

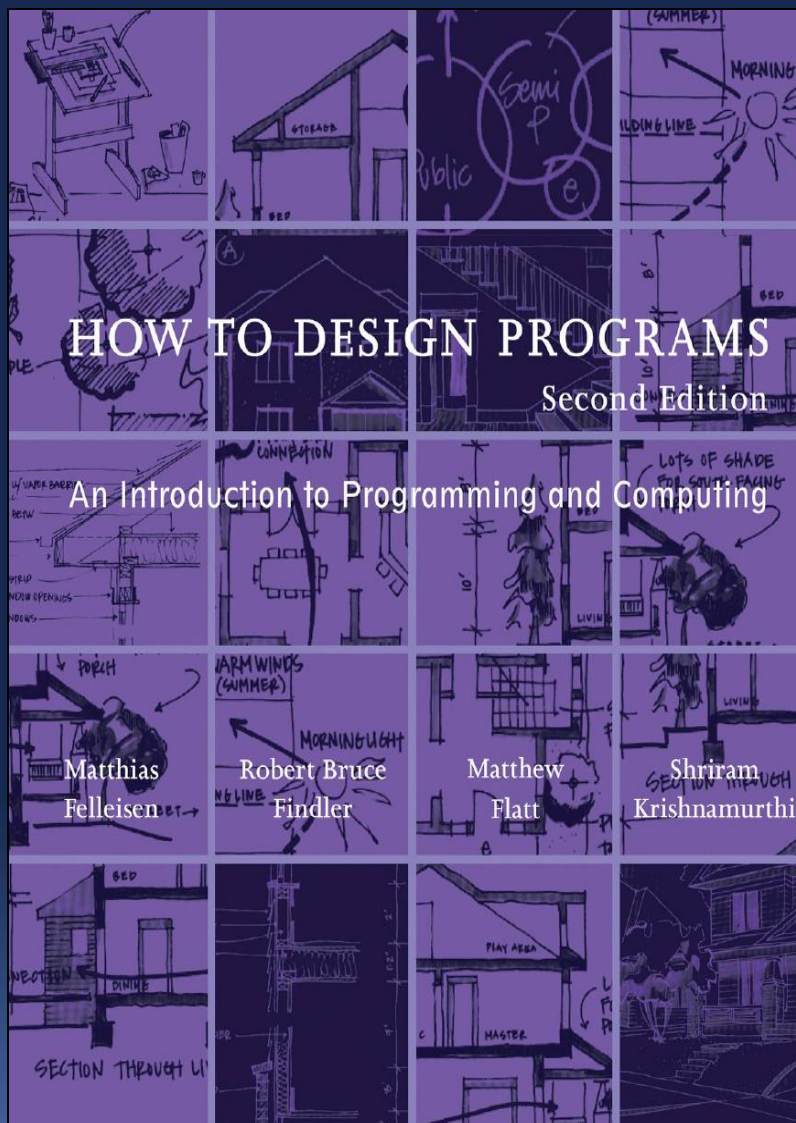
Programação Funcional

Unidade 2 – Programação Funcional com a Linguagem Racket



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Bibliografia



HOW TO DESIGN PROGRAMS

Second Edition

An Introduction to Programming and Computing

Matthias
Felleisen

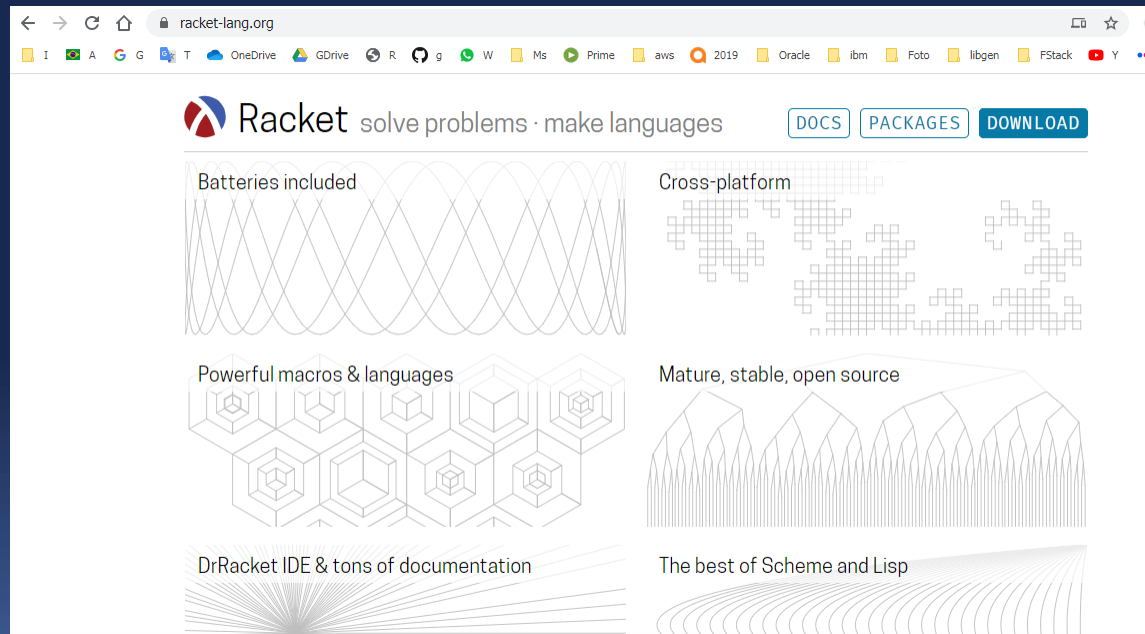
Robert Bruce
Findler

Matthew
Flatt

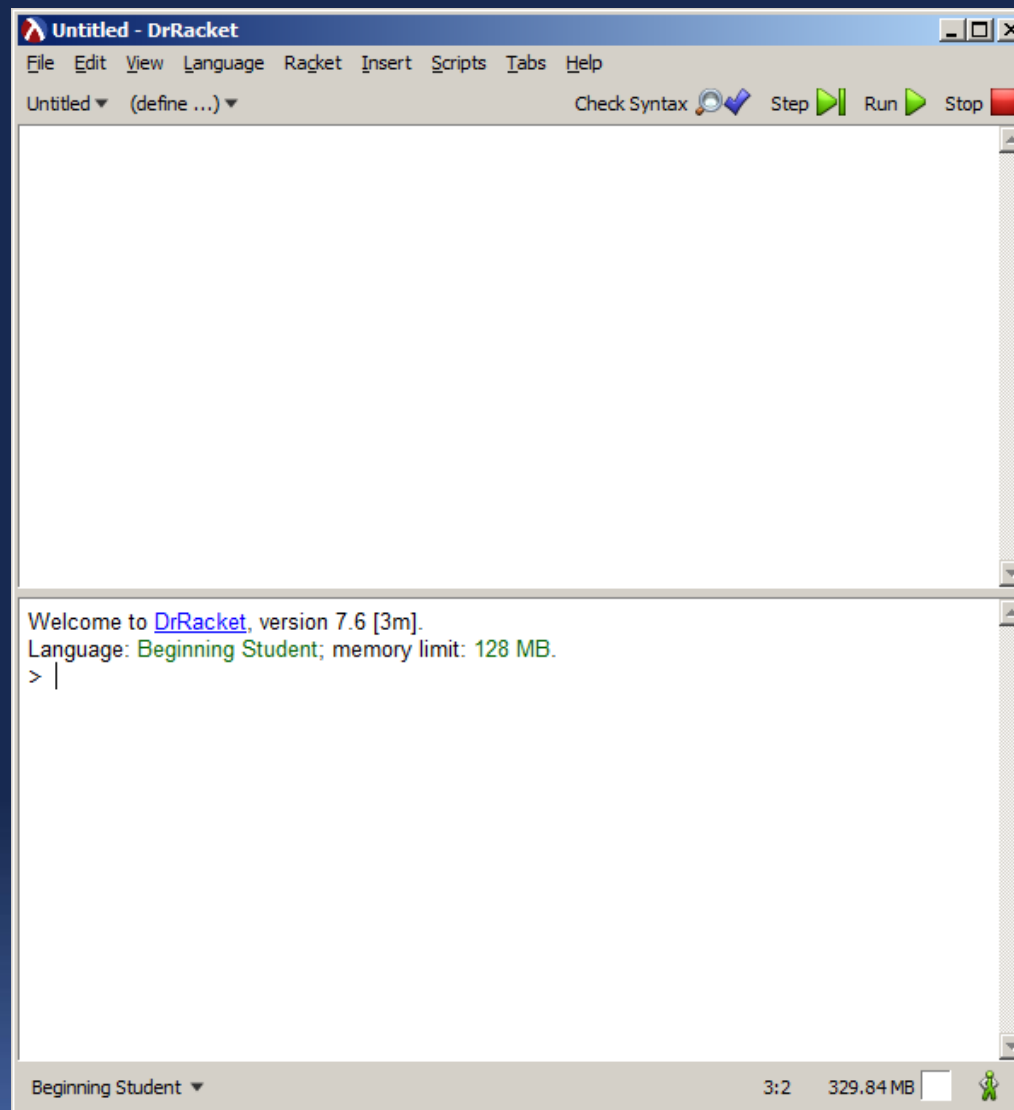
Shriram
Krishnamurthi

Introdução

- ✓ Nesta unidade trataremos de conceitos da **Programação Funcional**, um paradigma onde o foco da computação é realizado por meio de **funções**;
- ✓ Para exercitarmos os conceitos da Programação Funcional, empregaremos um ambiente de programação, desenvolvido no **MIT**, chamado **DrRacket**;
- ✓ Assim, será necessário baixar o ambiente no endereço: <https://racket-lang.org/>

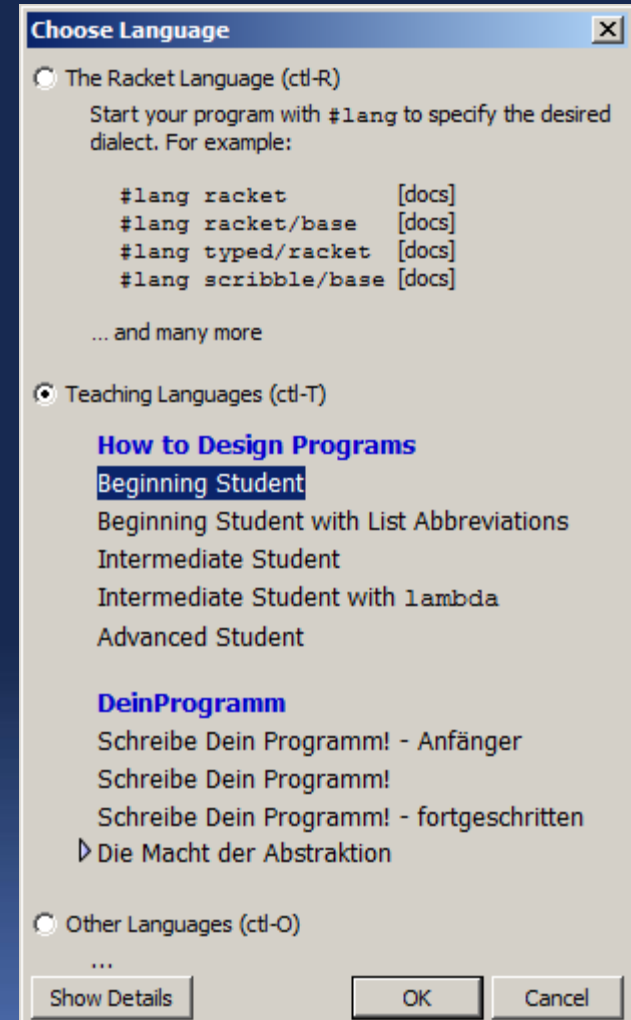
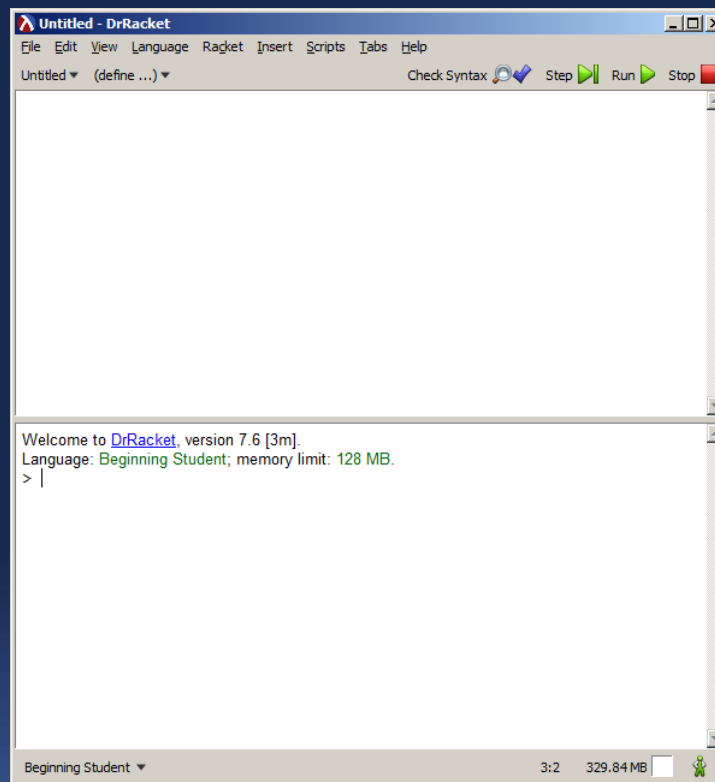


DrRacket



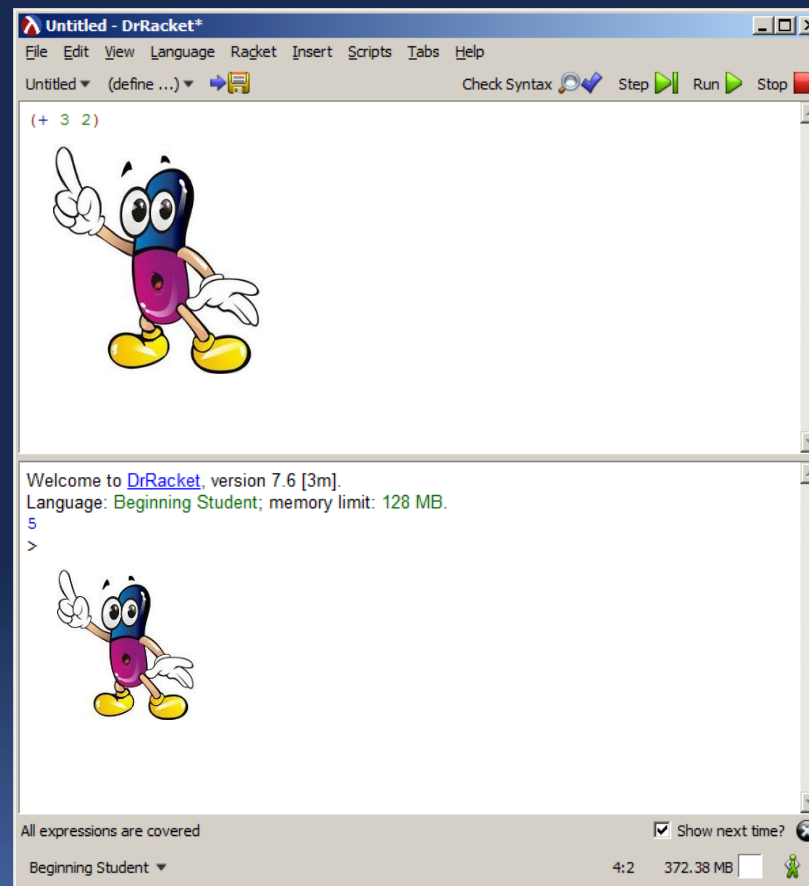
DrRacket

- ✓ Após iniciar o **DrRacket**, selecione "**Choose Language**" a partir do menu "**Language**", o qual abre um diálogo.
- ✓ Definir em **Teaching Languages** a opção "**Beginning Student**";
- ✓ Tecle **OK** após a definição da Teaching Languages.

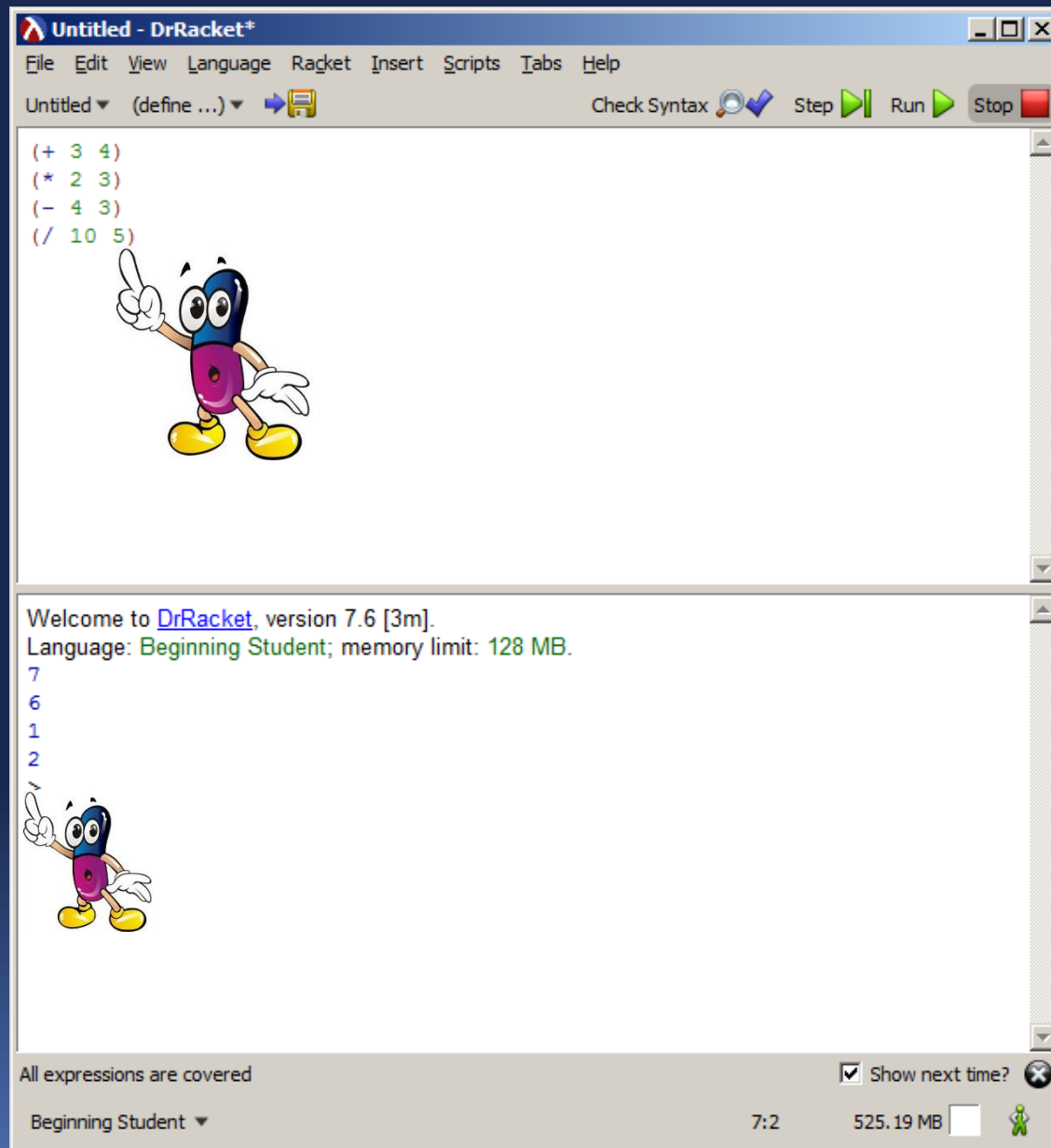


DrRacket

- ✓ Após essa definição, podemos iniciar a programação com o DrRacket;
- ✓ Iniciaremos com um simples cálculo: $(+ 3 2)$
- ✓ Em seguida clique em **Run**;
- ✓ O resultado será exibido na parte inferior da janela principal do ambiente.

