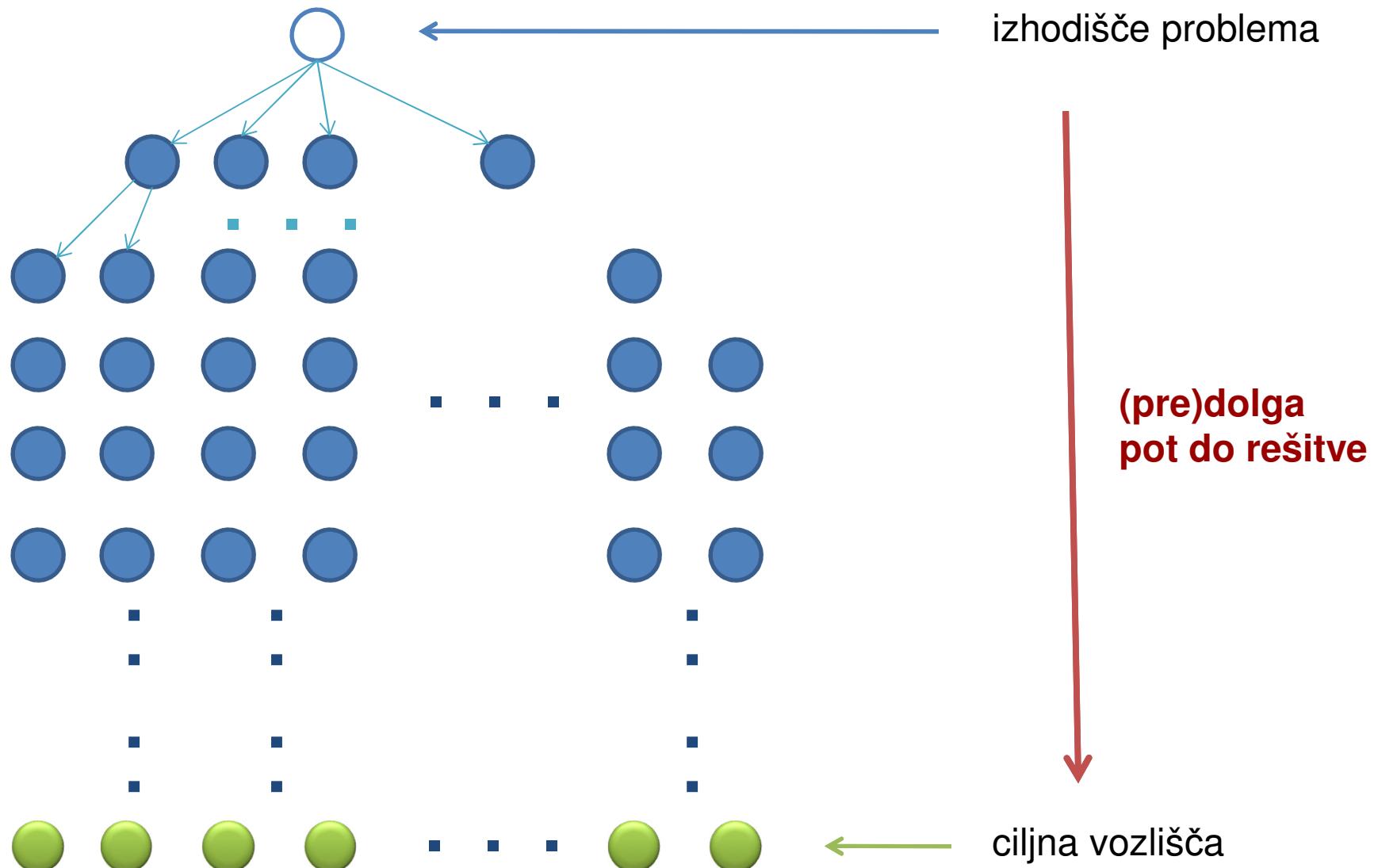
postopki v obliki IF-THEN pravil  
enostavna in kompaktna pravila  
enostavno pomnjenje

...

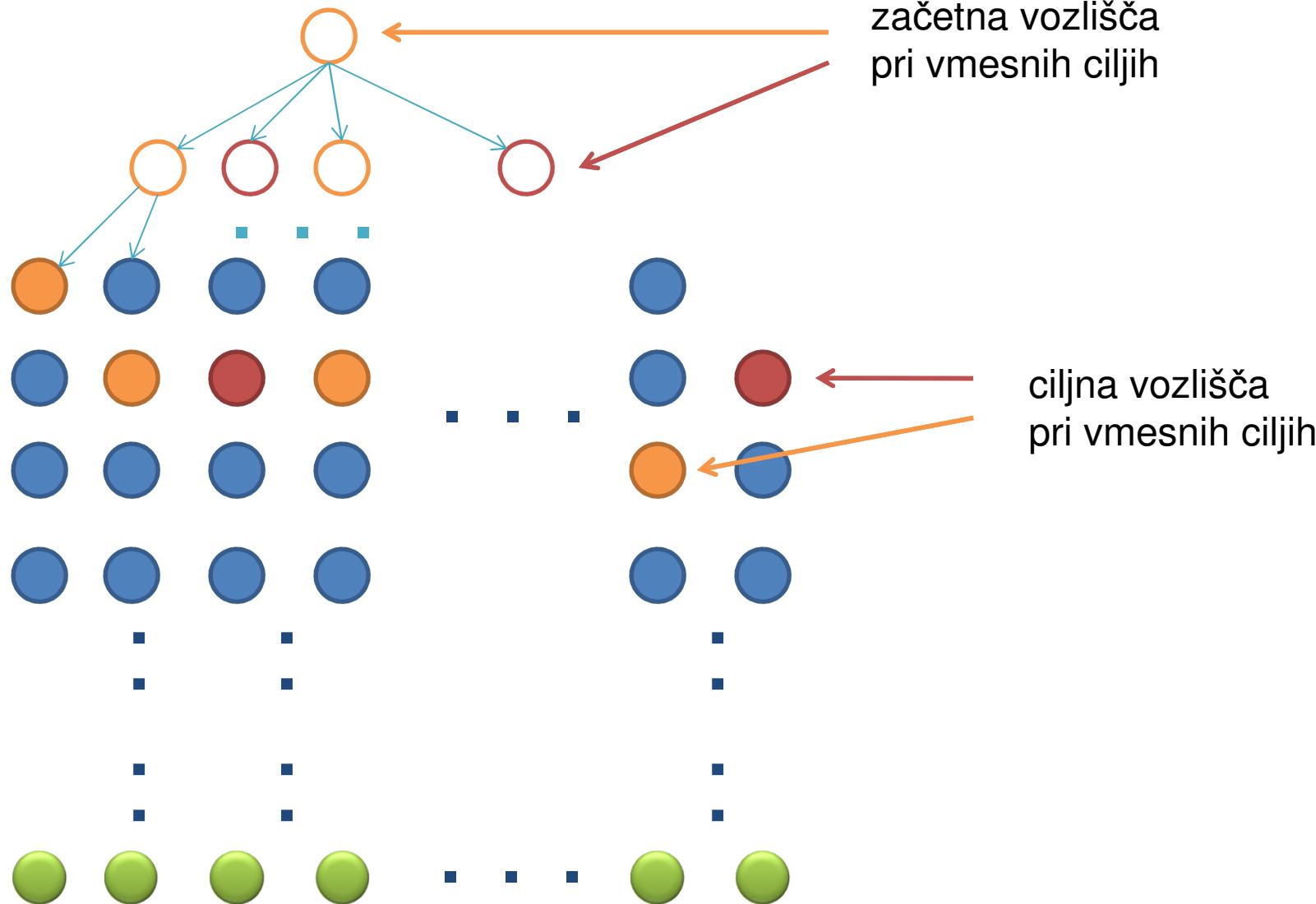
intuitivno znanje

...

# REŠEVANJE PROBLEMOV: PROBLEMSKI PROSTOR



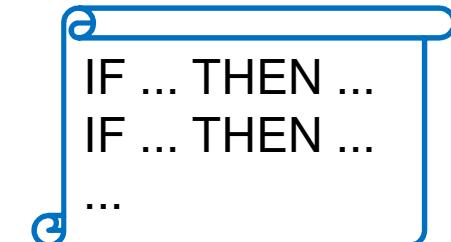
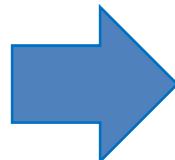
# UČENJE VMESNIH CILJEV