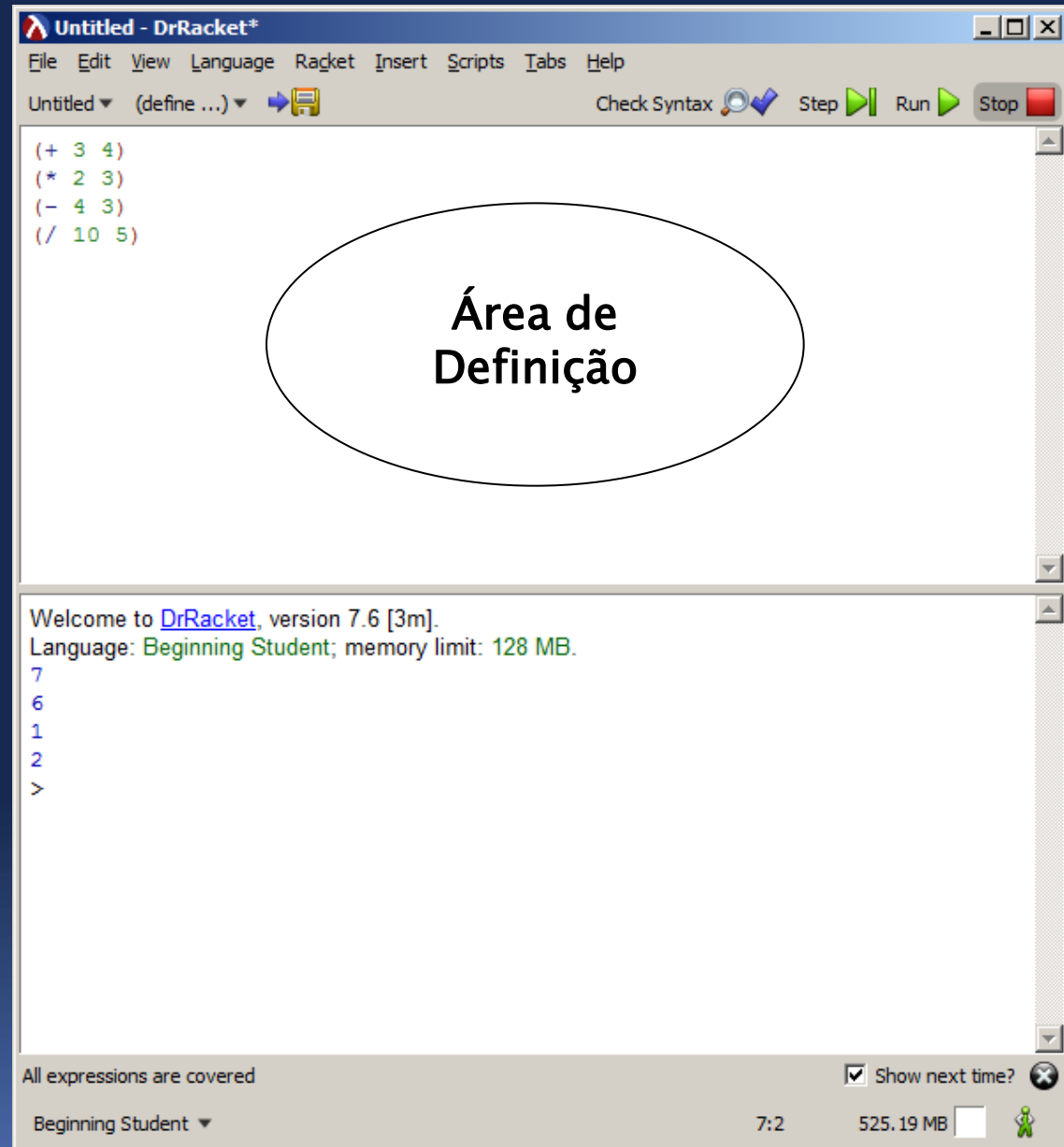


Efetuating diversos cálculos



DrRacket – Área de Definição

- ✓ A parte superior é chamada de **Área de Definição**;
- ✓ Nesta área, pode-se criar programas ;
- ✓ Esta área também é chamada de área de **edição**.

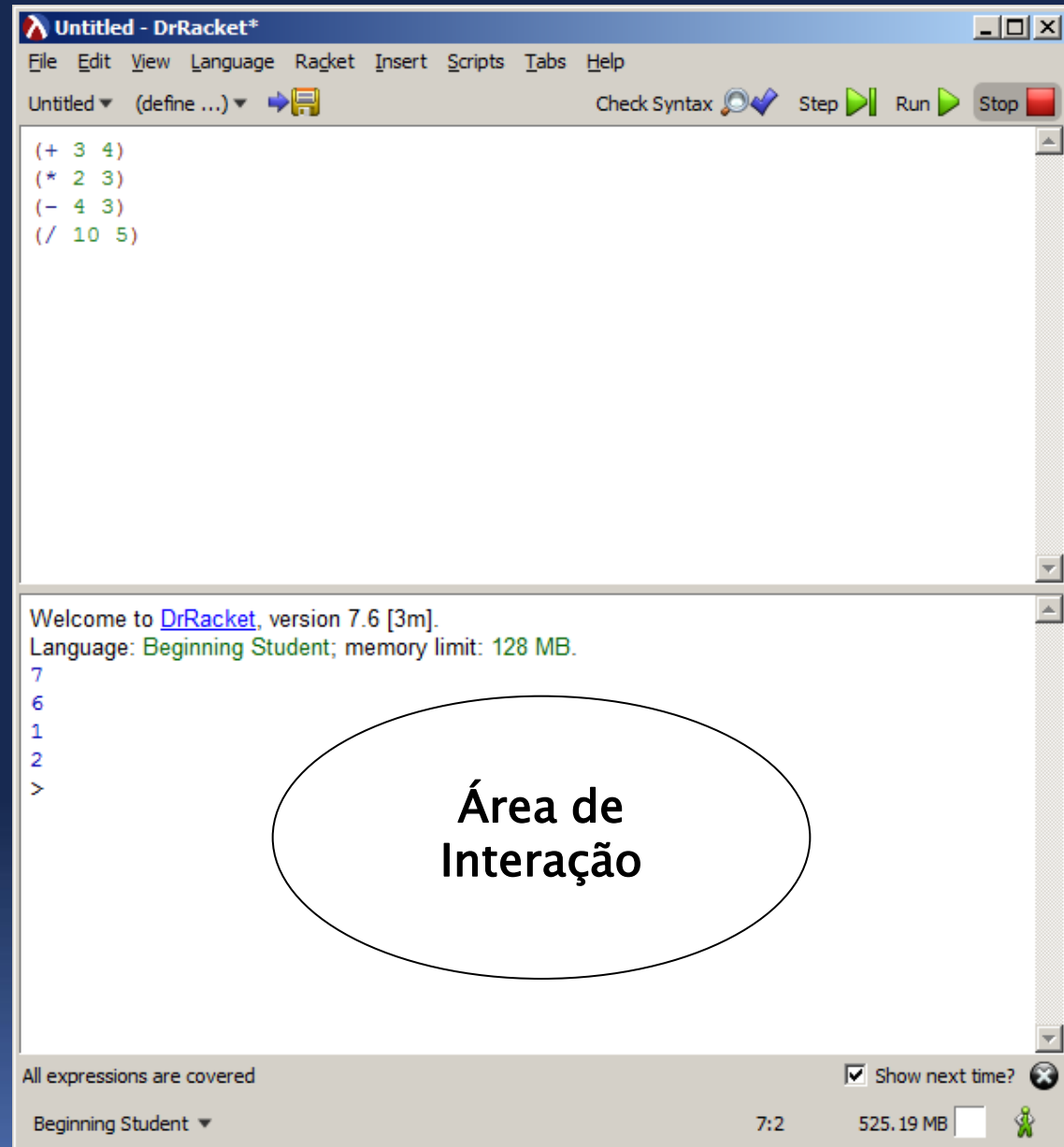


DrRacket – Área de Interação

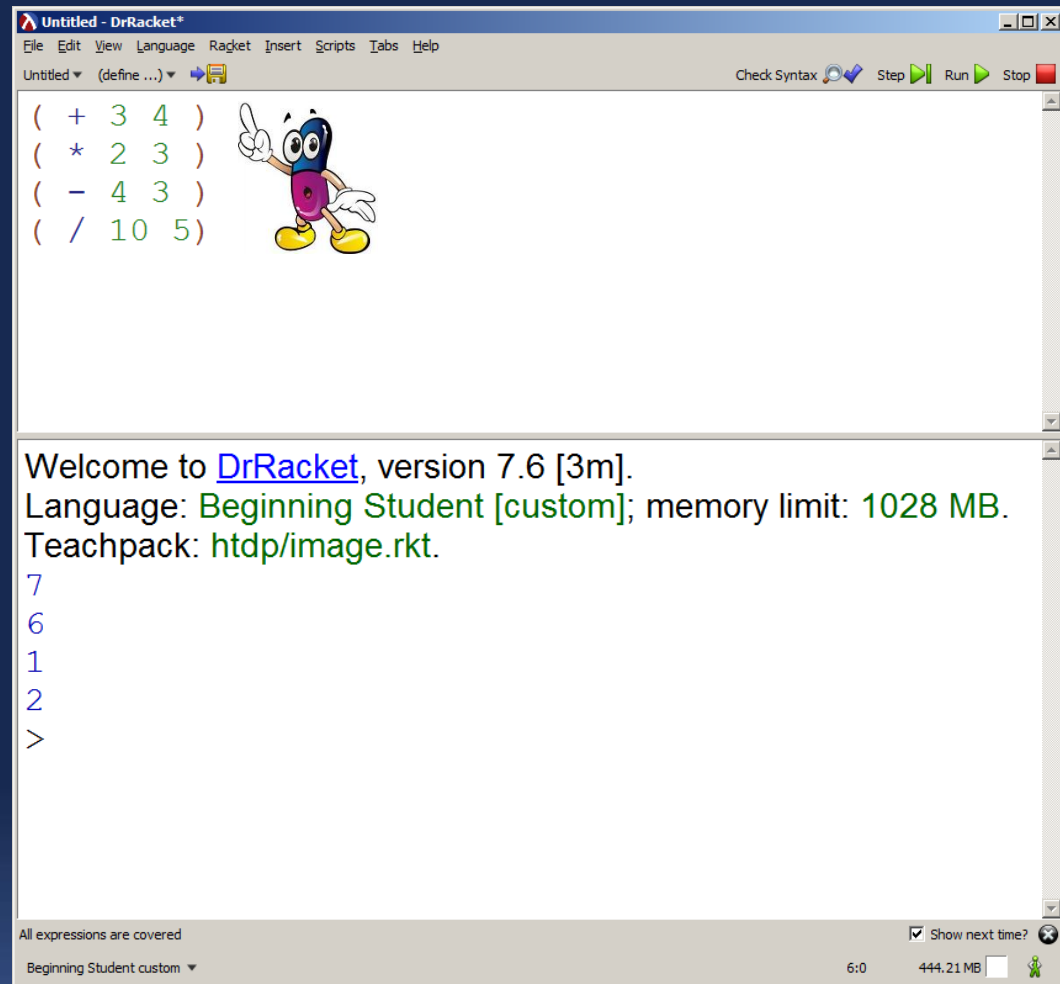
- ✓ A parte inferior é chamada de área de **Interação**;
- ✓ Nesta área, pode-se entrar com **expressões** para serem avaliadas de forma interativa (**REPL**)



- ✓ **REPL** = Read-Eval-Print Loop



DrRacket – Botão Save

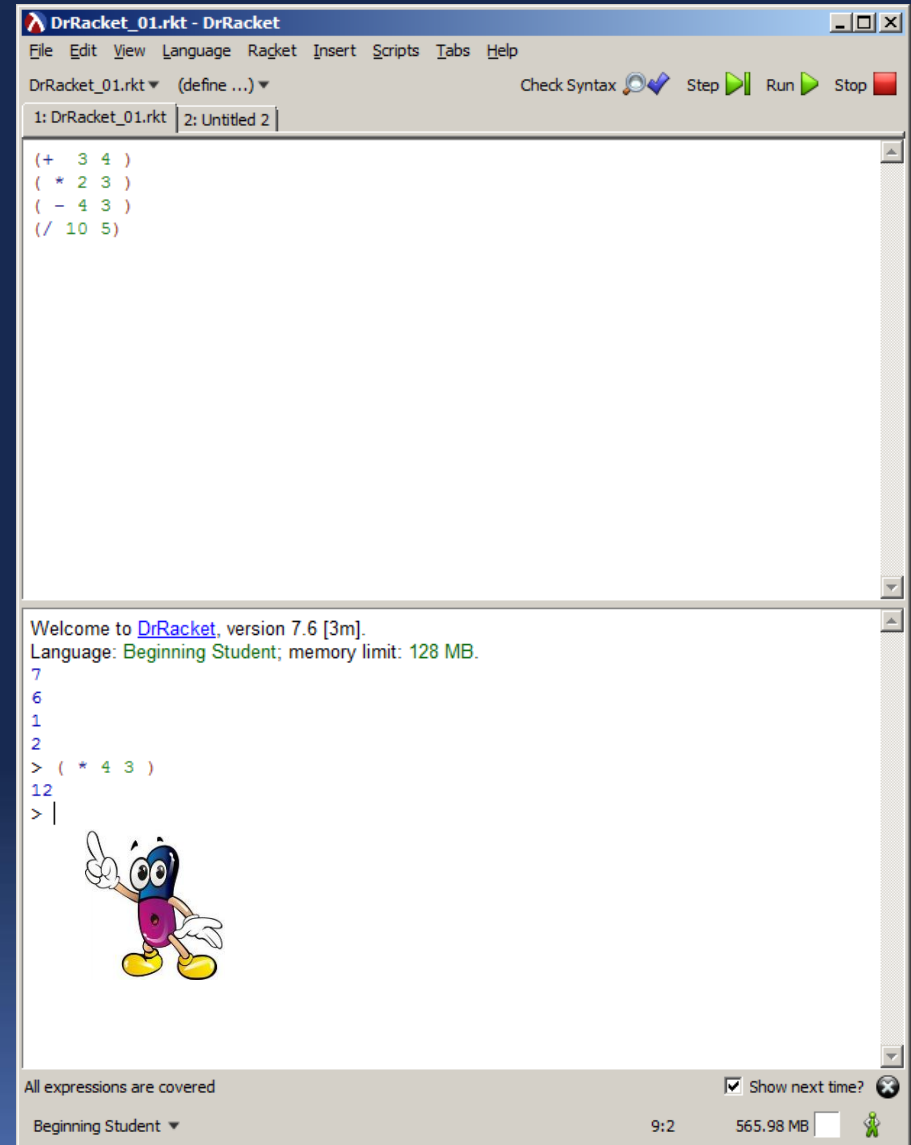


- ✓ Quando se clica no botão **Save** pela primeira vez, Dr Racket solicita o nome do arquivo para ser salvo;



Programas

- ✓ Consistem de expressões;
- ✓ Uma expressão consiste de termos que são iniciados por "(" e encerrados por ")";
- ✓ Ao se clicar no botão **RUN**, **DrRacket** avalia as expressões existentes na área de definição e mostra o resultado na **área de interações**. (janela inferior do ambiente)
- ✓ Na **área de interações**, o prompt ">" indica que o **DrRacket** está esperando novas expressões para serem avaliadas.

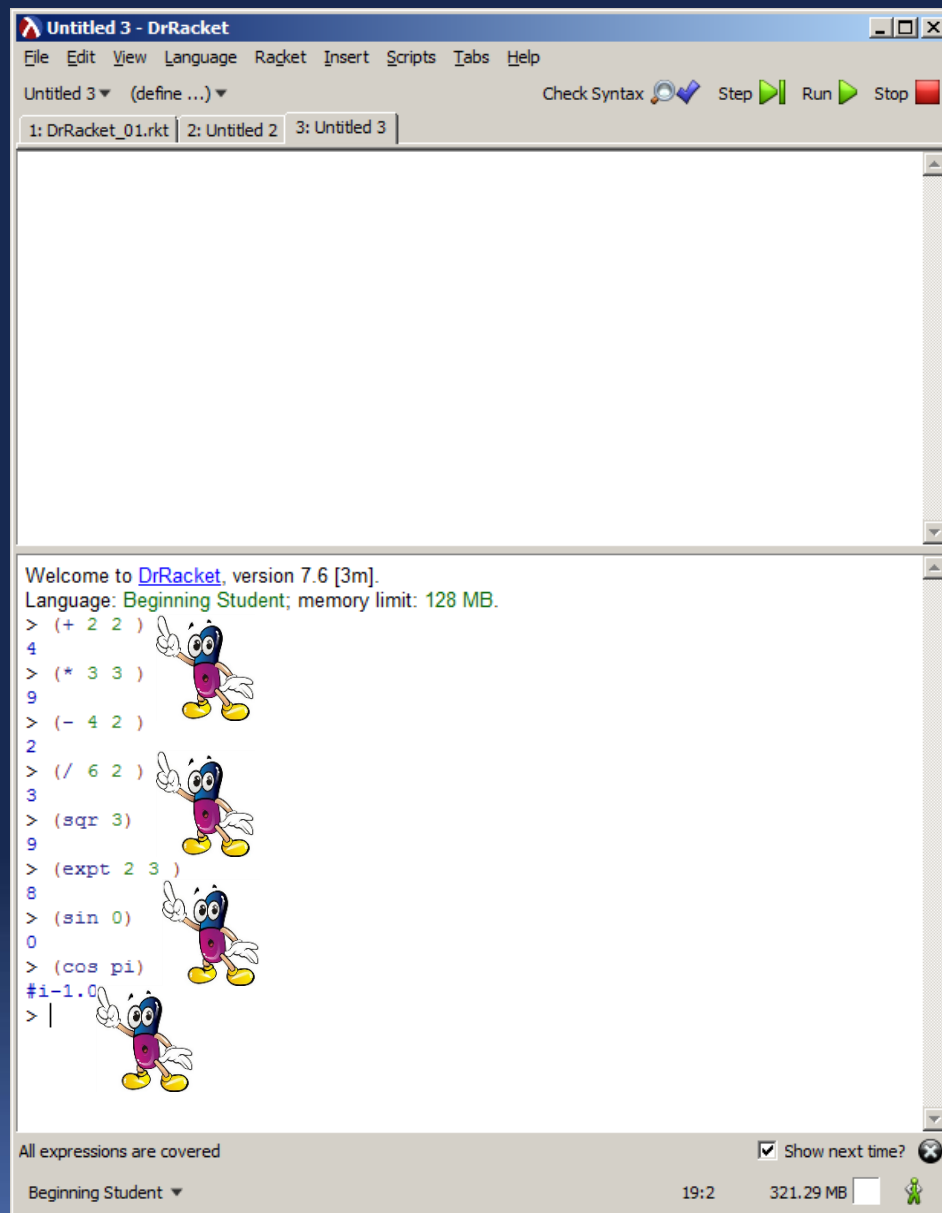


Exemplo

- ✓ Entre com as expressões abaixo, na área de interações, em seguida, tecle **<enter>** e aguarde a resposta do **DrRacket** com os resultados;

```
> (+ 2 2)
4
> (* 3 3)
9
> (- 4 2)
2
> (/ 6 2)
3
> (sqr 3)
9
> (expt 2 3)
8
> (sin 0)
0
> (cos pi)
#i-1.0
```

Exemplo



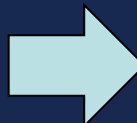
The screenshot shows the DrRacket IDE window titled "Untitled 3 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The tab bar shows "1: DrRacket_01.rkt", "2: Untitled 2", and "3: Untitled 3". The main text area contains the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student; memory limit: 128 MB.  
> (+ 2 2 )  
4  
> (* 3 3 )  
9  
> (- 4 2 )  
2  
> (/ 6 2 )  
3  
> (sqrt 3)  
9  
> (expt 2 3 )  
8  
> (sin 0)  
0  
> (cos pi)  
#i-1.0  
> |
```

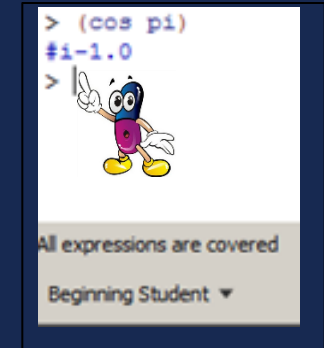
At the bottom of the window, there is a status bar with the text "All expressions are covered", a checkbox for "Show next time?", the text "Beginning Student", the time "19:2", the memory usage "321.29 MB", and a small green icon.

Observação

- ✓ Observe o resultado da avaliação da última expressão;