# ELICITACIJA ZNANJA Z ARGUMENTIRANIM STROJnim UČENJEM



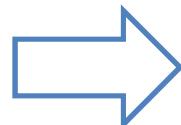
kritični primeri  
protiprimeri



## ABML

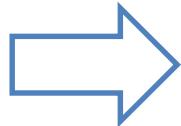
argumentirano strojno učenje

razlaga le enega  
primera hkrati



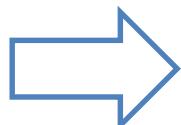
ekspertu je lažje izraziti svoje znanje

“kritični” primeri



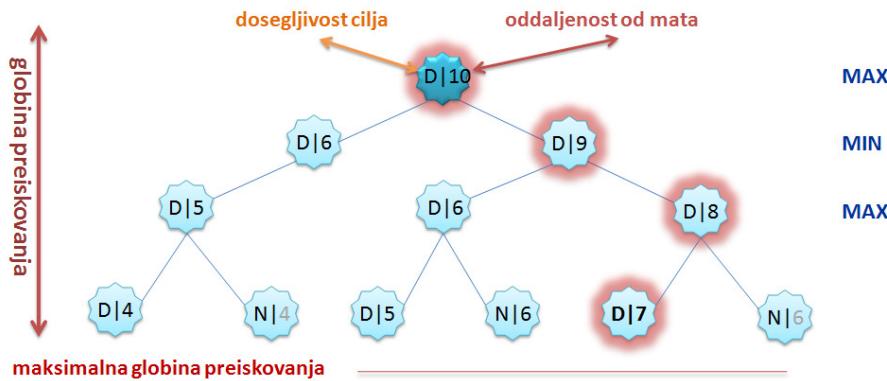
ekspert podaja le najbolj relevantno znanje

protiprimeri



detektiranje pomanjkljivosti v razlagah

# CILJNO ORIENTIRANO UČENJE PRAVIL



- ali je cilj izvedljiv?
- ali cilj vodi do napredka?



**ABML**



**GBRL**

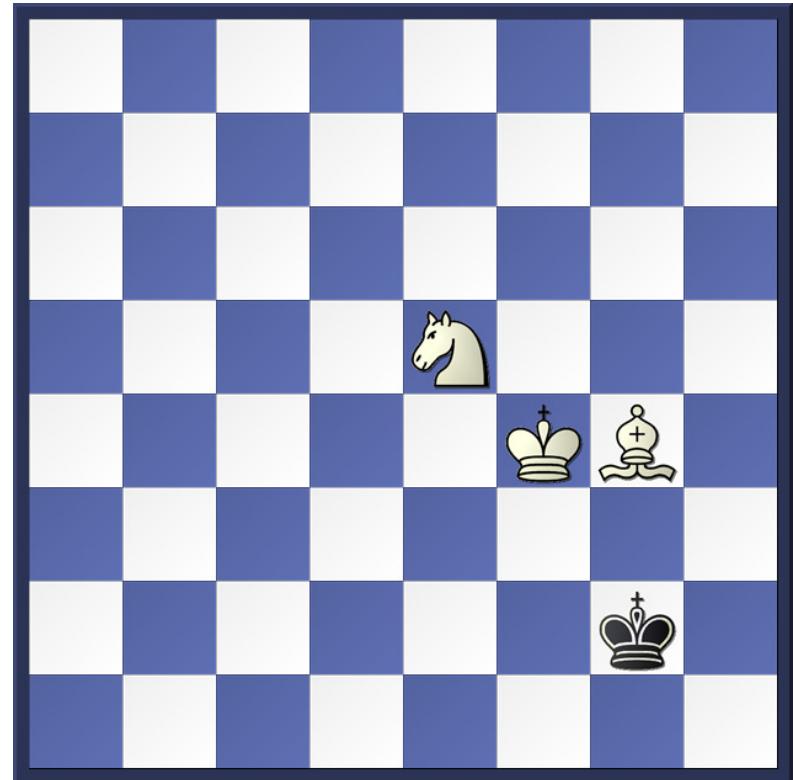
ciljno orientirano učenje pravil

# CILJNO ORIENTIRANO UČENJE PRAVIL: “KRITIČNI” PRIMER

Računalnik vpraša eksperta:

“Kateri **cilj** bi predlagal belemu v tej poziciji?”

Kaj so **razlogi** za primernost tega cilja v tem primeru?”