```
> (cos pi)
#i -1.0
>
```

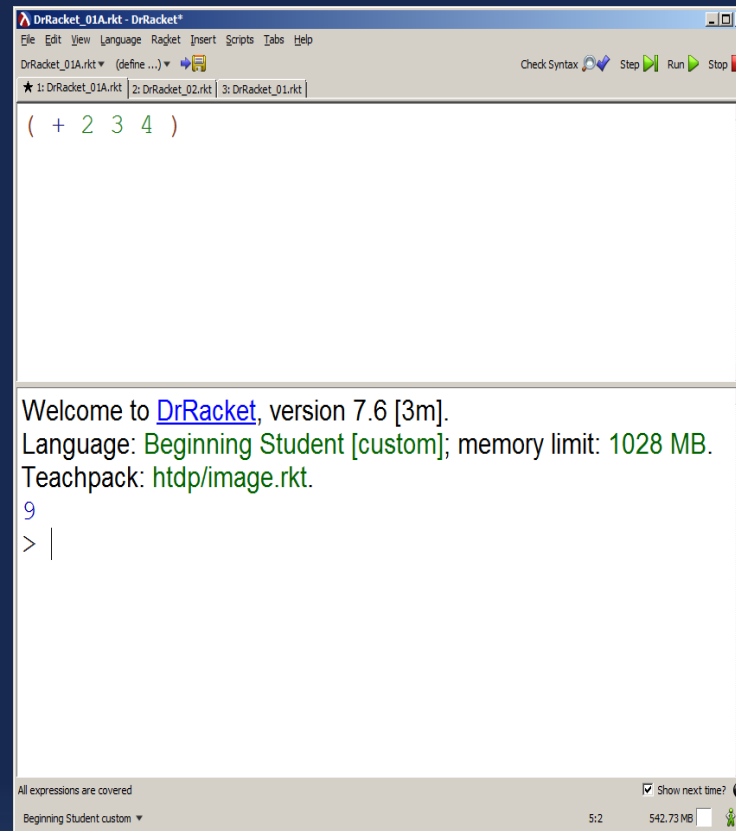


- ✓ No resultado da avaliação, consta o prefixo “**#i**” que significa “**inexact number**”;
- ✓ Nesse caso o prefixo “**#i**” é acrescentado ao resultado para indicar (**warning**) que o valor **não** é exato.



DrRacket é honesto, quando o valor não é exato ele sinaliza um **warning**!!!!

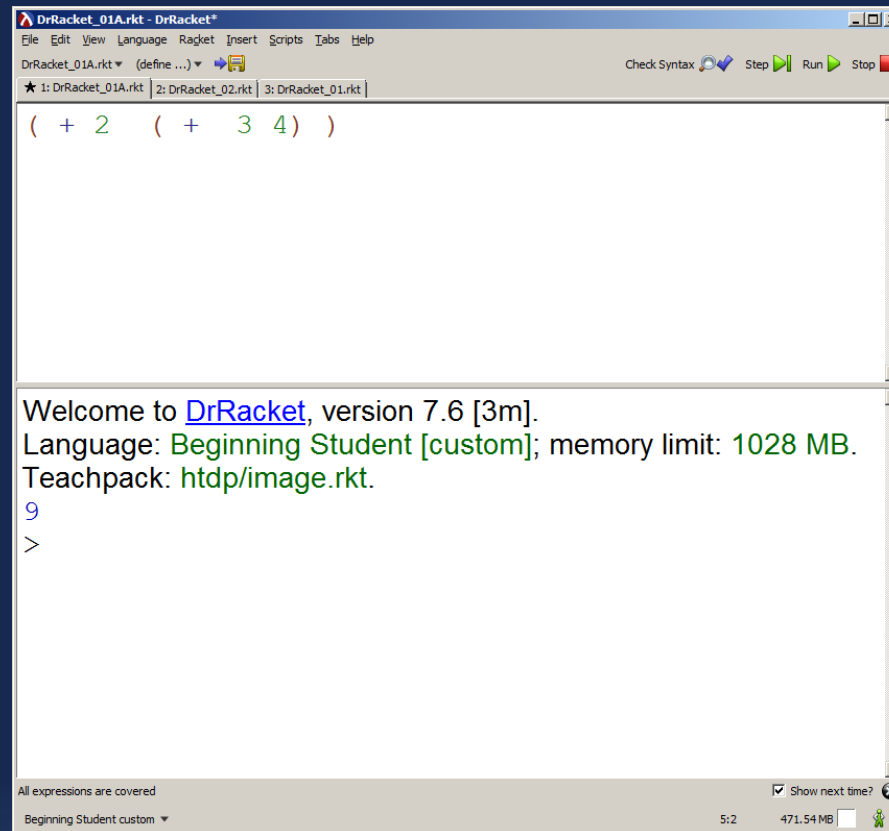
Encadeando operações (BSL Arithmetic)



The screenshot shows the DrRacket IDE window titled "DrRacket_01A.rkt - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The editor area contains the expression `(+ 2 3 4)`. The bottom pane displays the welcome message: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: **Beginning Student** [custom]; memory limit: 1028 MB. Teachpack: [http/image.rkt](#)." Below this, the prompt `> |` is shown. The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "5:2 542.73 MB".

- ✓ Em **BSL**, deve-se **abrir** parênteses, em seguida definir a operação a ser executada, os valores a serem operados (**operandos**) e por fim um **fecha** parênteses.
- ✓ **BSL** = **B**egin **S**tudent **L**anguage.

Encadeando operações (Nested Arithmetic)



The screenshot shows the DrRacket IDE interface. The title bar reads "DrRacket_01A.rkt - DrRacket*". The menu bar includes "File", "Edit", "View", "Language", "Racket", "Insert", "Scripts", "Tools", and "Help". The toolbar contains icons for "Check Syntax", "Step", "Run", and "Stop". The text area displays the code `(+ 2 (+ 3 4))`. Below the code area, a message box says: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: [Beginning Student](#) [custom]; memory limit: 1028 MB. Teachpack: [http/image.rkt](#)." Below this message is a prompt `>`. At the bottom of the window, a status bar shows "All expressions are covered", "Beginning Student custom", "5:2", and "471.54 MB".

- ✓ Em **Nested Arithmetic**, deve-se **abrir** parênteses, em seguida definir a operação a ser executada, os **operandos** a serem operados e por fim um **fecha** parênteses.
- ✓ Mas, nessa aritmética, um operando pode ser substituído por uma expressão, como é o caso do exemplo acima.

Encadeando funções – Exemplo

The screenshot shows the DrRacket IDE interface. The title bar reads "DrRacket_01A.rkt - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for opening a file, saving, checking syntax, stepping through code, running, and stopping. The file list shows three tabs: "1: DrRacket_01A.rkt", "2: DrRacket_02.rkt", and "3: DrRacket_01.rkt". The main editor area contains the following Racket code:

```
(+ (* 5 5) (+ (* 3 (/ 12 4)) 4))
```

Below the editor, the DrRacket welcome message is displayed:

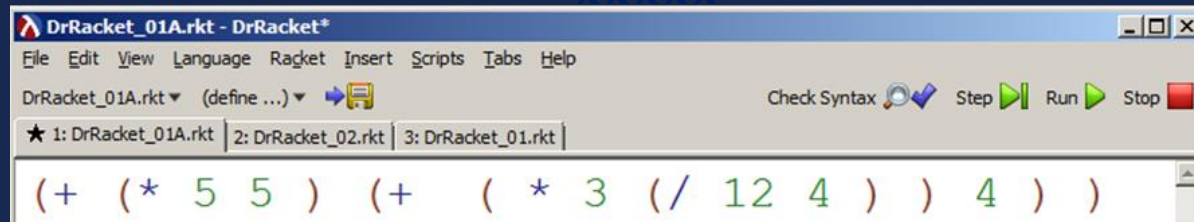
Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [htdp/image.rkt](#).
38
> |

At the bottom of the window, the status bar shows "All expressions are covered", a checked box for "Show next time?", the language "Beginning Student custom", and the memory usage "479.45 MB".

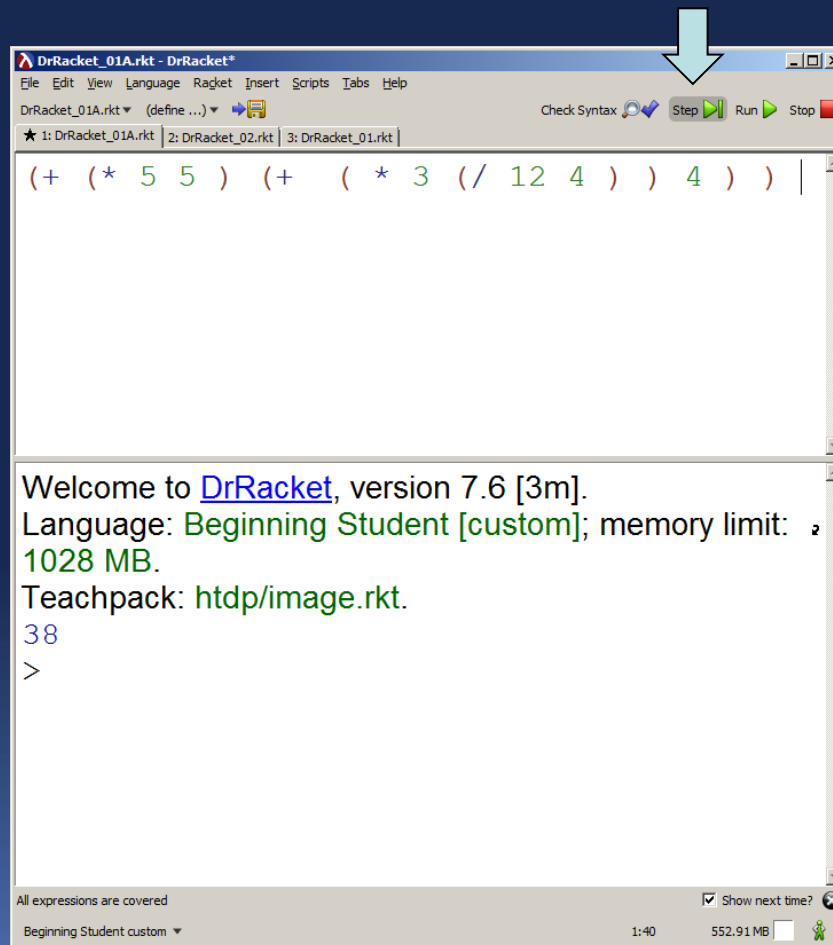
XXXXXX

Observações

- ✓ A **avaliação** de uma expressão é feita por meio de **regras**;
- ✓ As **regras** no caso de operações aritméticas são as usuais da **Matemática**;
- ✓ Assim, o resultado de uma operação somente será obtido **após** a avaliação de seus **operandos**;
- ✓ Sempre que um **abre** parênteses ocorre, será determinado o resultado da primeira expressão encadeada (**nested**).



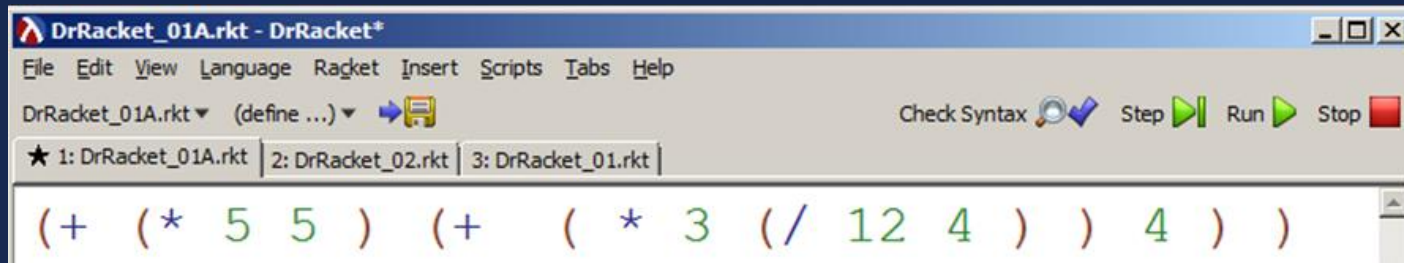
- ✓ Clique no botão **Step** para **rastrear** a execução da expressão acima;



```
DrRacket_01A.rkt - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
DrRacket_01A.rkt (define ...) [Save]
★ 1: DrRacket_01A.rkt | 2: DrRacket_02.rkt | 3: DrRacket_01.rkt
(+ (* 5 5) (+ (* 3 (/ 12 4)) 4))
```

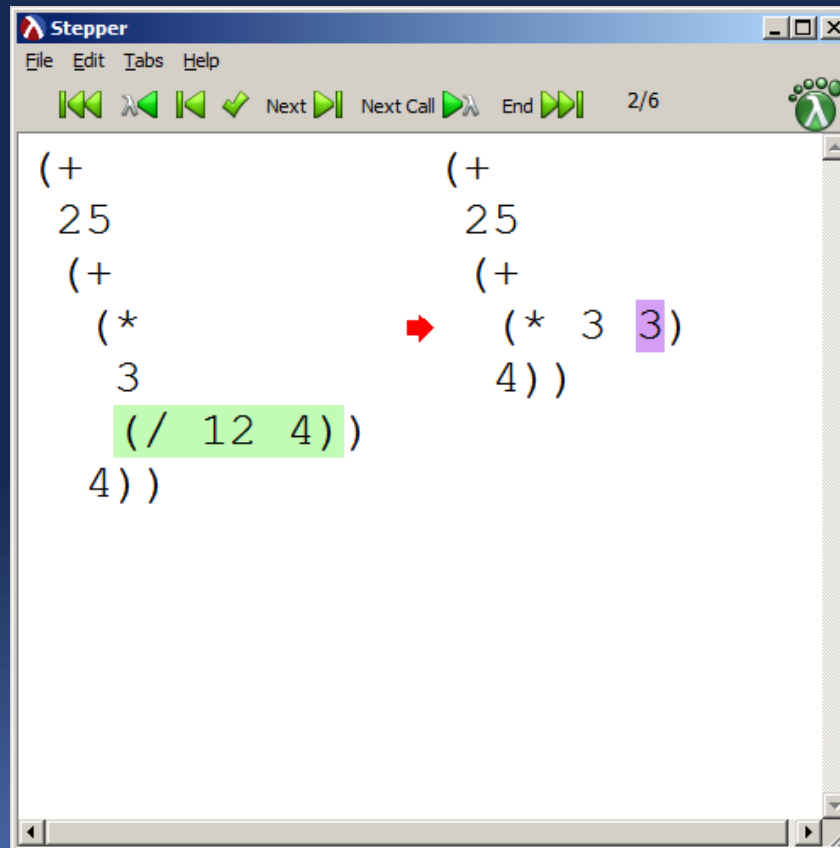
- ✓ A expressão $(* 5 5)$ é primeiramente avaliada;
- ✓ Clique agora no botão **Next** para continuar o rastreamento.

```
Stepper
File Edit Tabs Help
[Back] [Next] [Next Call] [End] 1/6
(+ (* 5 5) (+ (* 3 (/ 12 4)) 4))
(+ 25 (+ (* 3 (/ 12 4)) 4))
```



```
(+ (* 5 5) (+ (* 3 (/ 12 4)) 4))
```

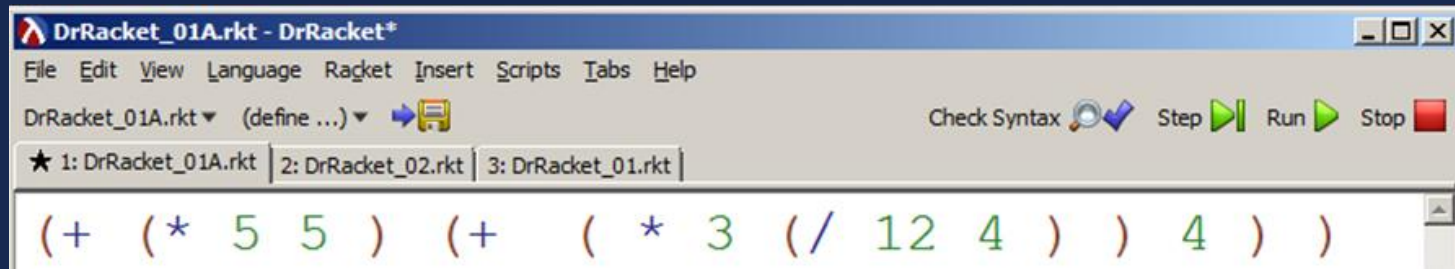
- ✓ A expressão $(/ 12 4)$ é avaliada na sequência;
- ✓ Clique novamente no botão **Next**;



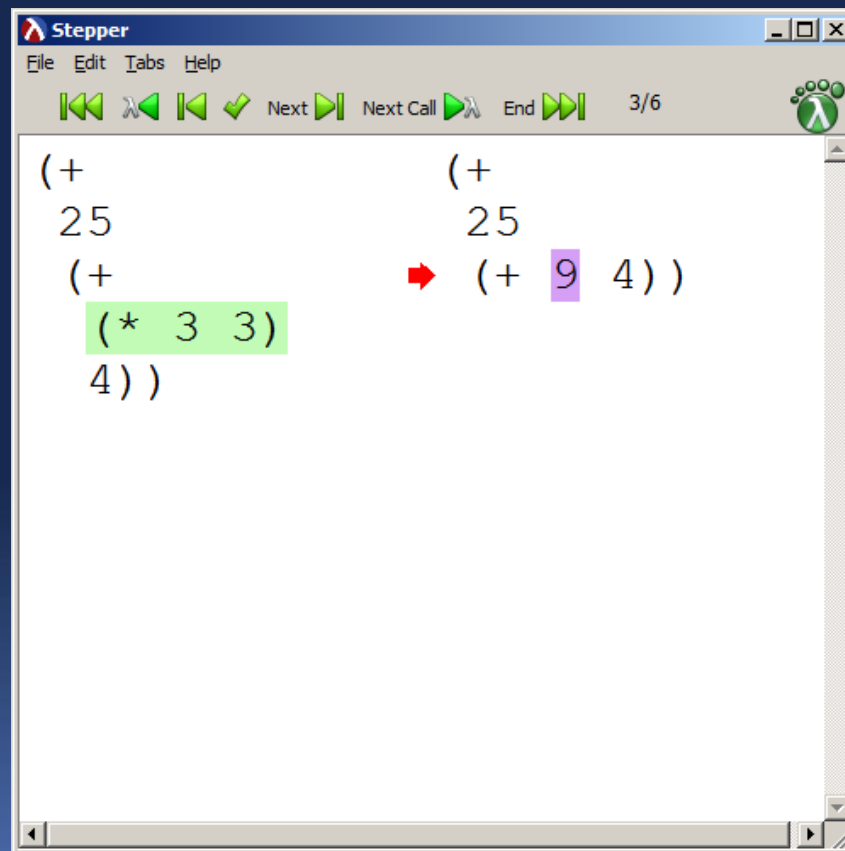
```
(+ 25 (+ (* 3 (/ 12 4)) 4))
```

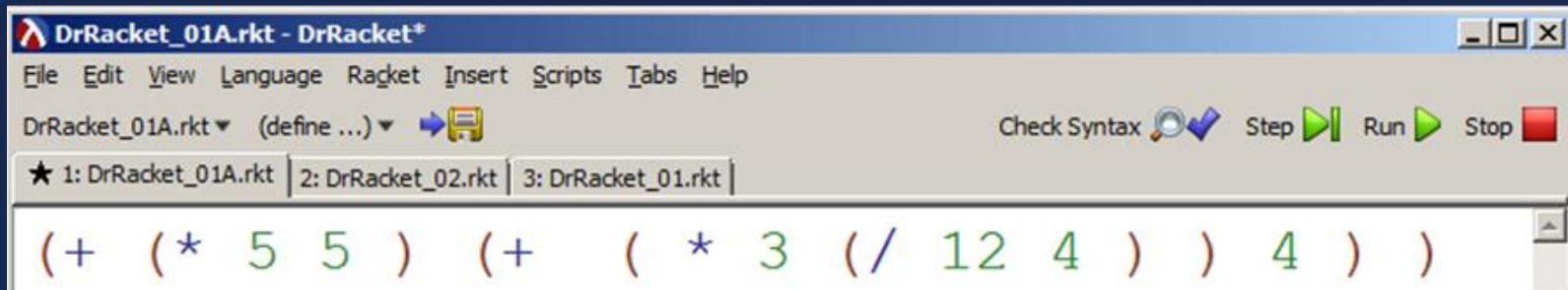