# GOAL-ORIENTED RULE LEARNING: A “CRITICAL” EXAMPLE

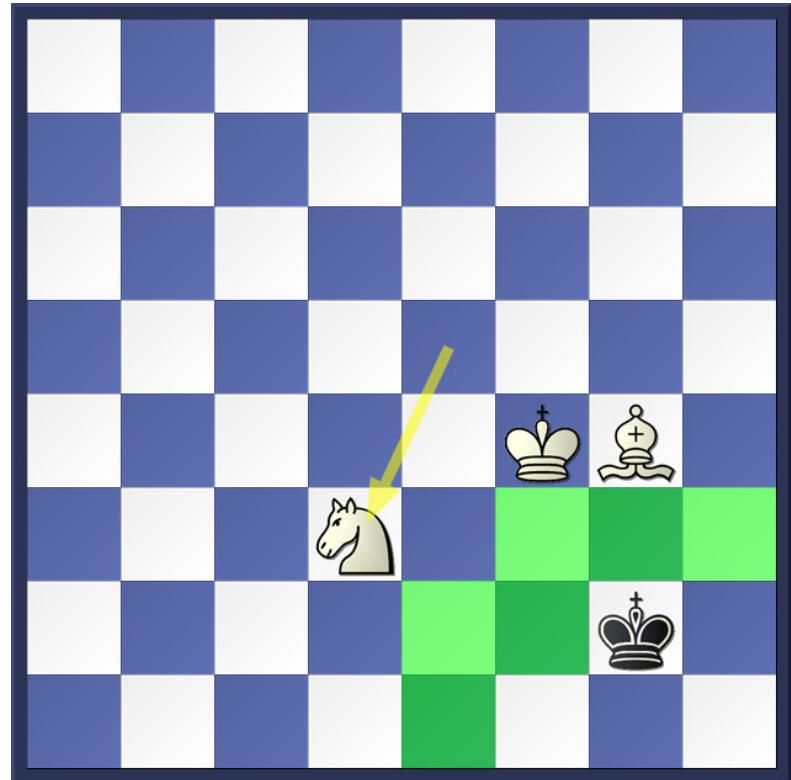
Računalnik vpraša eksperta:

“Kateri **cilj** bi predlagal belemu v tej poziciji?”

Kaj so **razlogi** za primernost tega cilja v tem primeru?”

Ekspert(mojster FIDE):

“Beli lahko omeji področje gibanja črnega kralja. Mogoče je izgraditi **bariero** in s tem omejiti območje, ki je na voljo črnemu kralju.”



## hierarhično urejena pravila v računalniški obliki

1. IF *true*  
THEN checkmate = *true*
2. IF *min\_area* = *true*  
THEN knight\_prepare = *true*
3. IF *min\_area* = *false*  
THEN *min\_area* = *true*
4. IF *king\_area* > 70 AND *ndist* <= 3  
THEN *king\_area* should decrease AND *king\_area* minimise
5. IF *cpdist* > 1  
THEN *cpdist* should decrease AND *king\_area* should not increase  
AND *mkdist* should not increase AND *mkdist* minimise
6. IF *edist* < 1  
THEN *edist* should not increase AND *knight\_on\_edge* = *false* AND  
*wrong\_corner\_way* should decrease AND *wrong\_corner\_way*  
minimise AND *white\_king\_more\_central* = *true*
7. IF *kdist* < 3 AND *ndist* < 6 AND *rdist* > 0  
THEN *edist* should not increase AND *rdist* should decrease
8. IF *kdist* < 3 AND *edist* > 0  
THEN *edist* should decrease AND *piece\_safety* = *true* AND  
*wrong\_corner\_way* should not increase
9. IF *cpdist* > 0 AND *mkdist* > 2  
THEN *edist* should not increase AND *mkdist* should decrease AND  
*mkdist* minimise



### Goal 4: Build A Barrier and Squeeze Defending King

The attacker is advised to build a *barrier* that holds the defending king in an area beside the right-coloured corner. When such barrier is built, the attacker should aim to squeeze the constrained area in order to further restrain the king:

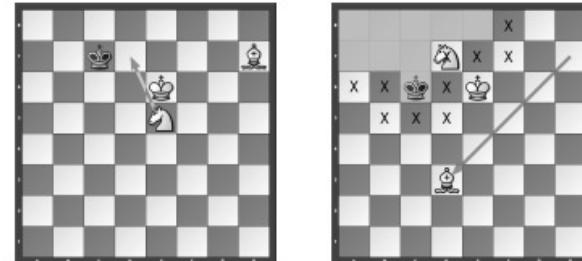


Fig. 3. In the position shown in the left diagram, the attacking side could build the barrier in the following manner: 1.Ne5-d7 Kc7-c6 2.Bh7-d3!, leading to the position on the right. The area around the right-coloured corner to which the defending king is confined, could be squeezed further, e.g., after 2...Kc6-c7 3.Bd3-b5.

### Goal 5: Approach Defending King from Central Side

A part of the basic strategy is to drive the opposing king to the edge of the board. In order to achieve this, it is beneficial for the attacking side to occupy squares closer to the center of the chessboard than the defending king does. The attacker should aim to approach the opposing king from the central side of the chessboard:

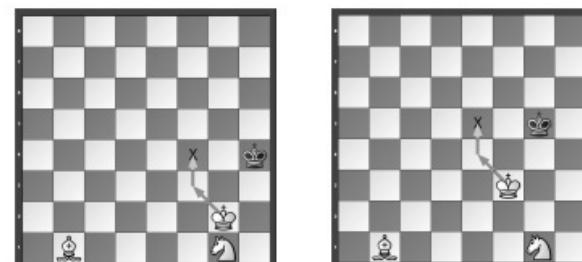


Fig. 4. White king aims to approach the opponent's king from the central side of the board. By playing 1.Kg2-f3 (left diagram) white decreases the distance to the square beside black king that lies on a straight line between black king and the center of the board. If black responds with 1...Kh4-g5 (right diagram), white again follows this rule and moves towards e5 with 2.Kf3-e4, centralising the white king.

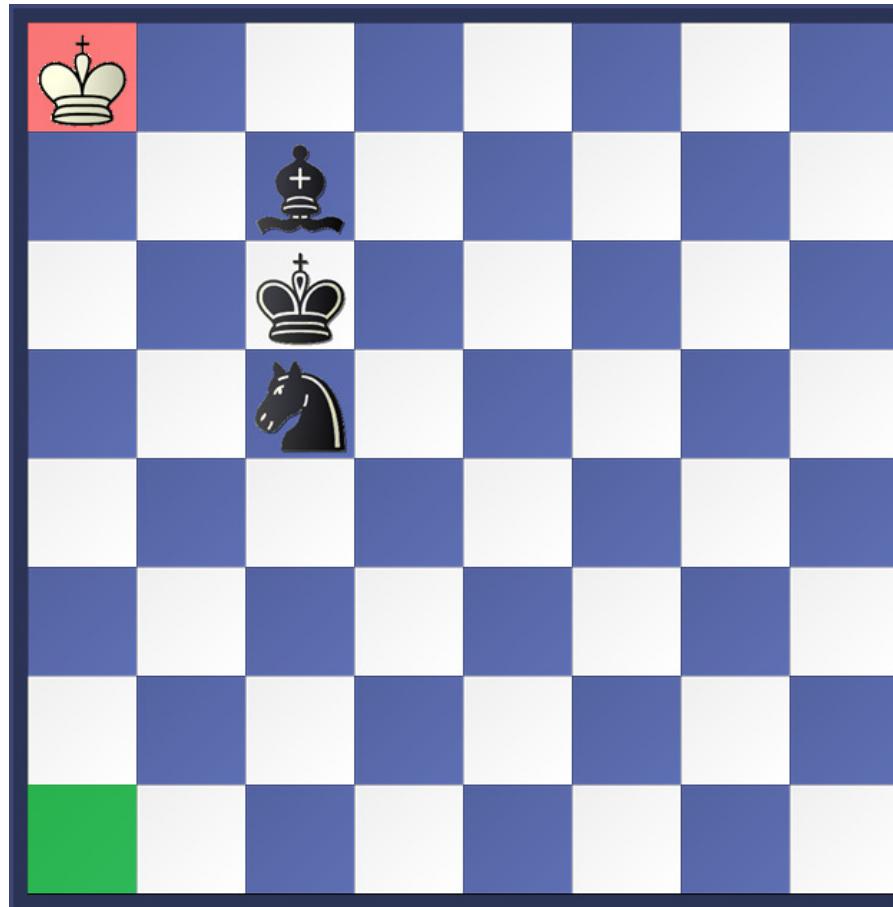
**VELEMOJSTRU NI USPELO ZMAGATI ...**

**Šahovskemu velemojstru ni uspelo  
zmagati v naslednji končnici...**

# VELEMOJSTRU NI USPELO ZMAGATI ...

GM Kempinski (white) – GM Epishin (black), *Bundesliga* 2001

“napačen kot”