```
(+ 25 (+ (* 3 3) 4))
```

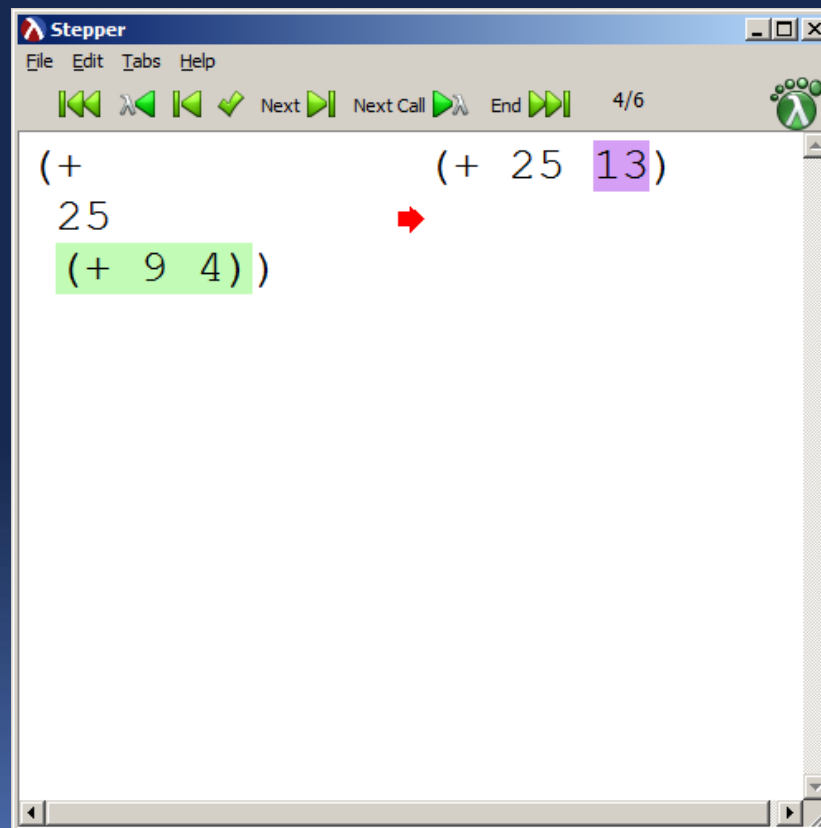


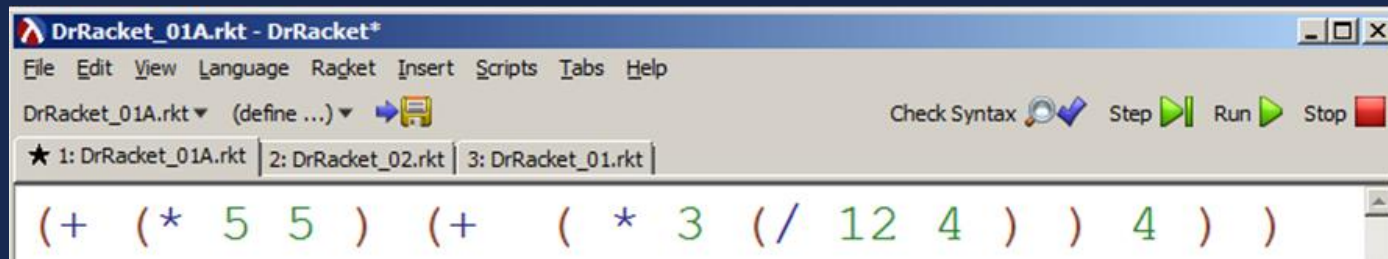
- ✓ A expressão $(+ 3 3)$ é avaliada na sequência;
- ✓ Clique novamente no botão **Next**;



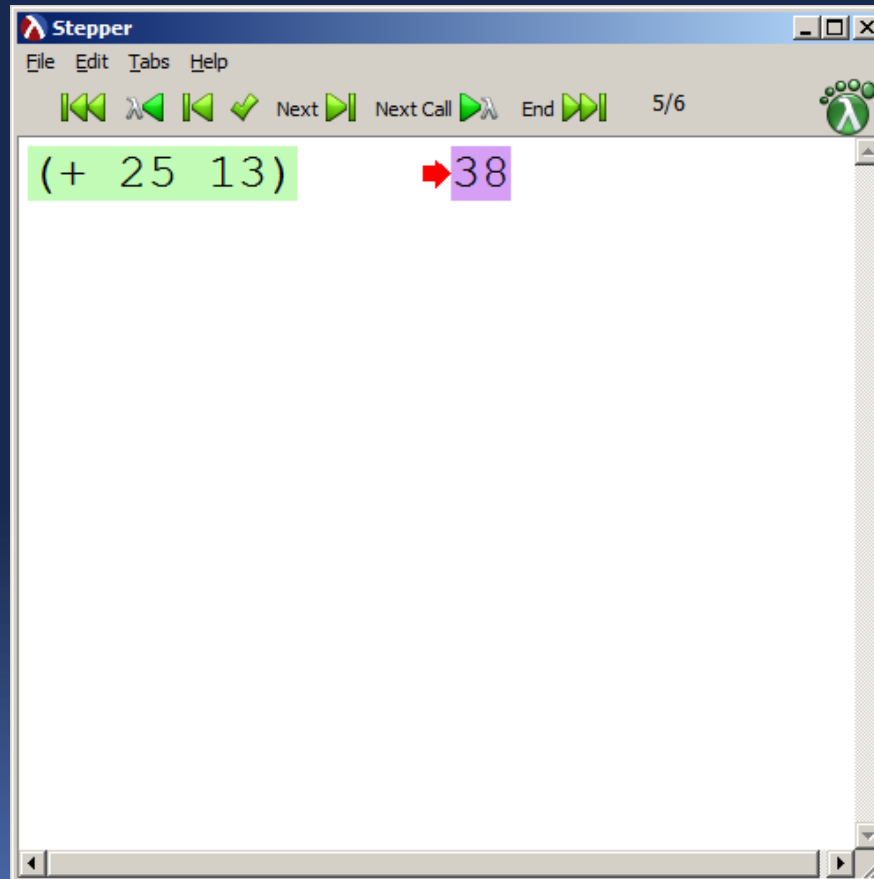


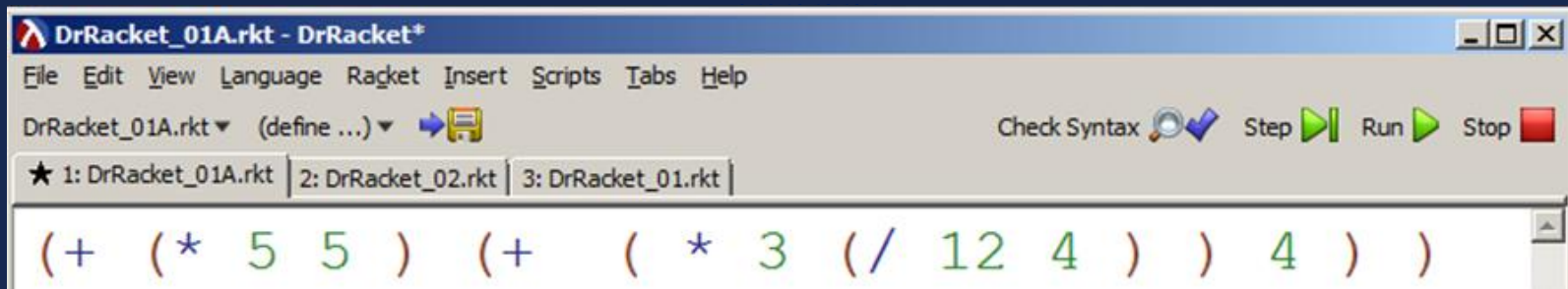
- ✓ A expressão $(+ 9 4)$ é avaliada na sequência;
- ✓ Clique novamente no botão **Next**;



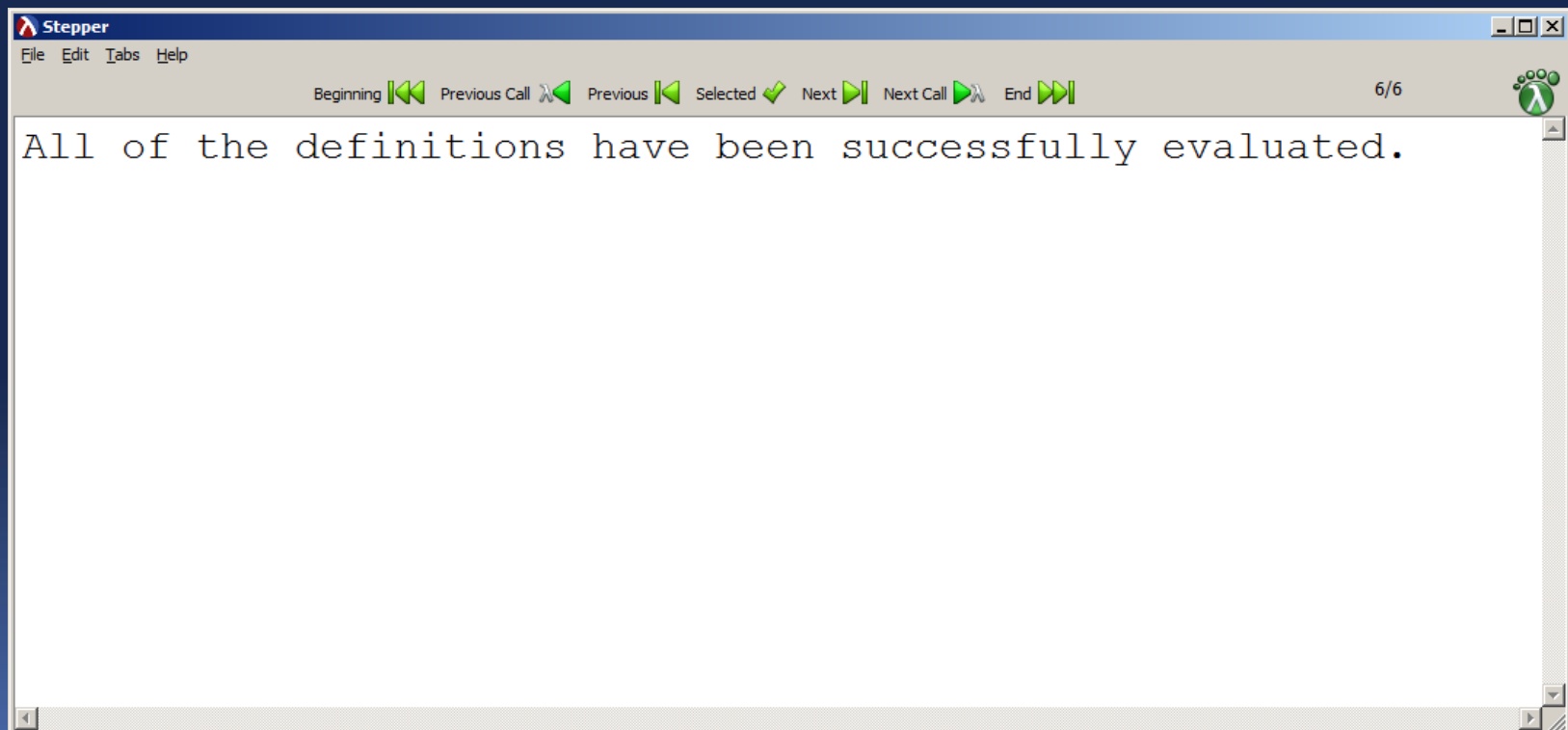


- ✓ A expressão $(+ 25 13)$ é avaliada na sequência;
- ✓ Clique novamente no botão **Next**;

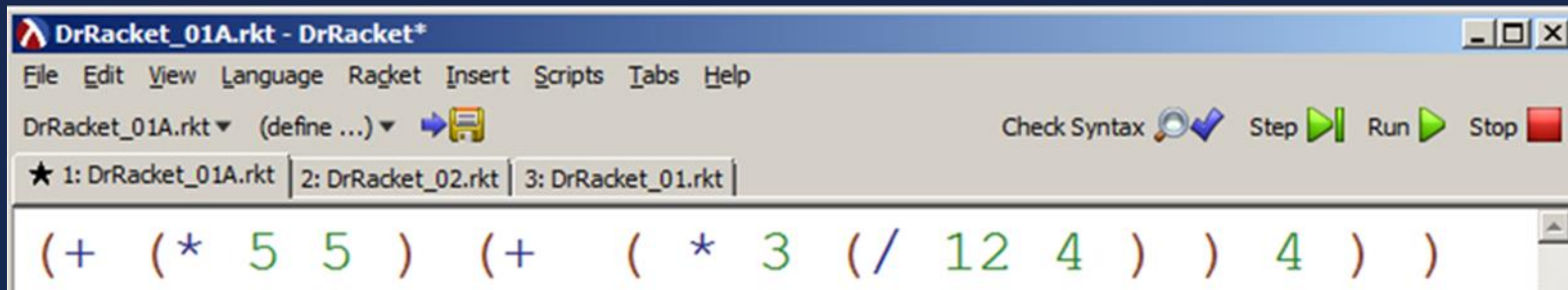




✓ O DrRacket indica que o **rastreamento** chegou ao fim e com sucesso !



Observação Importante



- ✓ Observe que na avaliação da expressão acima, o DrRacket nunca necessitou ponderar qual regra deveria ser aplicada!
- ✓ Por uma simples razão ! SÓ EXISTE UMA REGRA A SER APLICADA!



Parênteses têm significado

- ✓ Deve-se entrar a quantidade **correta** de parênteses no aninhamento;
- ✓ Nem **mais**, nem **menos** !
- ✓ Por exemplo, matematicamente a expressão $(+ (1) (2))$ pode estar correta, **mas** na **semântica** das linguagens funcionais, após um abre parênteses deve haver uma função, o que causaria **erro** em tempo de interpretação.

```
DrRacket_01A.rkt - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
DrRacket_01A.rkt (define ...)
★ 1: DrRacket_01A.rkt 2: DrRacket_02.rkt 3: DrRacket_01.rkt

( + (1) (2) )

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http/image.rkt.
function call: expected a function
after the open parenthesis, but found a
number
>
```

Manuseando Strings

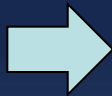
- ✓ Em BSL, texto é uma sequência de caracteres delimitados por " e são denominados **strings**;



- ✓ Assim, **"Hello DrRacket"** é um perfeito string;

Manuseando Strings

- ✓ Quando **DrRacket** avalia um string, ele ecoa o próprio string na área de interação, como um número;



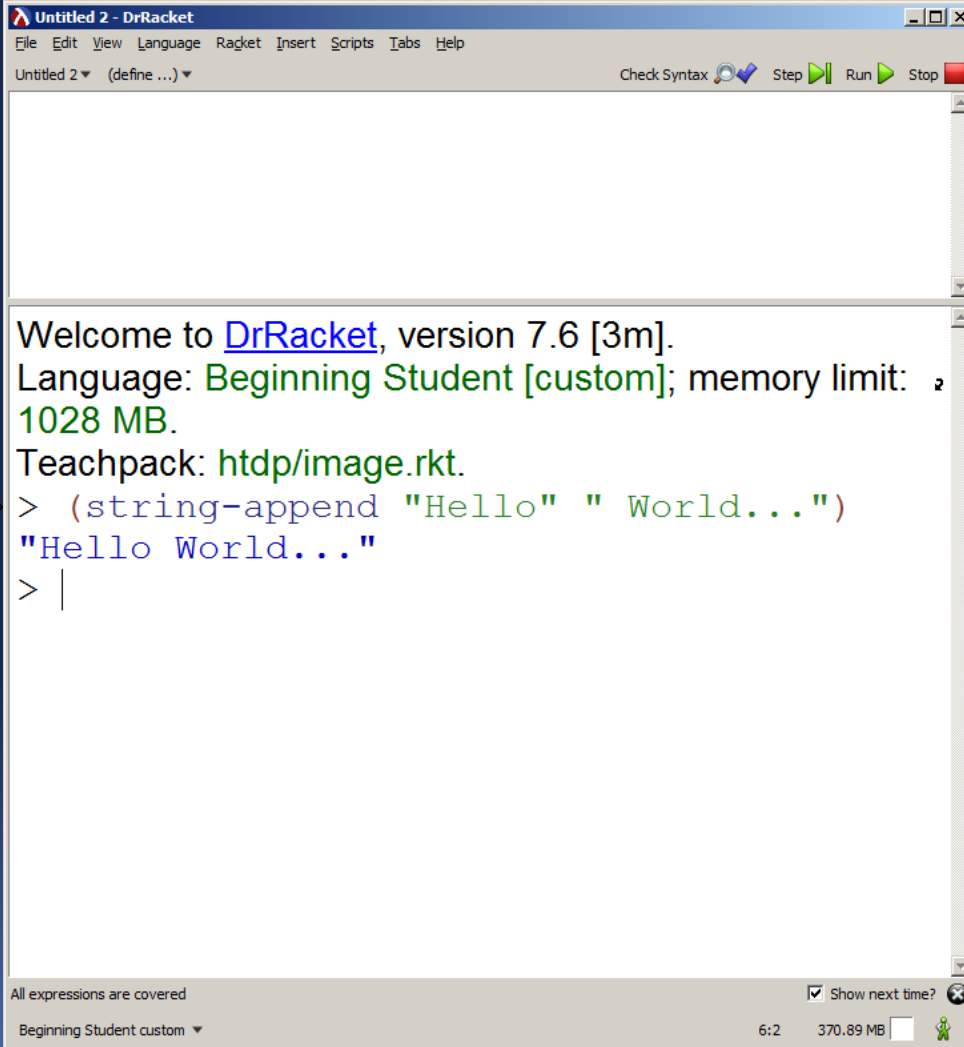
```
Untitled - DrRacket
File Edit View Language Racket Insert Scripts Tabs Help
Untitled (define ...) Check Syntax Step Run Stop

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http/image.rkt.
> "Hello DrRacket"
"Hello DrRacket"
> |

All expressions are covered
Beginning Student custom 6:2 325.44 MB
```


Concatenando strings

- ✓ A função **string-append** retorna um string que corresponde à concatenação de strings passados como argumentos;
- ✓ O segundo string é adicionado ao final do primeiro ;

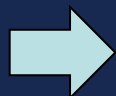


```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
> (string-append "Hello" " World...")  
"Hello World..."  
> |
```

Retornando tamanho do string

xxxxx

- ✓ A função **string-length** retorna um valor numérico que corresponde ao tamanho do string passado como argumento ;



The screenshot shows the DrRacket IDE window titled "Untitled 3 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The code editor contains the following Racket code:

```
(string-append "Hello" " World...")  
(string-length (string-append "Hello" " World..."))
```

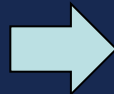
The output window below the code editor displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
"Hello World..."  
14  
>
```

At the bottom of the window, the status bar shows "All expressions are covered", "Beginning Student custom", and "6:2 505.28 MB".

Convertendo strings para números

- ✓ A função **string->number** retorna o **valor numérico** que corresponde ao **string** passado como argumento.



The screenshot shows the DrRacket IDE window titled "Untitled 3 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The code editor contains the expression `(+ (string->number "20") (string->number "30"))`. The output window displays the following text: "Welcome to [DrRacket](#), version 7.6 [3m].", "Language: **Beginning Student [custom]**; memory limit: 1028 MB.", "Teachpack: [http/image.rkt](#).", "50", and a prompt character ">". The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", "5:2", and "467.44 MB".

XXXXX

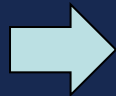
Convertendo strings para números

- ✓ E se na função **string->number** for passado um argumento que não corresponde a um número ?



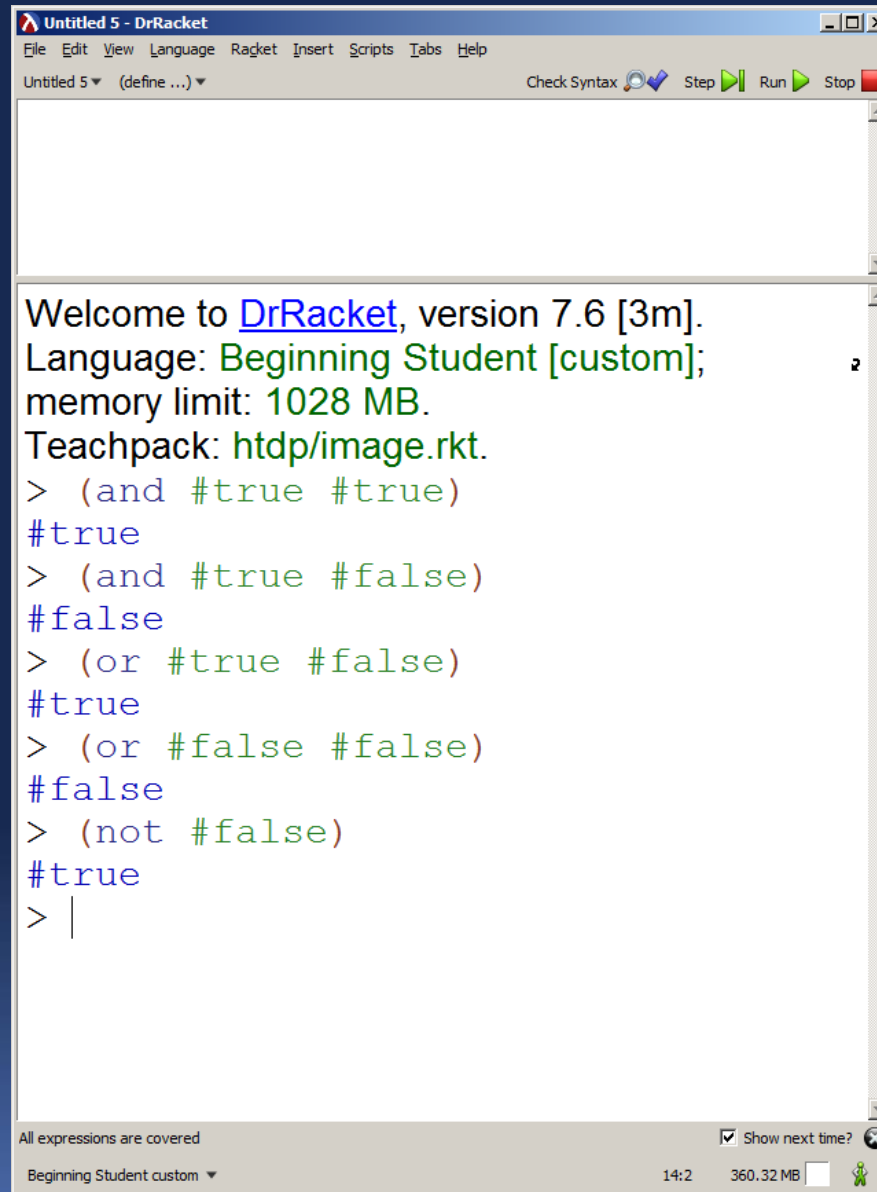
Convertendo strings para números

- ✓ Se o **argumento** passado para **string->number** **não** for um número apropriado, a função retornará **#false**, um tipo Boolean;
- ✓ Valores Boolean podem assumir dois valores: **#true** ou **#false**.



The screenshot shows the DrRacket IDE window titled "Untitled 3 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The code area contains the expression `(string->number "AA")`. The output area displays the following text: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: **Beginning Student [custom]**; memory limit: 1028 MB. Teachpack: [htdp/image.rkt](#). #false". The status bar at the bottom shows "All expressions are covered", "Beginning Student custom", "5:2", and "602.38 MB".