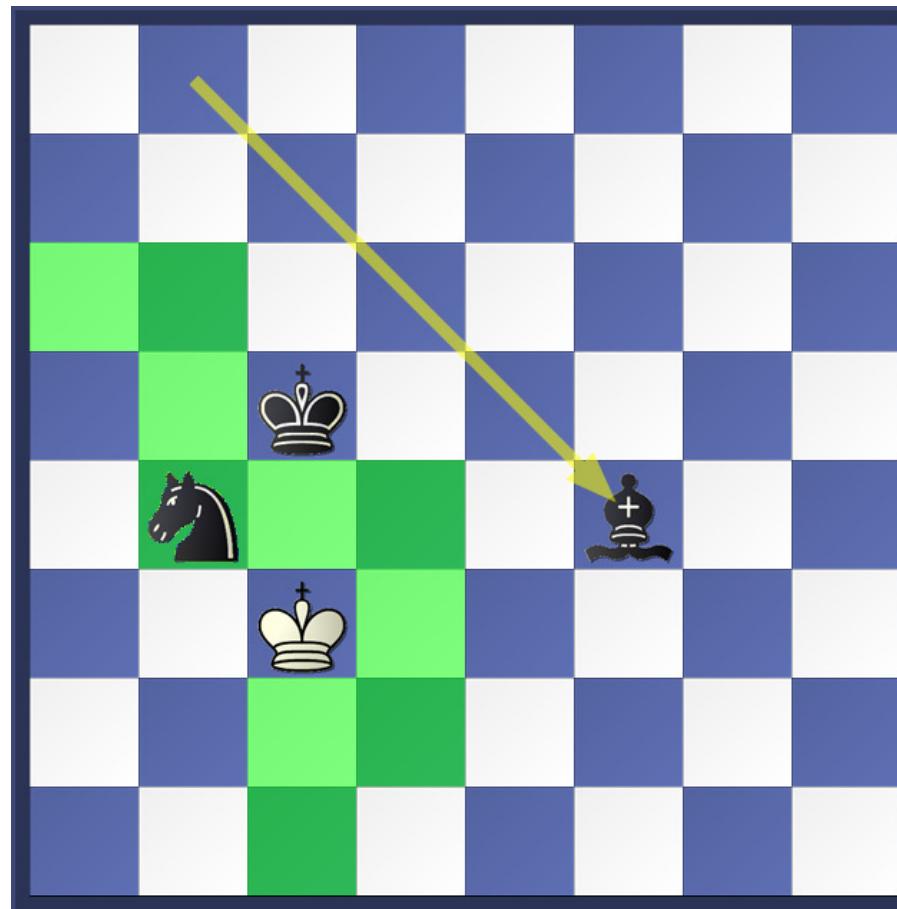


“pravi kot”

**VELEMOJSTRU NI USPELO ZMAGATI ...**

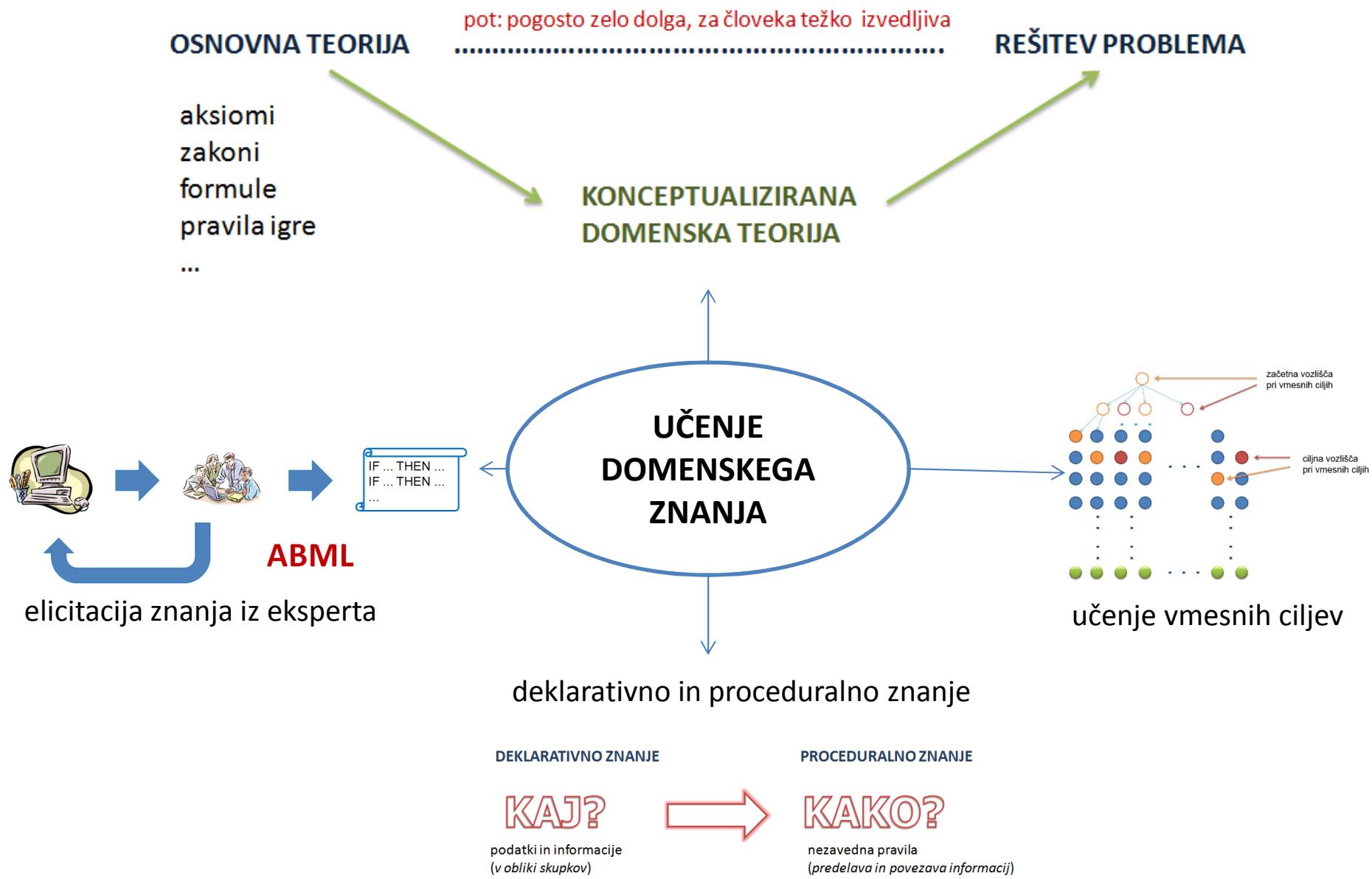
**... medtem ko našim učencem  
uspeva zmagovati?**