Trabalhando com valores Boolean



The screenshot shows the DrRacket IDE window titled "Untitled 5 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. Below the menu bar is a toolbar with buttons for Check Syntax, Step, Run, and Stop. The main text area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom];  
memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> (and #true #true)  
#true  
> (and #true #false)  
#false  
> (or #true #false)  
#true  
> (or #false #false)  
#false  
> (not #false)  
#true  
> |
```

At the bottom of the window, there is a status bar with the text "All expressions are covered" and a checkbox for "Show next time?". Below this, it says "Beginning Student custom" and shows the time "14:2" and memory usage "360.32 MB".

Comparando valores numéricos

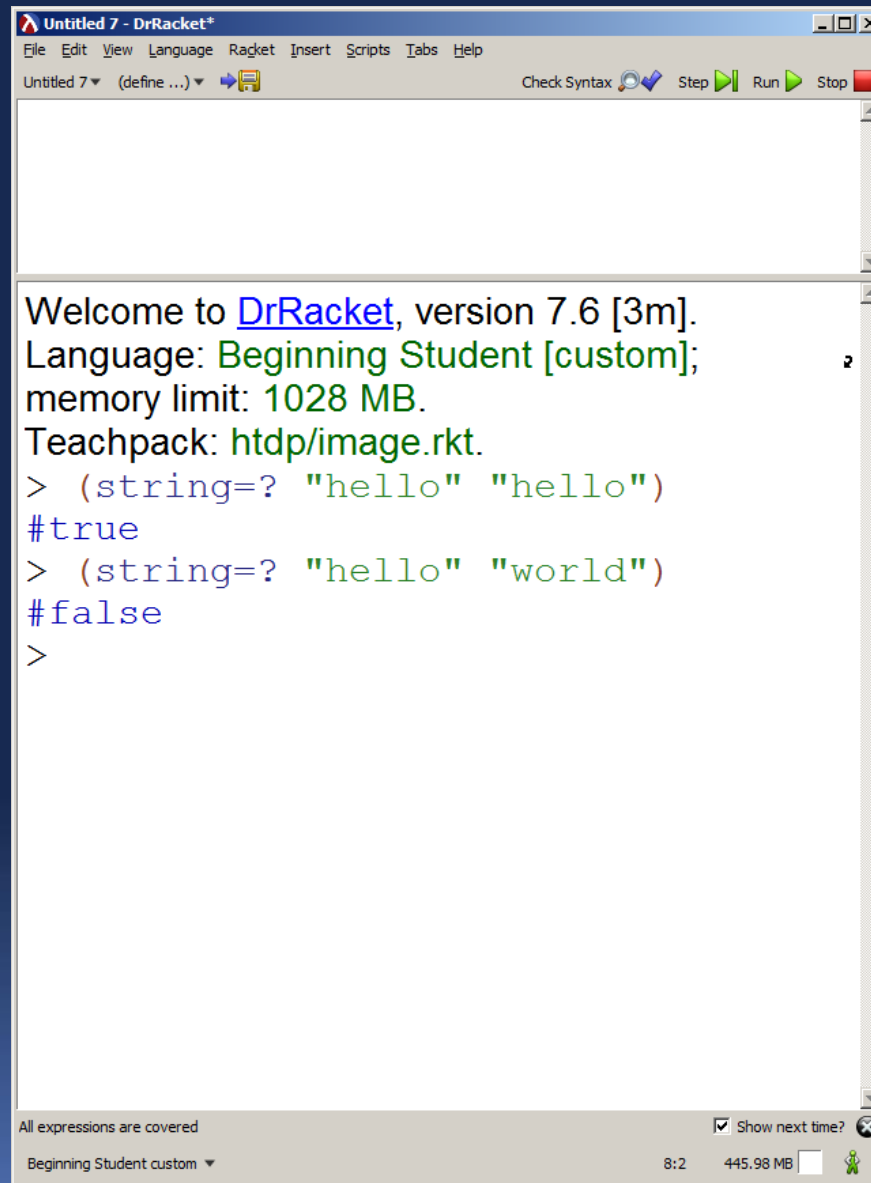


The screenshot shows the DrRacket IDE window titled "Untitled 6 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The main text area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom];  
memory limit: 1028 MB.  
Teachpack: http://image.rkt.  
> (> 10 9 )  
#true  
> (<= -1 0)  
#true  
> (= 45 9)  
#false  
> |
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "Show next time?" (checked). The time is 10:2 and the memory usage is 407.61 MB.

Comparando strings

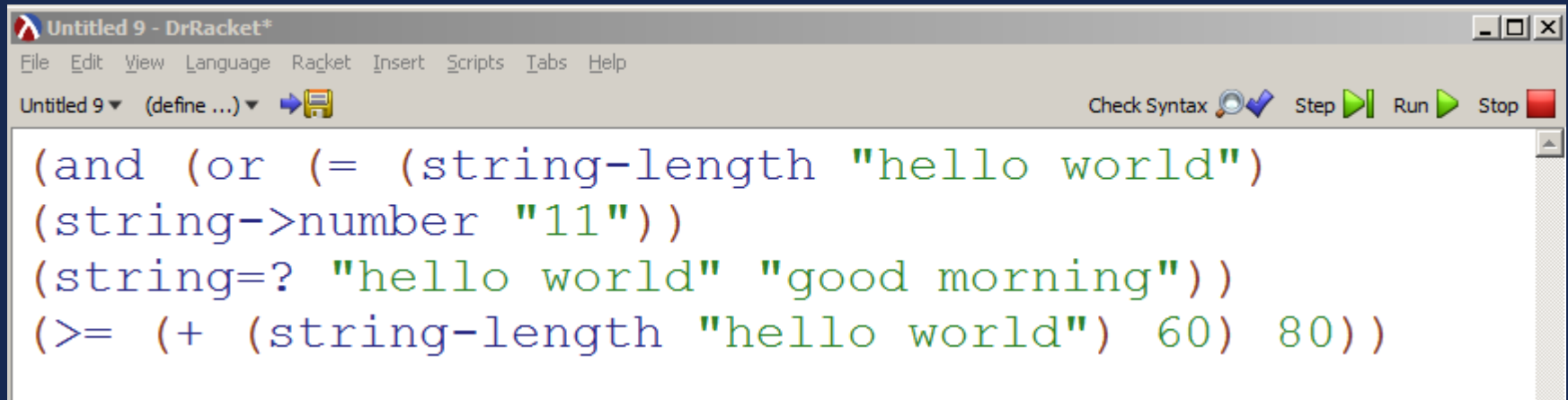


The screenshot shows the DrRacket IDE window titled "Untitled 7 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The main text area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom];  
memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
> (string=? "hello" "hello")  
#true  
> (string=? "hello" "world")  
#false  
>
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", "8:2", "445.98 MB", and a "Show next time?" checkbox.

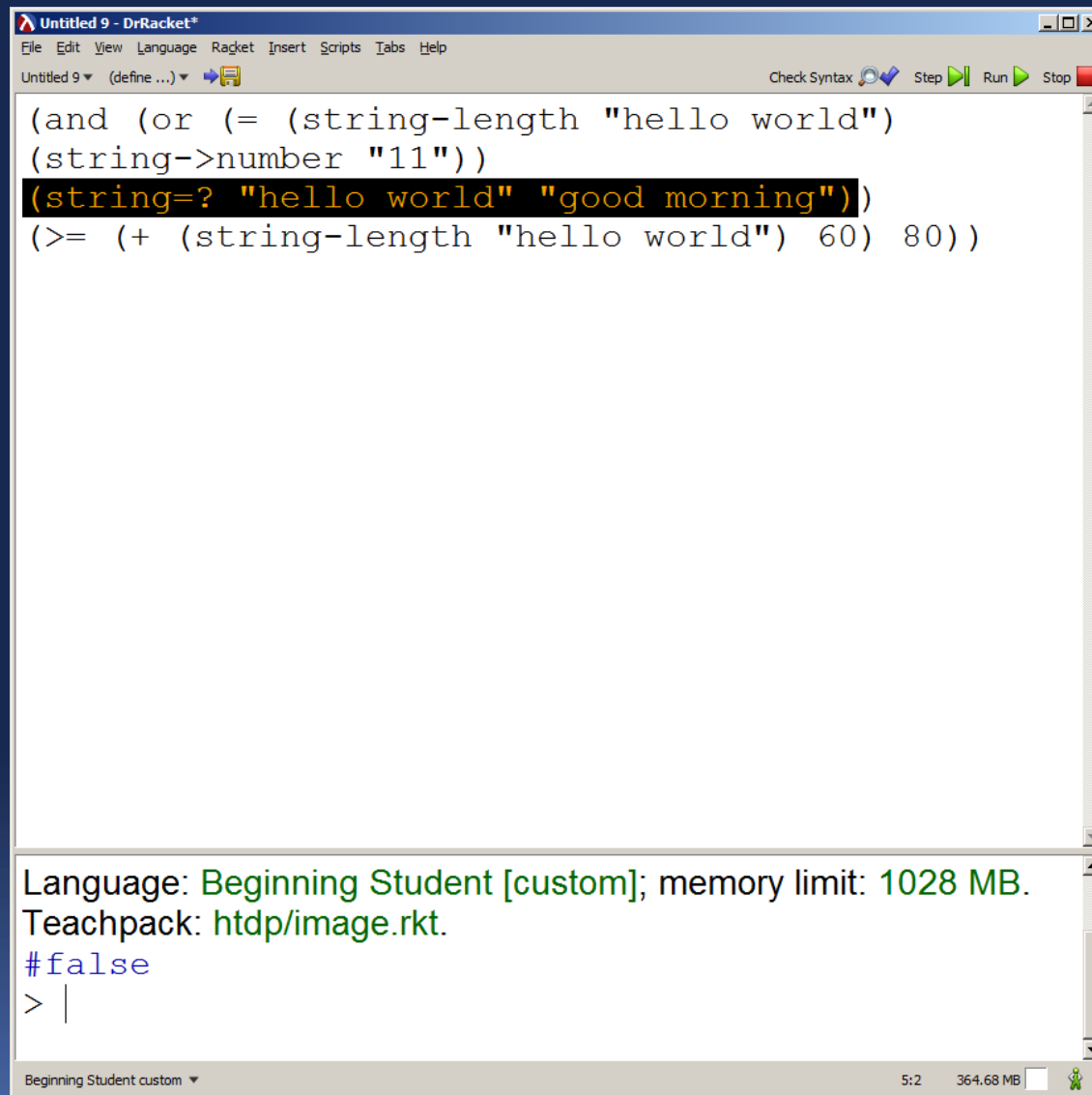
✓ Qual o resultado da avaliação da expressão abaixo:



```
(and (or (= (string-length "hello world")  
(string->number "11"))  
(string=? "hello world" "good morning"))  
(>= (+ (string-length "hello world") 60) 80))
```



✓ Qual o resultado da avaliação da expressão abaixo:



The screenshot shows the DrRacket IDE window titled "Untitled 9 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has icons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket expression:

```
(and (or (= (string-length "hello world")  
(string->number "11"))  
(string=? "hello world" "good morning"))  
(>= (+ (string-length "hello world") 60) 80))
```

The expression is evaluated, and the result is displayed in the bottom panel:

```
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
#false  
> |
```

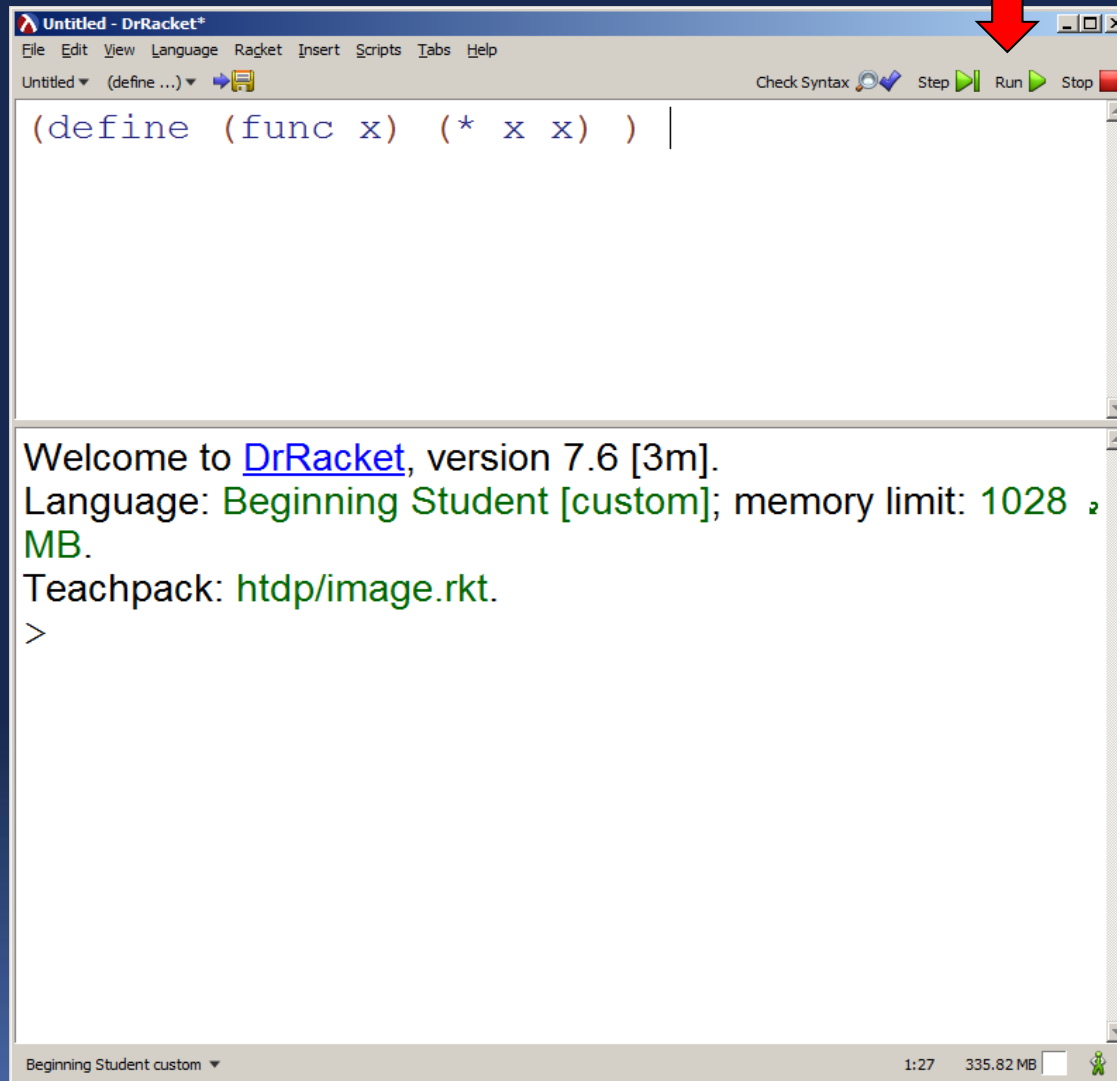
The status bar at the bottom indicates "Beginning Student custom", "5:2", and "364.68 MB".

Definindo Funções

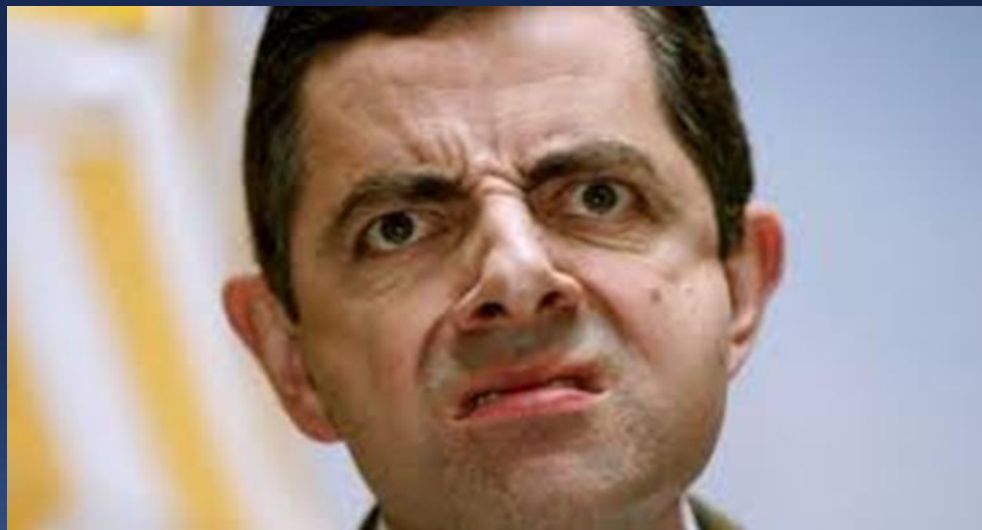
- ✓ Funções são definidas por outra função chamada **define**;
- ✓ Por exemplo: `(define (func x) (* x x))`
- ✓ **define** significa: “**considere func uma função**”, a qual, como uma expressão, computará um valor;
- ✓ O valor de uma função, depende, dos valores entrados (input), os quais são expressos por `(func x)`, sendo **func** o nome da função e **x** o **parâmetro** que será consumido por ela;
- ✓ Na segunda parte da definição, define-se a expressão na forma de **lista**, cuja avaliação retornará o valor computado.

Definindo Funções

- ✓ Após a escrita da função, clique em >Run.

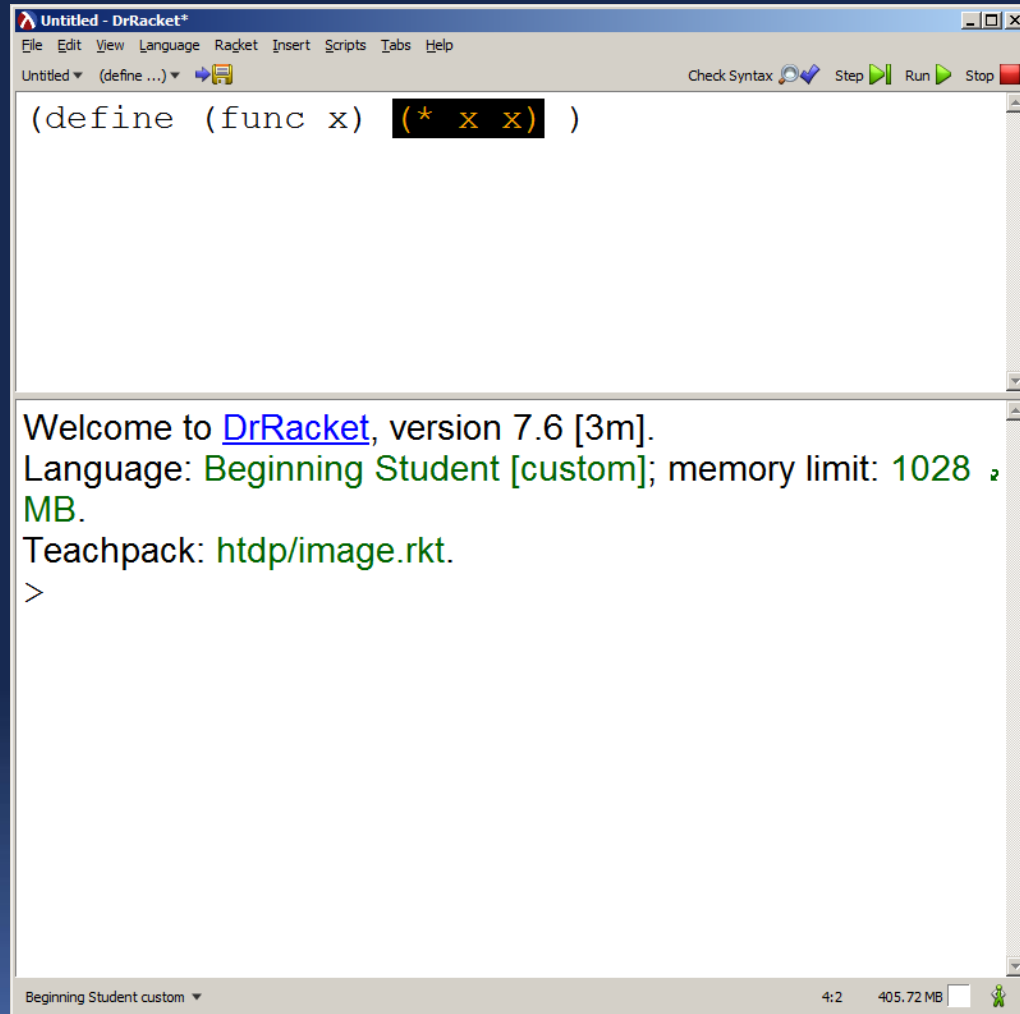


Vê ... Mas, ao clicar no Botão nada acontece ????



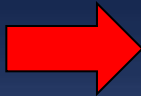
Definindo Funções

- ✓ Aparentemente nada foi feito, mas DrRacket armazenou no ambiente a definição da função, podendo ser executada mais tarde.



Aplicação da Função

- ✓ Após a definição da função, pode-se executá-la da seguinte forma, na área de interação: **(func 2)**
- ✓ **(func 2)** é chamado de **Aplicação da Função**.



```
Untitled - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
Untitled (define ...) [Check Syntax] [Step] [Run] [Stop]

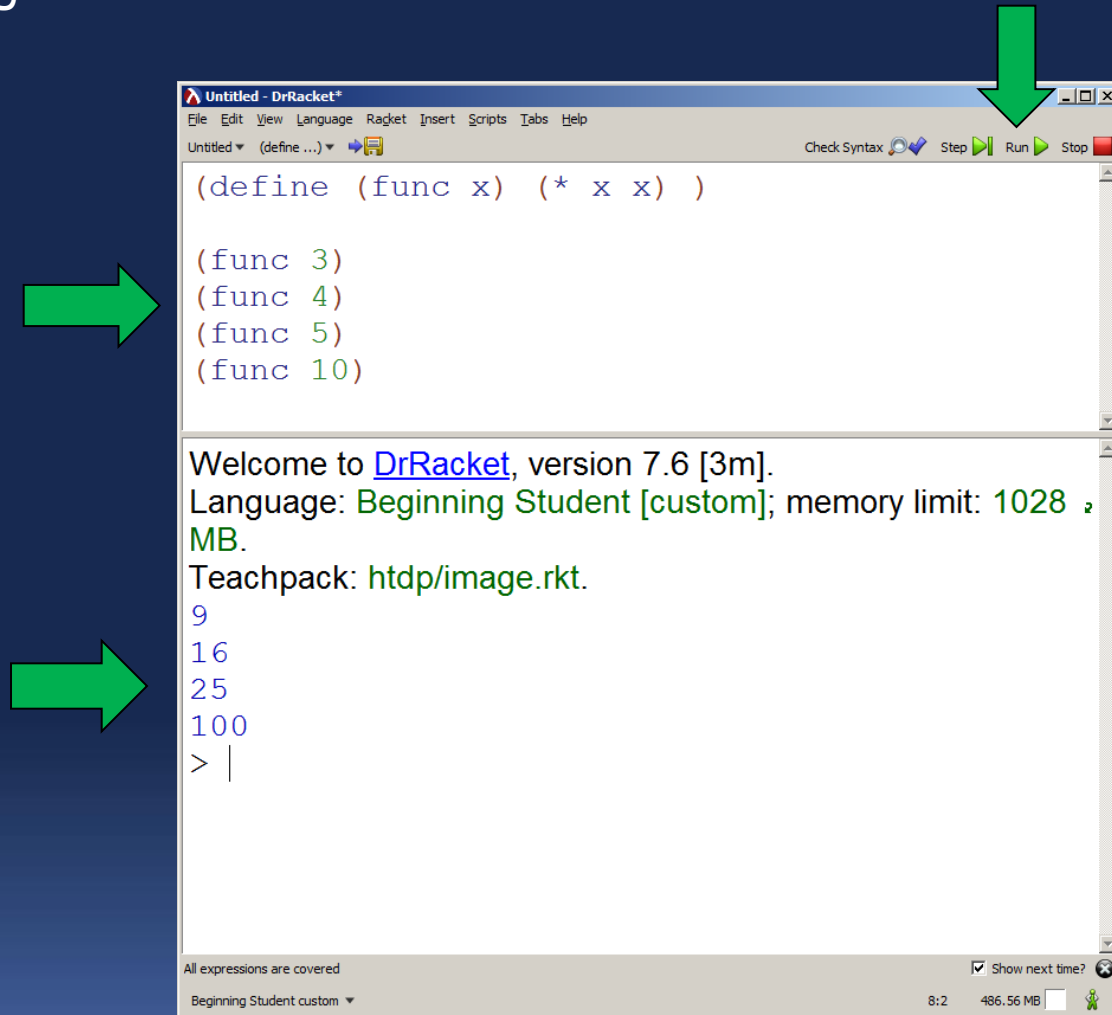
(define (func x) (* x x) )

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: httpd/image.rkt.
> (func 2)
4
> |

Beginning Student custom 6:2 404.67 MB
```


Aplicação da Função

- ✓ Pode-se definir a função e suas respectivas **aplicações** na área de definição e em seguida clicar em **>Run**.



```
(define (func x) (* x x))

(func 3)
(func 4)
(func 5)
(func 10)
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](http://image.rkt).

```
9
16
25
100
> |
```

All expressions are covered ☒ Show next time?

Beginning Student custom 8:2 486.56 MB

Funções em DrRacket

- ✓ No Paradigma Funcional **programas** são **funções**;
- ✓ Assim, a compreensão do conceito de função é vital para a Programação Funcional;
- ✓ Genericamente, definição da função é:

```
(define (FunctionName InputName) BodyExpression)
```

- ✓ "**define**" é uma keyword usada para definição de Função;
- ✓ A definição é feita em 2 partes: Na primeira parte, define-se o **nome** da função e o ou os **parâmetros** que são desconhecidos até o momento de se efetuar a aplicação da função;
- ✓ Na segunda parte, define-se a **expressão** que representa o corpo da função usada para se **computar** o resultado.

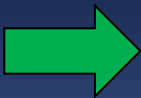
Aplicação da Função

- ✓ Escrita por:

```
(FunctionName ArgumentExpression)
```

- ✓ Na primeira parte escreve-se o nome da função a ser aplicada;
- ✓ Na segunda parte escrevem-se os argumentos (inputs) que serão empregados para a aplicação da função.

Aplicação da Função - Exemplo



```
Untitled - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
Untitled (define ...) [Save] Check Syntax [Check] Step [Step] Run [Run] Stop [Stop]

(define (tamanho-string s)
  (string-length s) )

(define (dobro num)
  (+ num num))

(dobro (tamanho-string "USCS"))

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: htdp/image.rkt.

8
>
|

All expressions are covered
Beginning Student custom 6:0 448.85 MB [Show next time?] [Close]
```

Descontinuidade de Funções

- ✓ Considere e a seguinte **função matemática**:

$$\text{sign}(x) = \begin{cases} +1 & \text{if } x > 0 \\ 0 & \text{if } x = 0 \\ -1 & \text{if } x < 0 \end{cases}$$


- ✓ Essa função tem **três diferentes tipos de entrada**: os valores que são **maiores** que zero, aqueles que são **iguais** a zero ou ainda aqueles que são **menores** que zero.
- ✓ Dependendo do argumento, o resultado da função poderá ser +1, 0 ou -1.

$$\text{sign}(x) = \begin{cases} +1 & \text{if } x > 0 \\ 0 & \text{if } x = 0 \\ -1 & \text{if } x < 0 \end{cases}$$

✓ No DrRacket, essa função pode ser definida por:

```
(define ( sign x)
  (cond
    [(> x 0) 1]
    [(= x 0) 0]
    [< x 0) -1]) )
```

$$\text{sign}(x) = \begin{cases} +1 & \text{if } x > 0 \\ 0 & \text{if } x = 0 \\ -1 & \text{if } x < 0 \end{cases}$$



Untitled 2 - DrRacket*

File Edit View Language Racket Insert Scripts Tabs Help

Untitled 2 (define ...) [icon]

Check Syntax [icon] Step [icon] Run [icon] Stop [icon]

```
(define ( sign x)
  (cond
    [(> x 0) 1]
    [(= x 0) 0]
    [< x 0) -1]))
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.

```
> (sign 2)
1
> (sign 0)
0
> (sign -1)
-1
> |
```

Beginning Student custom ▼ 10:2 426.70 MB [icon]

Expressões Condicionais - Sintaxe

```
(cond  
  [ConditionExpression1 ResultExpression1]  
  [ConditionExpression2 ResultExpression2]  
  ...  
  [ConditionExpressionN ResultExpressionN])
```

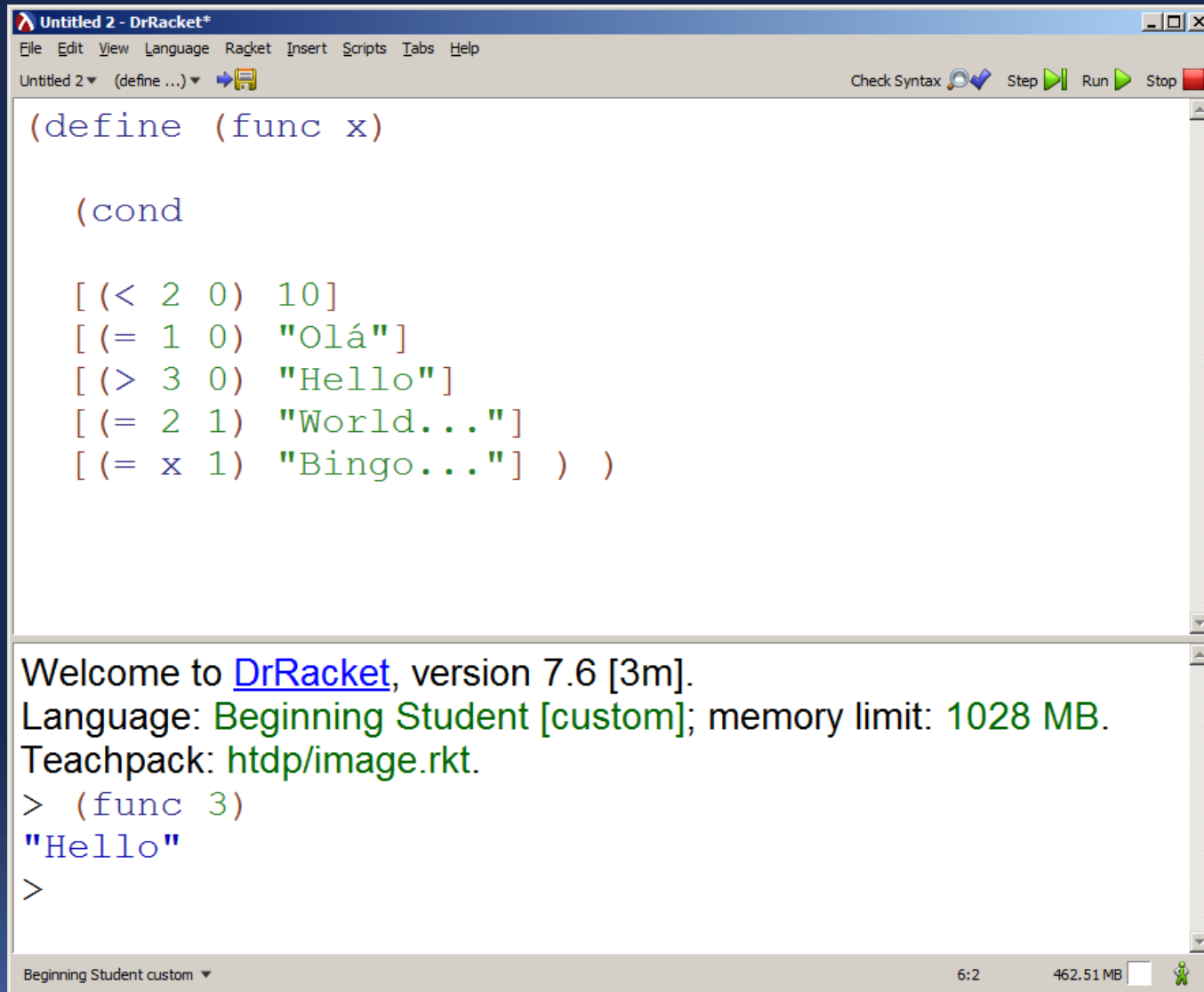
- ✓ Em geral, **expressões condicionais** consistem de tantas linhas condicionais quantas forem necessárias;
- ✓ Cada linha contém duas expressões: a da **esquerda** define a **condição** e a da **direita** define o **resultado**;

Expressões Semântica

```
(cond  
  [ConditionExpression1 ResultExpression1]  
  [ConditionExpression2 ResultExpression2]  
  ...  
  [ConditionExpressionN ResultExpressionN])
```

- ✓ DrRacket avalia a **primeira expressão condicional**. Se esta resultar **#true**, DrRacket usa o valor dessa linha para o resultado inteiro da expressão cond e **encerra a avaliação**;
- ✓ Se a avaliação for **falsa**, Dr. Racket salta essa linha e passa a avaliar a **próxima**, e assim, sucessivamente.
- ✓ Caso todas as condições forem **falsas**, DrRacket sinaliza **erro**.

Exemplo 1



The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The editor contains the following Racket code:

```
(define (func x)

  (cond

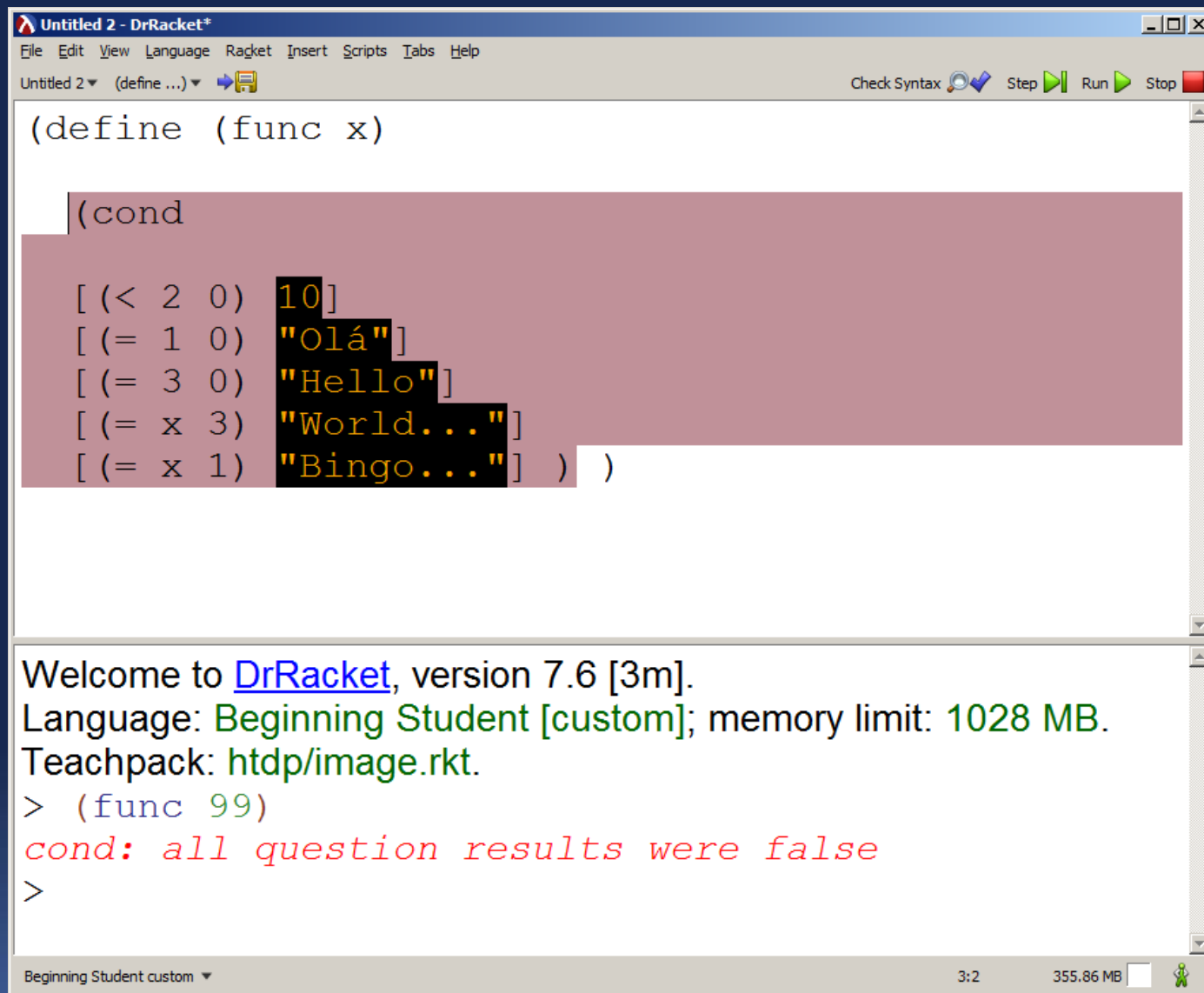
    [(< 2 0) 10]
    [(= 1 0) "Olá"]
    [(> 3 0) "Hello"]
    [(= 2 1) "World..."]
    [(= x 1) "Bingo..."] ) )
```

The bottom panel shows the welcome message and the execution of the code:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: htdp/image.rkt.
> (func 3)
"Hello"
>
```

The status bar at the bottom indicates "Beginning Student custom", "6:2", and "462.51 MB".

Exemplo 3



The screenshot shows the DrRacket IDE with a file named "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The code editor contains the following Racket code:

```
(define (func x)

  (cond

    [ (< 2 0) 10]
    [ (= 1 0) "Olá"]
    [ (= 3 0) "Hello"]
    [ (= x 3) "World..."]
    [ (= x 1) "Bingo..."] ) )
```

The output window displays the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](http://image.rkt).
> (func 99)
cond: all question results were false
>

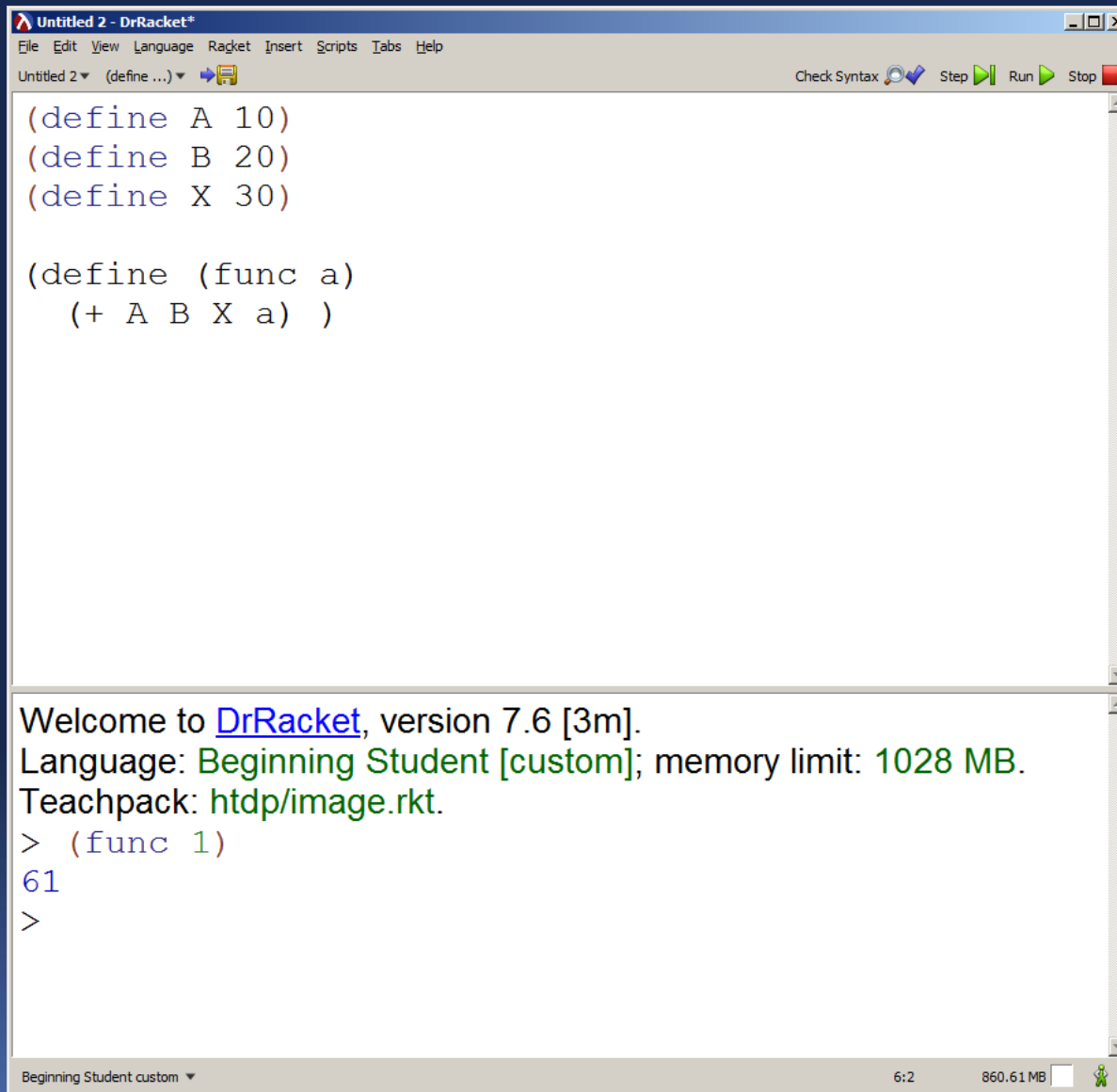
The status bar at the bottom shows "Beginning Student custom", "3:2", "355.86 MB", and a small green icon.

Definindo constantes

- ✓ Vimos nos exemplos anteriores que funções são definidas pela função **define**;
- ✓ Mas, **define** também pode ser usado para se definir **constantes**;
- ✓ Ou seja, nesse caso atribuímos um nome a uma constante;
- ✓ A sintaxe geral para essa situação é:

```
(define Name Expression)
```

Definindo constantes



The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The editor area contains the following Racket code:

```
(define A 10)
(define B 20)
(define X 30)

(define (func a)
  (+ A B X a) )
```

Below the editor, the Welcome message reads: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: **Beginning Student [custom]**; memory limit: **1028 MB**. Teachpack: <http://image.rkt>." The interactive prompt shows the command `> (func 1)` being entered, with the output `61` displayed below it. The status bar at the bottom indicates "Beginning Student custom", "6:2", and "860.61 MB".

Definindo constantes

The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has icons for Check Syntax, Step, Run, and Stop. The editor contains the following Racket code:

```
(define A 10)
(define B 20)
(define X (+ A B) )

(define (func Y )

  (+ X Y) )
```

The console at the bottom displays the following output:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: htdp/image.rkt.
> (func 5)
35
>
```

The status bar at the bottom shows "Beginning Student custom", "6:2", and "967.18 MB".

Definindo constantes

The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket+". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The code editor contains the following Racket code:

```
; constantes

(define A 5)
(define B 20)
(define X (+ A B ) )
(define Y (- B A ) )

; funções
(define (func a b )

  (+ (+ a b) X Y ) )
```

The console output at the bottom shows the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.
> (func 1 2)
43
>

The status bar at the bottom indicates "Beginning Student custom", "6:2", and "1045.22 MB".

Operações com dados de Tamanho Fixo

- ✓ Toda linguagem de programação vem com uma **linguagem de dados** e uma outra linguagem de operações sobre os dados;
- ✓ A primeira linguagem sempre provê algumas formas de dados atômicos;
- ✓ Para representar informações do mundo real, o programador deve **aprender a compor** esses dados básicos e descrever tais composições;
- ✓ Similarmente, a **segunda linguagem** provê algumas **operações** básicas sobre os dados atômicos;
- ✓ Cabe ao programador **compor** essas operações em programas que executem as tarefas necessárias.

Tipos Atômicos de Dados

- ✓ Números
- ✓ Strings
- ✓ Imagens
- ✓ Valores Booleanos

Aritmética de Números

- ✓ Para aritmética de números utiliza-se a notação **prefixada**;
- ✓ Exemplo: (+ 3 4)
- ✓ Algumas operações primitivas disponíveis na linguagem:

❖ +, -, *, /

❖ abs, add1, ceiling, denominator, exact->inexact, expt, floor, gcd

❖ log, max, numerator, quotient,

❖ random, remainder, sqr, tan.

Exercício 1 – Aritmética de Números

- ✓ Adicione no ambiente de programação DrRacket:

```
(define x 3)  
(define y 4)
```

- ✓ Agora, imagine que x e y sejam as coordenadas de um ponto Cartesiano.
- ✓ Escreva uma **função** que retorne a **distância** desse ponto até a origem (0,0)

Exercício 1

The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has icons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket code:

```
(define a 3)
(define b 4)

(define (quadrado x)
  (* x x))

(define (raizquadrada x)
  (sqrt x))

(define (somaquadrados x y)
  (+
   (quadrado x)
   (quadrado y) ))