## VMESNI CILJ: IZGRADI BARIERO



Črni je ustvaril bariero, ki preprečuje belemu kralju dostop do „napačnega“ kota.

# UČENJE DOMENSKEGA ZNANJA: POVZETEK



# 8 NAČEL ZA IZGRADNJO INTELIGENTNIH TUTORSKIH SISTEMOV

8

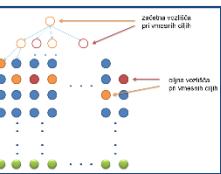


You are on the right track.

hierarhično urejena pravila  
v računalniški obliki

1. IF true  
THEN checkmate = true
2. IF min\_area = true  
THEN knight\_prepare = true
3. IF min\_area = false  
THEN min\_area = true
4. IF king\_area > 70 AND ndist <= 3  
THEN king\_area should decrease AND king\_area minimize
5. IF cpdist > 1  
THEN cpdist should decrease AND king\_area should not increase  
AND mdist should not increase AND mdist minimize
6. IF edist < 1  
THEN edist should not increase AND knight\_on\_edge = false AND wrong\_corner\_way should decrease AND wrong\_corner\_way minimize AND white\_king\_more\_central = true
7. IF kdist < 3 AND ndist <= 6 AND cdist > 0  
THEN edist should not increase AND rdist should decrease
8. IF kdist < 3 AND edist > 0  
THEN edist should decrease AND piece\_safety = true AND wrong\_corner\_way should not increase
9. IF cpdist > 0 AND mdist > 2  
THEN edist should not increase AND mdist should decrease AND mdist minimize

## GRADNJA ITS: 8 NAČEL

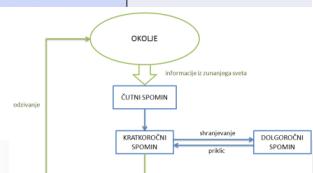


7

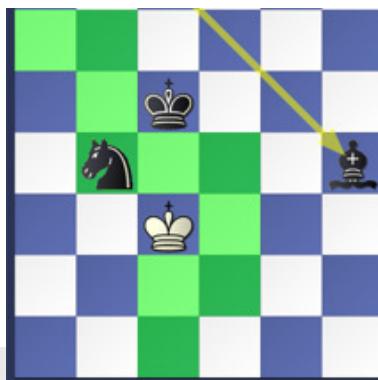


No, this part is still UNKNOWN. Please enter the known values first.

5



4



3

## Block the Way to the Wrong Corner

The goal can be achieved in 2 moves.