(define (distancia a b)
  (raizquadrada (somaquadrados a b) ) )
```

Below the code area, the Welcome message is displayed:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: **1028 MB**.
Teachpack: <http://image.rkt>.

The interaction area shows the following commands and results:

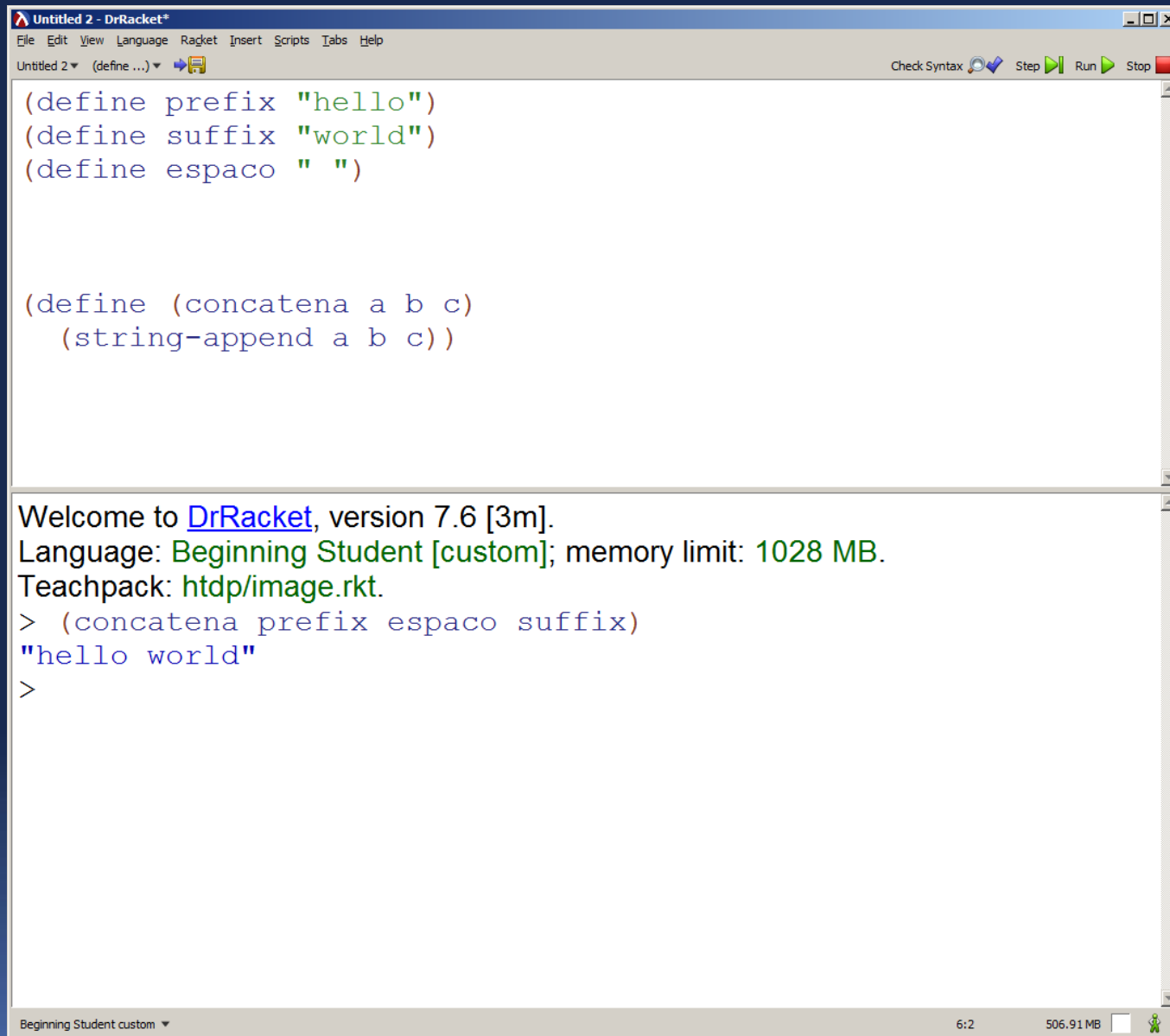
```
> (distancia a b)
5
>
```

The status bar at the bottom indicates "Beginning Student custom", "6:2", and "1724.76 MB".

Aritmética de Strings

- ✓ **String** é uma sequência de caracteres que se pode entrar pelo teclado e são delimitadas entre apóstrofes ("");
- ✓ Algumas operações primitivas estão disponíveis sobre strings;
 - ❑ **string-length** consome um string e produz um número;
 - ❑ **string-ith** consome um string *s* junto com um número *i* e extrai o 1String localizado na iésima posição (contando de 0)
 - ❑ **number->string** consome um número e produz um string;
 - ❑ **string-append** concatena uma sequência de strings.

Aritmética de Strings – Exemplo



The screenshot shows the DrRacket IDE with a file named 'Untitled 2'. The editor contains the following Racket code:

```
(define prefix "hello")
(define suffix "world")
(define espaco " ")

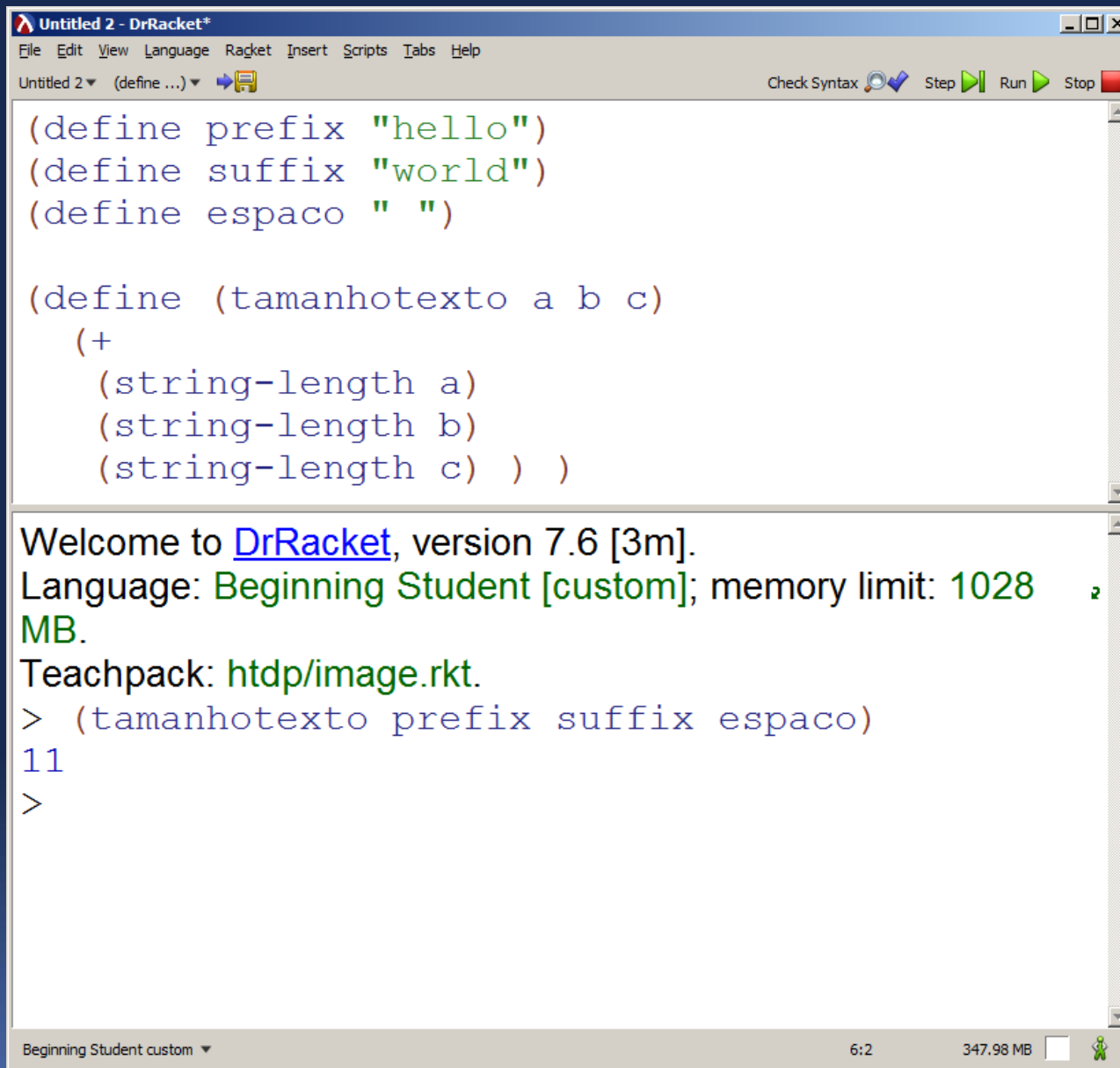
(define (concatena a b c)
  (string-append a b c))
```

The bottom pane shows the DrRacket welcome message and the execution of the `(concatena prefix espaco suffix)` function, which returns the string `"hello world"`.

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: [http/image.rkt](#).
> (concatena prefix espaco suffix)
"hello world"
>

The status bar at the bottom indicates the language is 'Beginning Student custom', the mode is '6:2', and the memory usage is '506.91 MB'.

Aritmética de Strings – Exemplo



The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The code editor contains the following Racket code:

```
(define prefix "hello")
(define suffix "world")
(define espaco " ")

(define (tamanhotexto a b c)
  (+
    (string-length a)
    (string-length b)
    (string-length c) ) )
```

The output window displays the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: **htdp/image.rkt**.
> (tamanhotexto prefix suffix espaco)
11
>

The status bar at the bottom shows "Beginning Student custom", "6:2", and "347.98 MB".

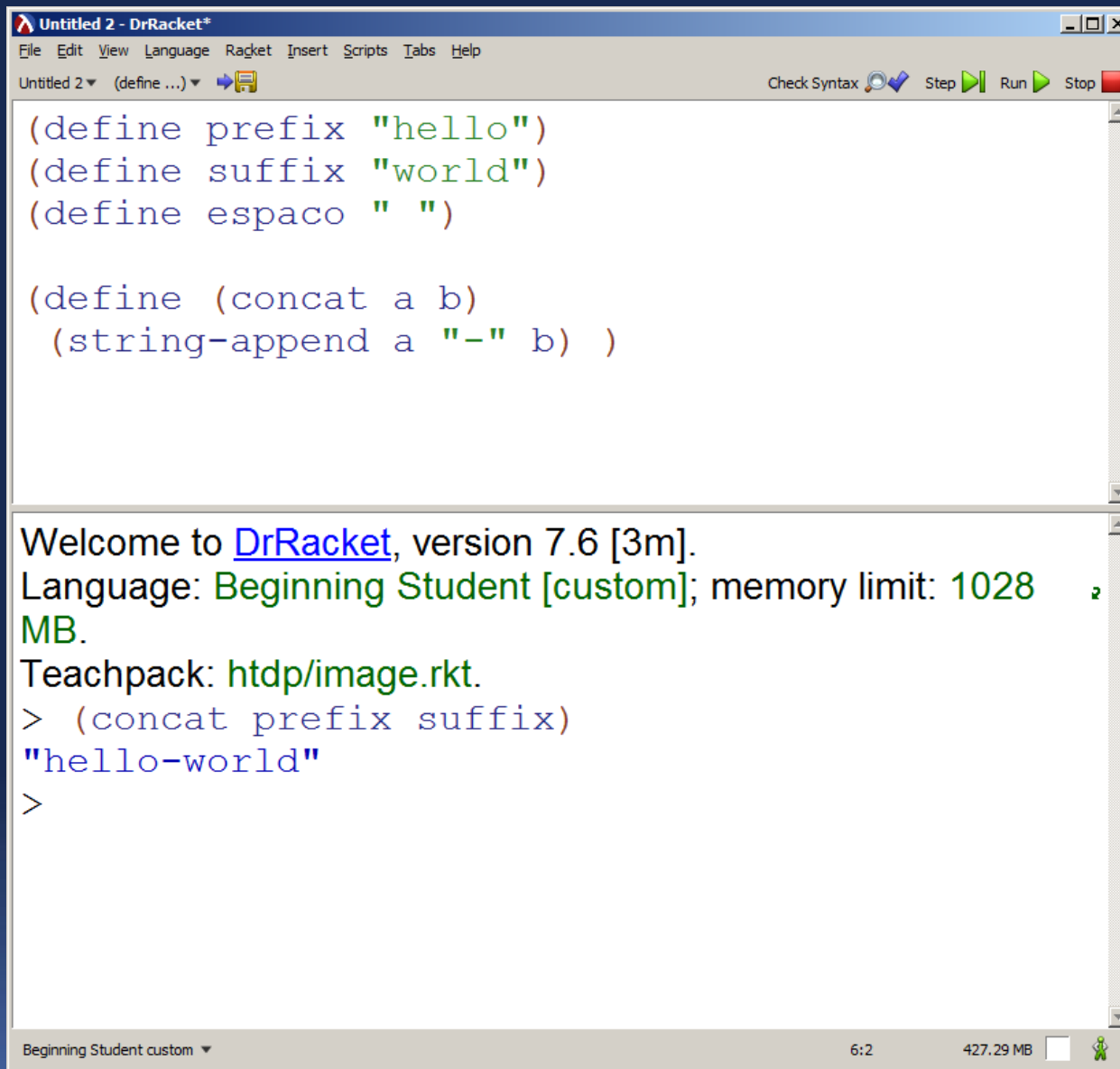
Exercício 2 – Aritmética de Strings

- ✓ Adicione no ambiente de programação DrRacket:

```
(define prefix "hello")  
(define suffix "world")
```

- ✓ Escreva uma função chamada `concat` que concatena `prefix` com `suffix` e adiciona "-" entre eles.

Exercício 2 – Aritmética de Strings



The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows icons for Check Syntax, Step, Run, and Stop. The code editor contains the following Racket code:

```
(define prefix "hello")  
(define suffix "world")  
(define espaco " ")  
  
(define (concat a b)  
  (string-append a "-" b) )
```

The output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
> (concat prefix suffix)  
"hello-world"  
>
```

The status bar at the bottom shows "Beginning Student custom", "6:2", and "427.29 MB".

Exercício 3 – Aritmética de Strings

- ✓ Adicione no ambiente de programação DrRacket:

```
(define str "helloworld")  
(define i 3)
```

- ✓ Escreva uma função usando operações primitivas chamada incluec que **adiciona** "_" na posição **i**.

Exercício 4 – Aritmética de Strings

- ✓ Adicione no ambiente de programação DrRacket:

```
(define str "helloworld")  
(define i 3)
```

- ✓ Escreva uma função usando operações primitivas chamada `deletec` que **deleta** a posição **ith** a partir de **str**. (Que valores para *i* são legítimos?)

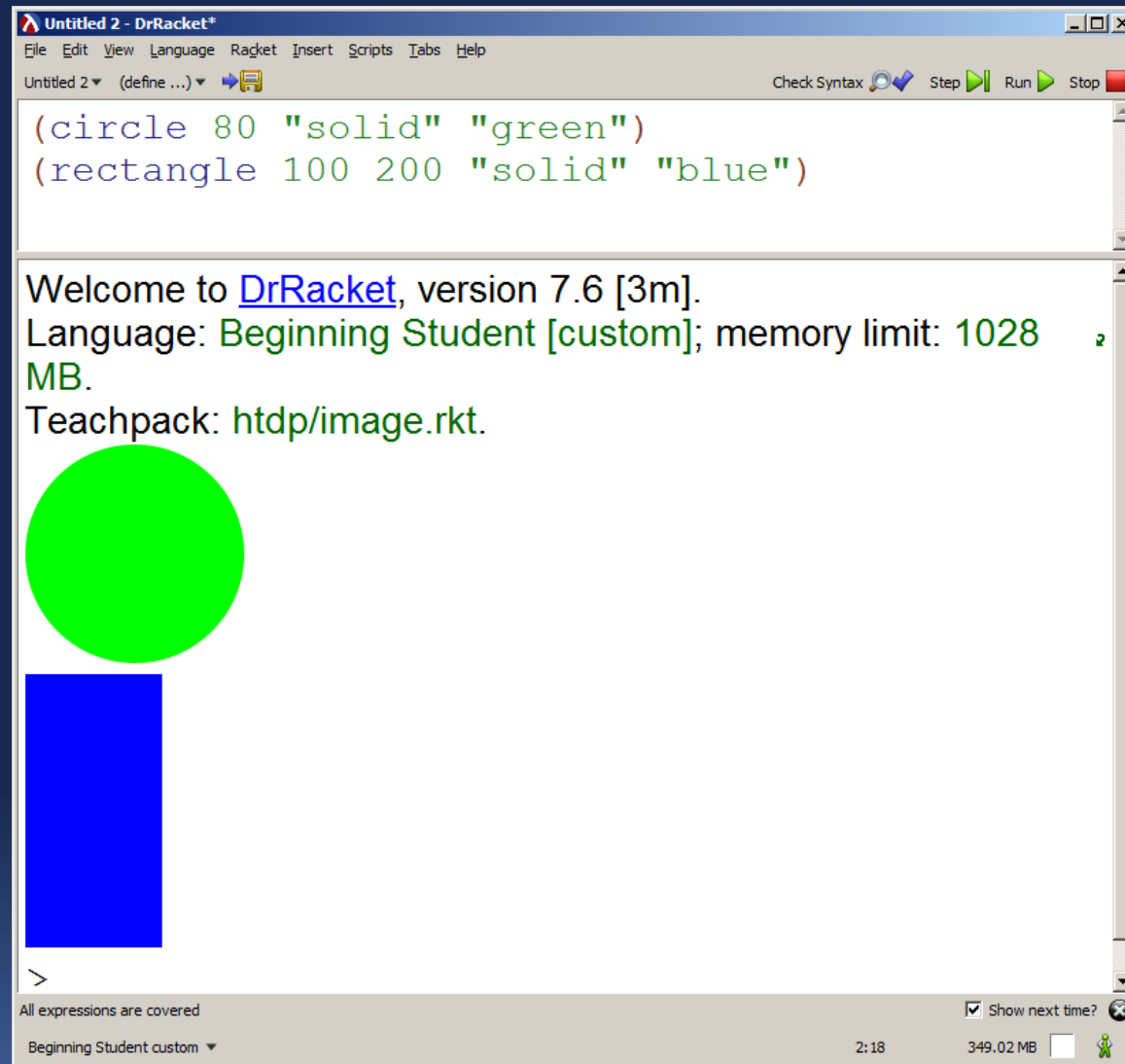
Aritmética de Strings

- ✓ **String** é uma **sequência** de caracteres que se pode entrar pelo teclado e são delimitadas entre apóstrofes ("");
- ✓ Algumas **operações primitivas** estão disponíveis sobre strings;
 - ❑ **string-length** **consume** um string **e** produz um número;
 - ❑ **string-ith** **consume** um string **s** junto com um número **i** e extrai o 1String localizado na iésima posição (contando de 0)
 - ❑ **number->string** **consume** um número **e** produz um string;
 - ❑ **string-append** **concatena** uma sequência de strings.

Aritmética de Imagens

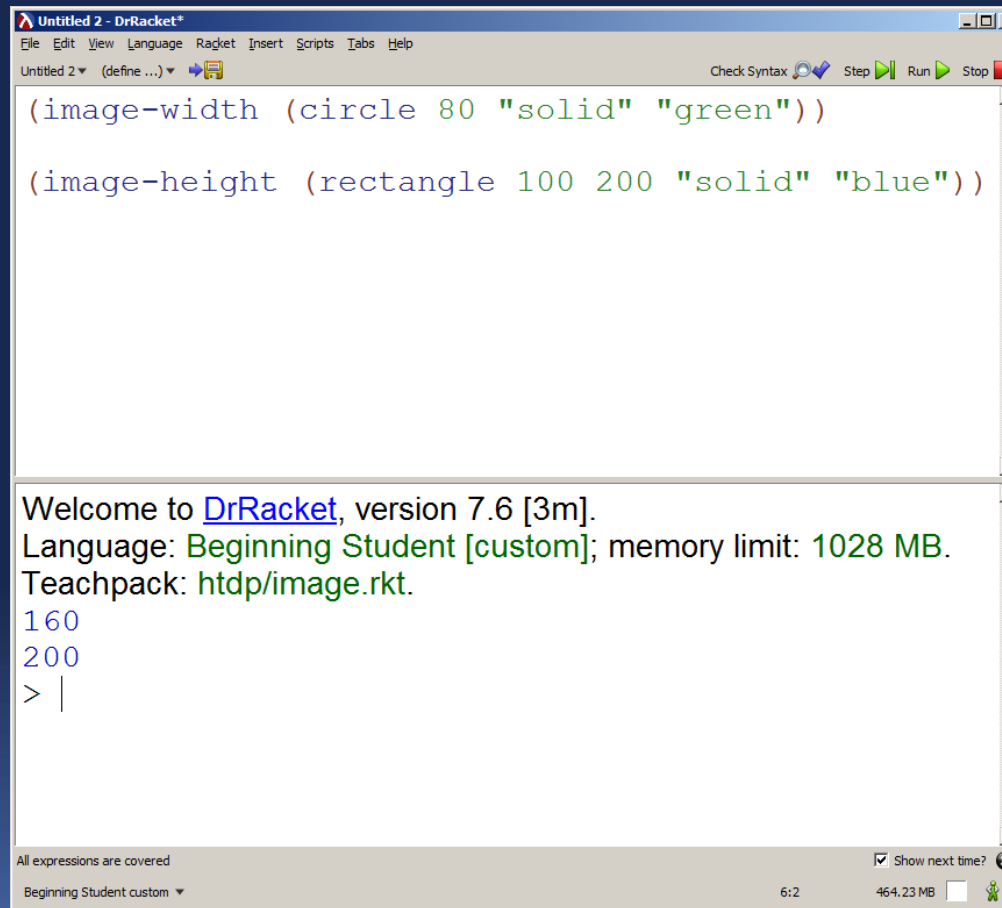
- ✓ Uma **imagem** representa dados visuais, por exemplo, uma **foto**, uma **figura**, etc;
- ✓ Pode-se inserir imagens em DrRacket e manipulá-las tal como números e strings;
- ✓ Um programa DrRacket pode manipular imagens como operações primitivas;
- ✓ Operações básicas primitivas para criação de imagens: **circle**, **ellipse**, **line**, **rectangle**, **text**, **triangle**.