2

1

Deliver Checkmate

Restrain Defending King to A Minimal Area Beside The Right Corner

Squeeze Defending King

Build A Barrier around Defending King

Approach Defending King from Central Side

Block the Way to the Wrong Corner

Push Defending King Towards The Right Corner

Push Defending King Towards the Edge

Approach With the King

Bring the Knight Closer to the Defending King

Keep the Kings Close

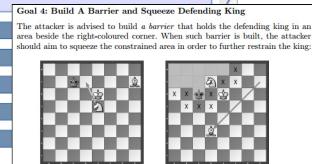
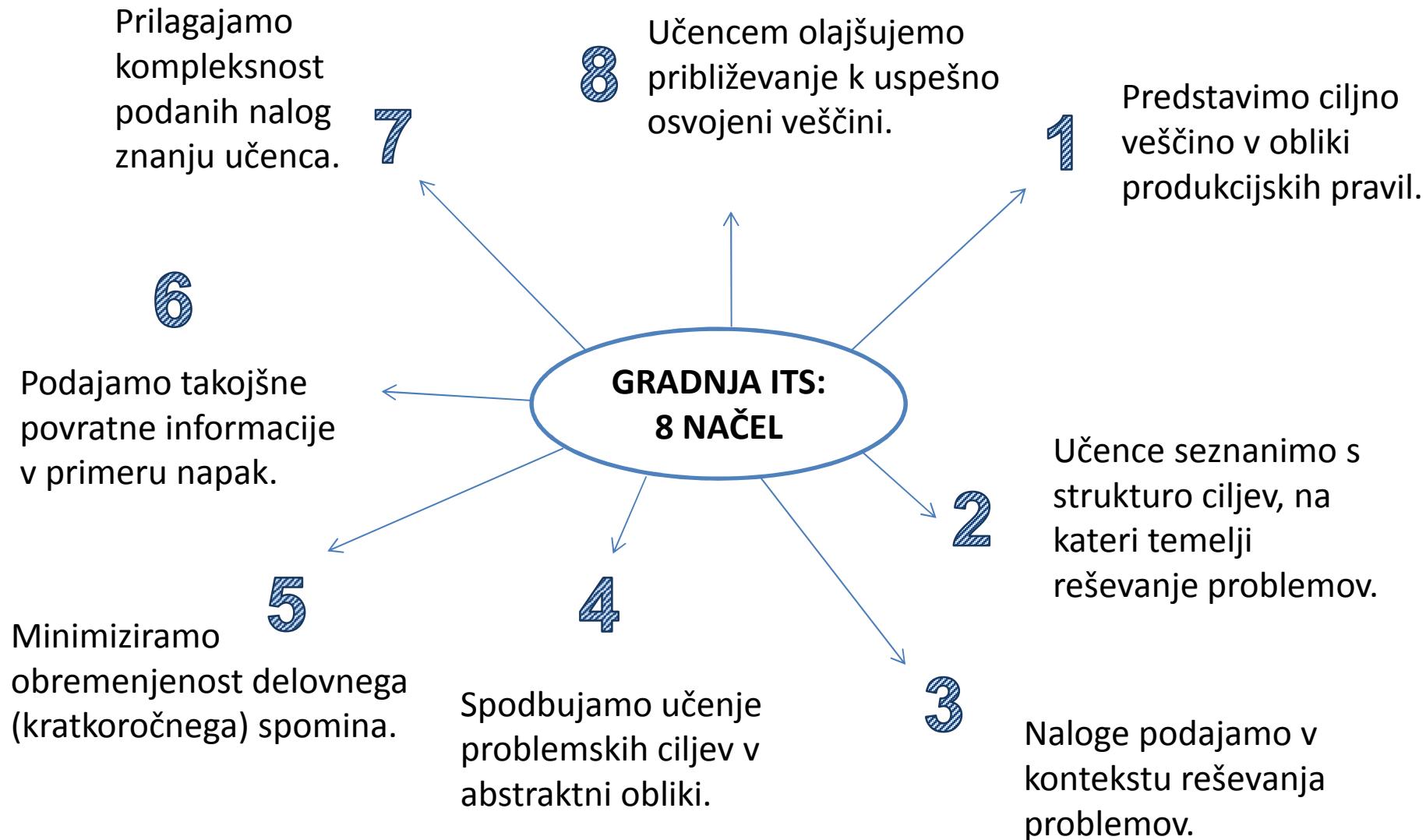
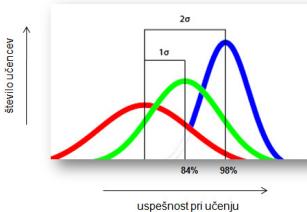
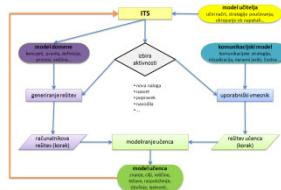


Fig. 3. In the position shown in the left diagram, the attacking side could build the barrier in the following manner: 1.Nc6-d7 Kc7-e6 2.Bb7-d3, leading to the position on the right. The area around the right-coloured corner to which the defending king is confined, could be squeezed further, e.g. after 2...Kc6-d5 3.Bd3-e4.

# 8 NAČEL ZA IZGRADNJO INTELIGENTNIH TUTORSKIH SISTEMOV



# ŠE ENA MODROST KOGNITIVNIH “TUTORJEV”: PONAVLJANJE :)



avtonomno in inteligentno prilagajanje  
specifičnim potrebam učencev

učinkovitost poučevanja ena na ena

ITS  
↔  
CAI

INTELIGENTNI  
TUTORSKI SISTEMI

vloga umetne inteligence



model učitelja

MODELIRANJE UČITELJA  
model učitelja



model učenca

MODELIRANJE UČENCA  
model učenca

UPRavljanje komunikacije  
komunikacijski model

komunikacijski model





<http://www.ailab.si/matej/>

## Matej Guid

[matej.guid@fri.uni-lj.si](mailto:matej.guid@fri.uni-lj.si)  
+386 (0)41 395 824



[Faculty of computer and information science](#)  
University of Ljubljana  
Trzaska 25, 1000 Ljubljana  
Slovenia