Operações de Criação de Imagens



Funções em propriedades de Imagens

- ✓ `image-width` determina a **largura** de uma imagem em pixels
- ✓ `image-height` determina a **altura** de uma imagem;



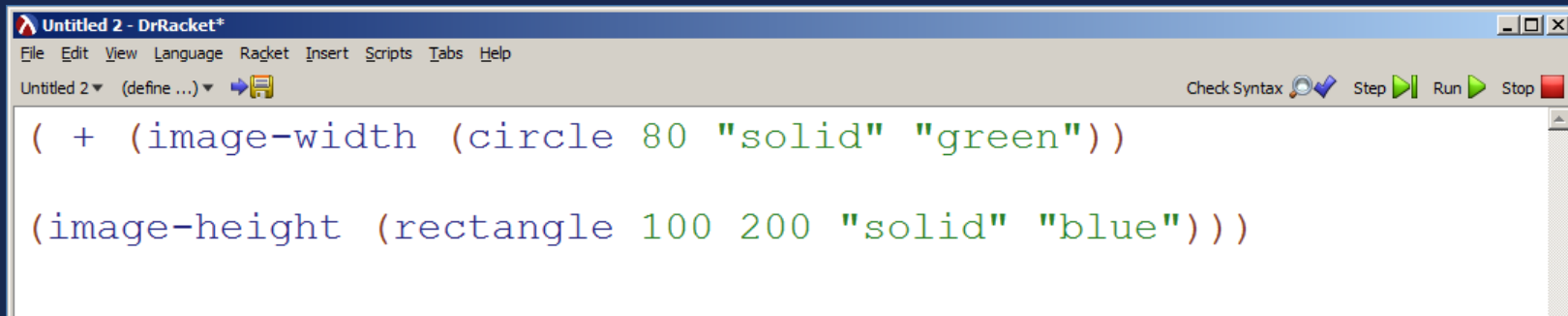
The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The code editor contains two lines of Racket code: `(image-width (circle 80 "solid" "green"))` and `(image-height (rectangle 100 200 "solid" "blue"))`. The bottom panel shows the REPL output: "Welcome to [DrRacket](#), version 7.6 [3m].", "Language: Beginning Student [custom]; memory limit: 1028 MB.", "Teachpack: [htdp/image.rkt](#).", followed by the results of the previous expressions: `160` and `200`, and a prompt `> |`. The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "6:2 464.23 MB".

```
(image-width (circle 80 "solid" "green"))

(image-height (rectangle 100 200 "solid" "blue"))
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: [htdp/image.rkt](#).
160
200
> |

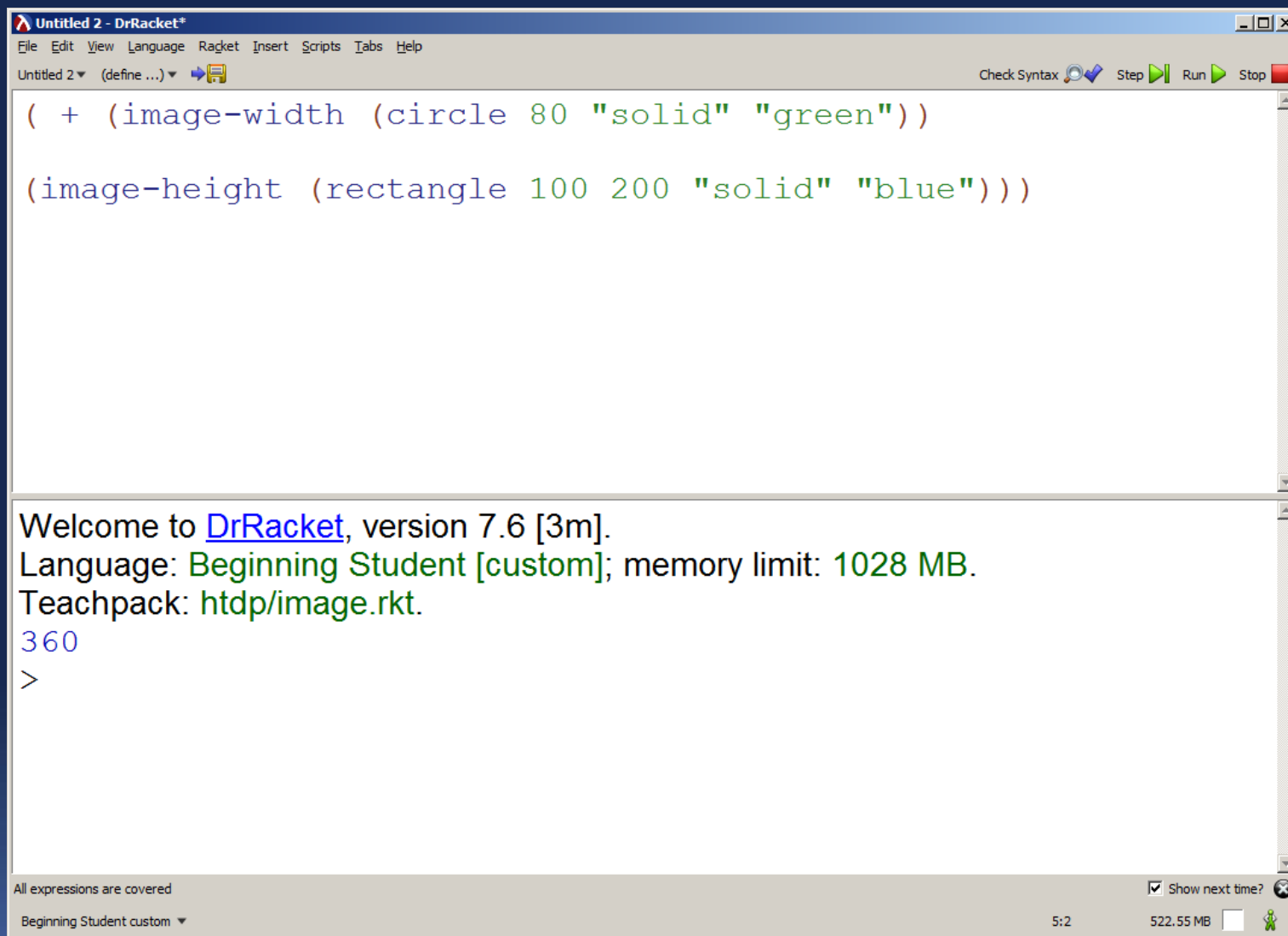
Qual o valor dessa expressão ?



The screenshot shows the DrRacket IDE window titled "Untitled 2 - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The code editor contains the following Racket expression:

```
( + (image-width (circle 80 "solid" "green"))  
(image-height (rectangle 100 200 "solid" "blue")))
```


Qual o valor dessa expressão ?



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket expression:

```
( + (image-width (circle 80 "solid" "green"))  
  
(image-height (rectangle 100 200 "solid" "blue"))) )
```

Below the text area, the output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
360  
>
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "5:2 522.55 MB".

Aritmética de Booleans

- ✓ Tipos primitivos booleanos são úteis no projeto de programas;
- ✓ Há dois tipos de valores booleanos: **#true** e **#false**.
- ✓ Programas usam os tipos booleanos para implementar **decisões**;
- ✓ Há três operações primitivas sobre booleans: **or**, **and** e **not**.

Aritmética de Booleans

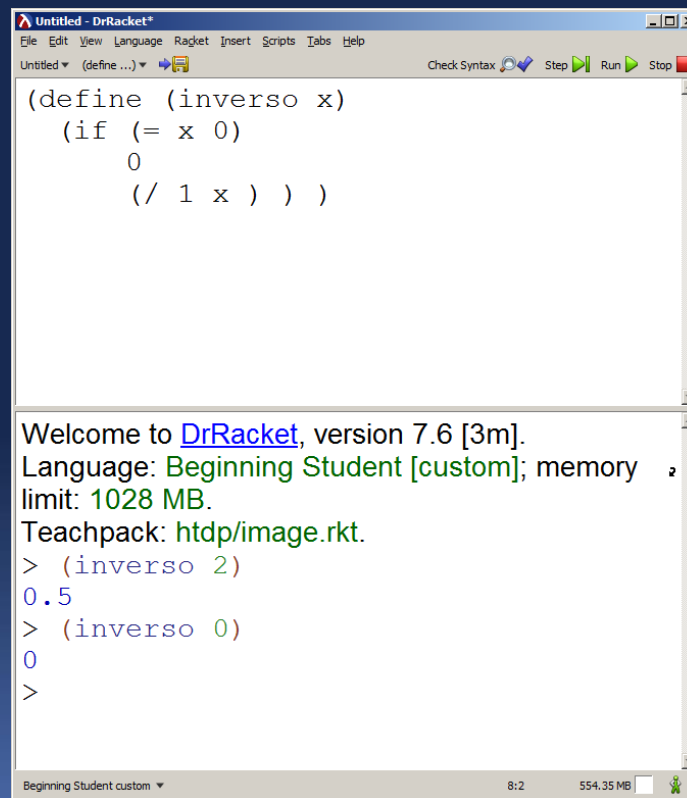
```
> (or #true #true)
#true
> (or #true #false)
#true
> (or #false #true)
#true
> (or #false #false)
#false
```

```
> (and #true #true)
#true
> (and #true #false)
#false
> (and #false #true)
#false
> (and #false #false)
#false
```

```
> (not #true)
#false
```

Misturando operações

- ✓ Operações com tipos **booleanos** podem manusear diferentes tipos de dados;
- ✓ No exemplo, a função **"if"** é seguida por 3 expressões separadas por espaços em branco, que são chamadas de **sub-expressões**.
- ✓ Se a avaliação da primeira expressão é **#true**, então a segunda expressão é avaliada, **caso contrário** a terceira expressão será avaliada.



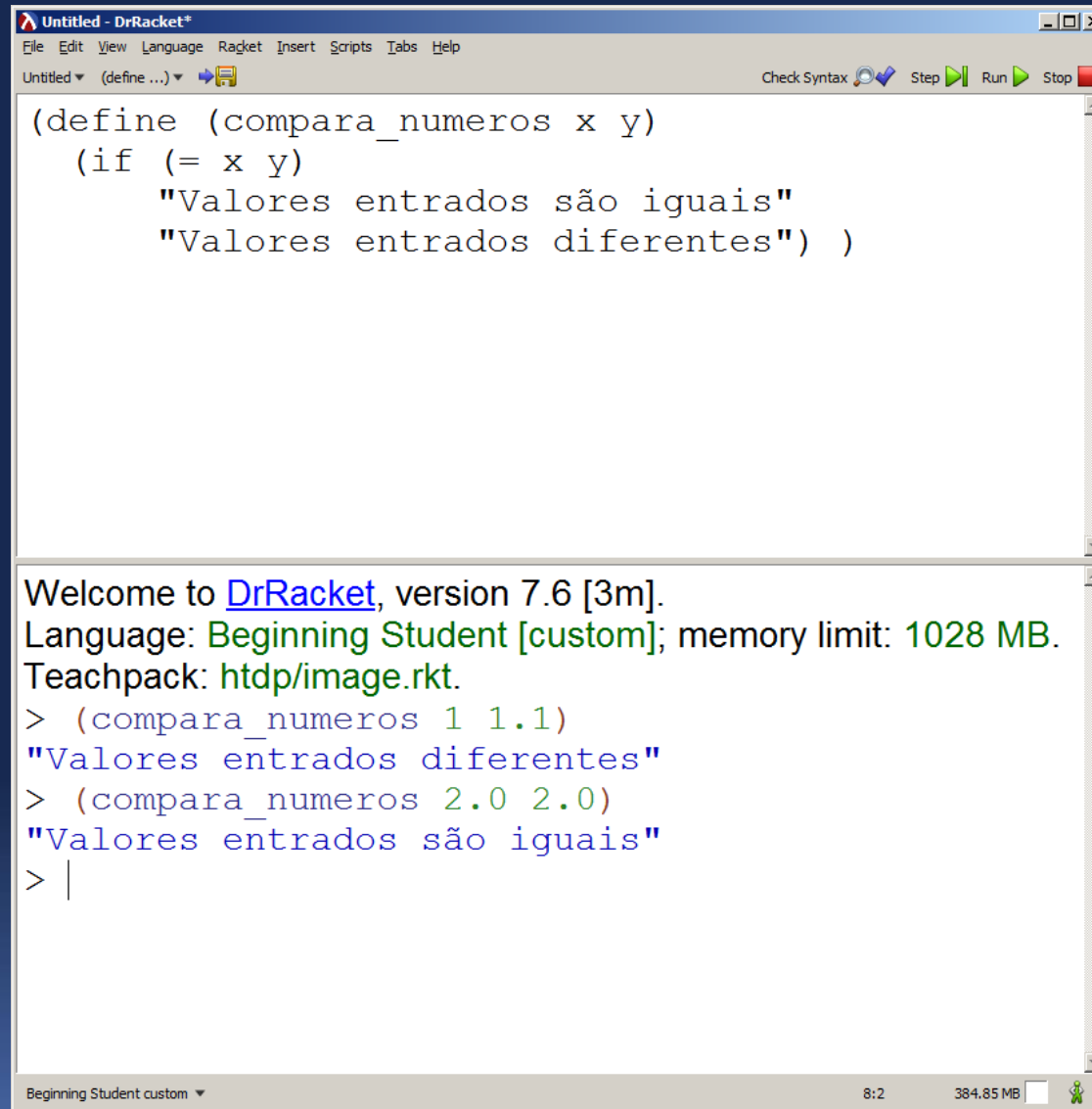
```
(define (inverso x)
  (if (= x 0)
      0
      (/ 1 x) ) )
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: [Beginning Student](#) [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](#).

```
> (inverso 2)
0.5
> (inverso 0)
0
>
```

Beginning Student custom 8:2 554.35 MB

Comparando valores numéricos



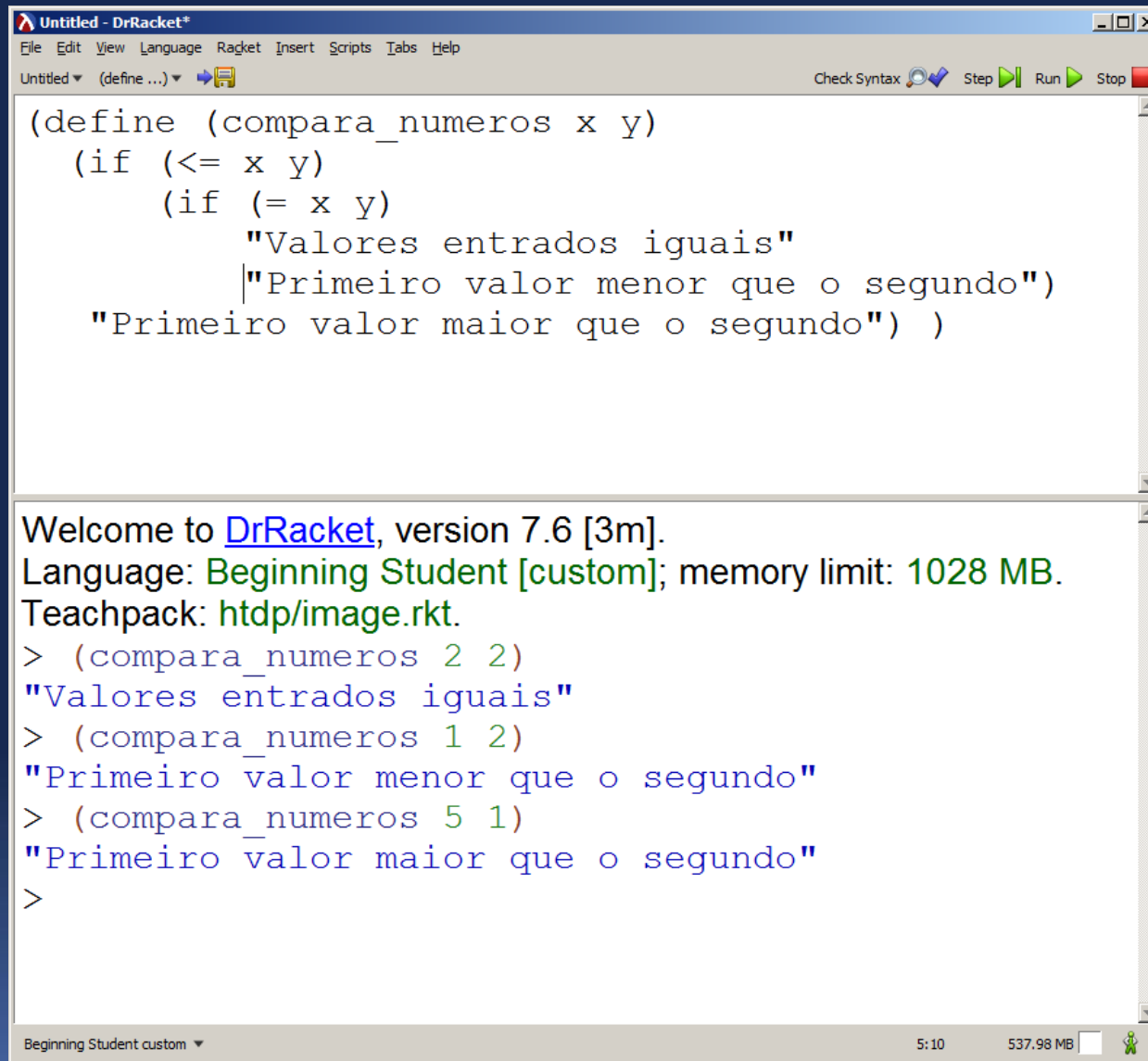
The screenshot shows the DrRacket IDE interface. The top window, titled 'Untitled - DrRacket*', contains a Racket program that defines a function `compara_numeros`. The function takes two arguments, `x` and `y`, and returns a string: `"Valores entrados são iguais"` if `x` equals `y`, and `"Valores entrados diferentes"` otherwise. The bottom window shows the DrRacket welcome message and the results of two function calls: `(compara_numeros 1 1.1)` returns `"Valores entrados diferentes"` and `(compara_numeros 2.0 2.0)` returns `"Valores entrados são iguais"`. The status bar at the bottom indicates 'Beginning Student custom' and '8:2 384.85 MB'.

```
(define (compara_numeros x y)
  (if (= x y)
      "Valores entrados são iguais"
      "Valores entrados diferentes"))
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.

```
> (compara_numeros 1 1.1)
"Valores entrados diferentes"
> (compara_numeros 2.0 2.0)
"Valores entrados são iguais"
> |
```

Comparando valores numéricos



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. Below the menu bar, there's a toolbar with buttons for 'Check Syntax', 'Step', 'Run', and 'Stop'. The main text area contains a Racket function definition for comparing two numbers, x and y. The function uses nested if statements to return a string indicating if the values are equal, the first is smaller, or the first is larger. Below the code editor, there's a console window showing the output of the function for three different inputs: (2, 2), (1, 2), and (5, 1). The status bar at the bottom indicates the current language is 'Beginning Student custom', the time is 5:10, and the memory usage is 537.98 MB.

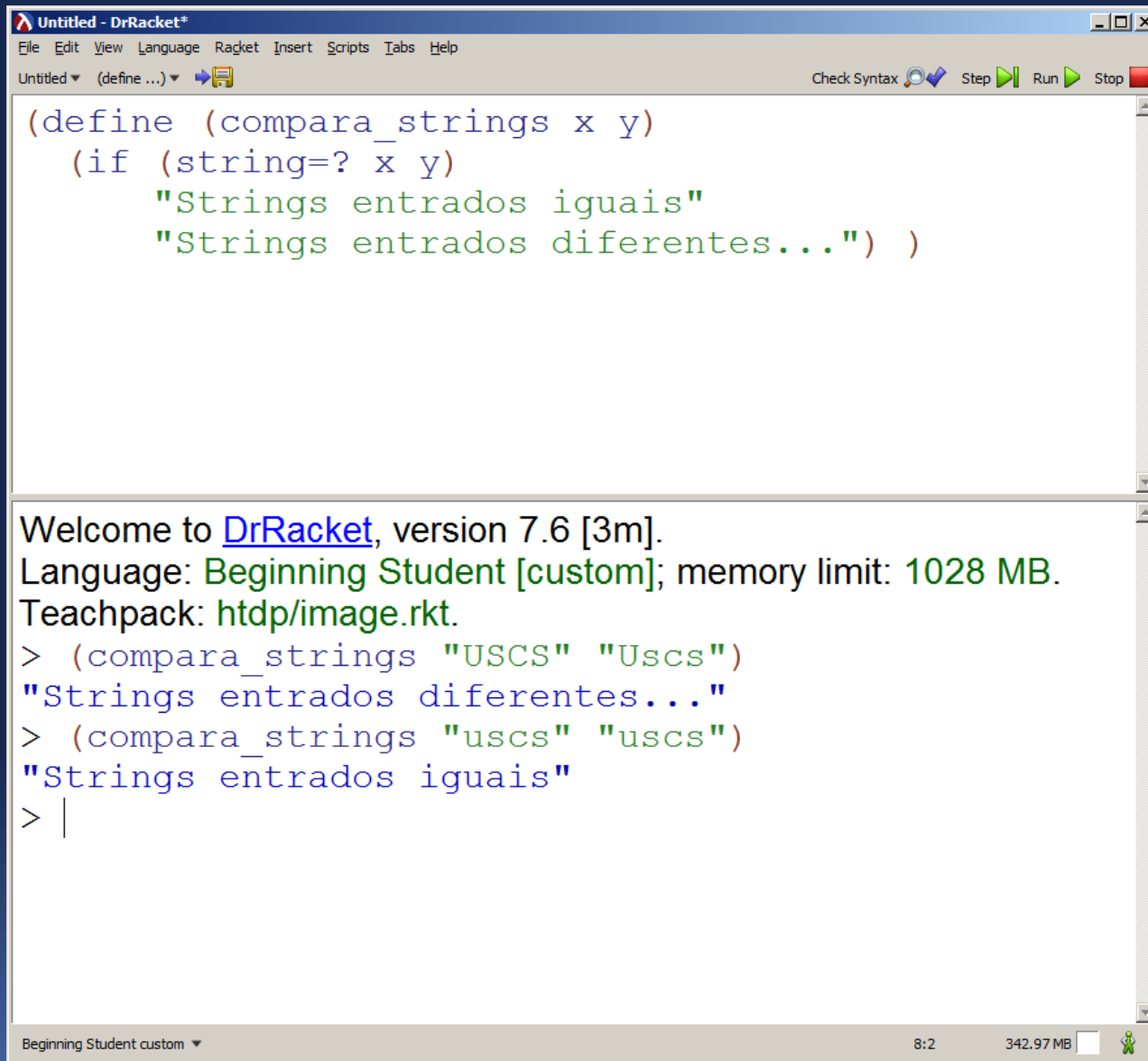
```
(define (compara_numeros x y)
  (if (<= x y)
      (if (= x y)
          "Valores entrados iguais"
          "Primeiro valor menor que o segundo")
      "Primeiro valor maior que o segundo") )
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: [http/image.rkt](http://image.rkt).

```
> (compara_numeros 2 2)
"Valores entrados iguais"
> (compara_numeros 1 2)
"Primeiro valor menor que o segundo"
> (compara_numeros 5 1)
"Primeiro valor maior que o segundo"
>
```

Beginning Student custom 5:10 537.98 MB

Comparando strings



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The main editor area contains the following Racket code:

```
(define (compara_strings x y)
  (if (string=? x y)
      "Strings entrados iguais"
      "Strings entrados diferentes...") )
```

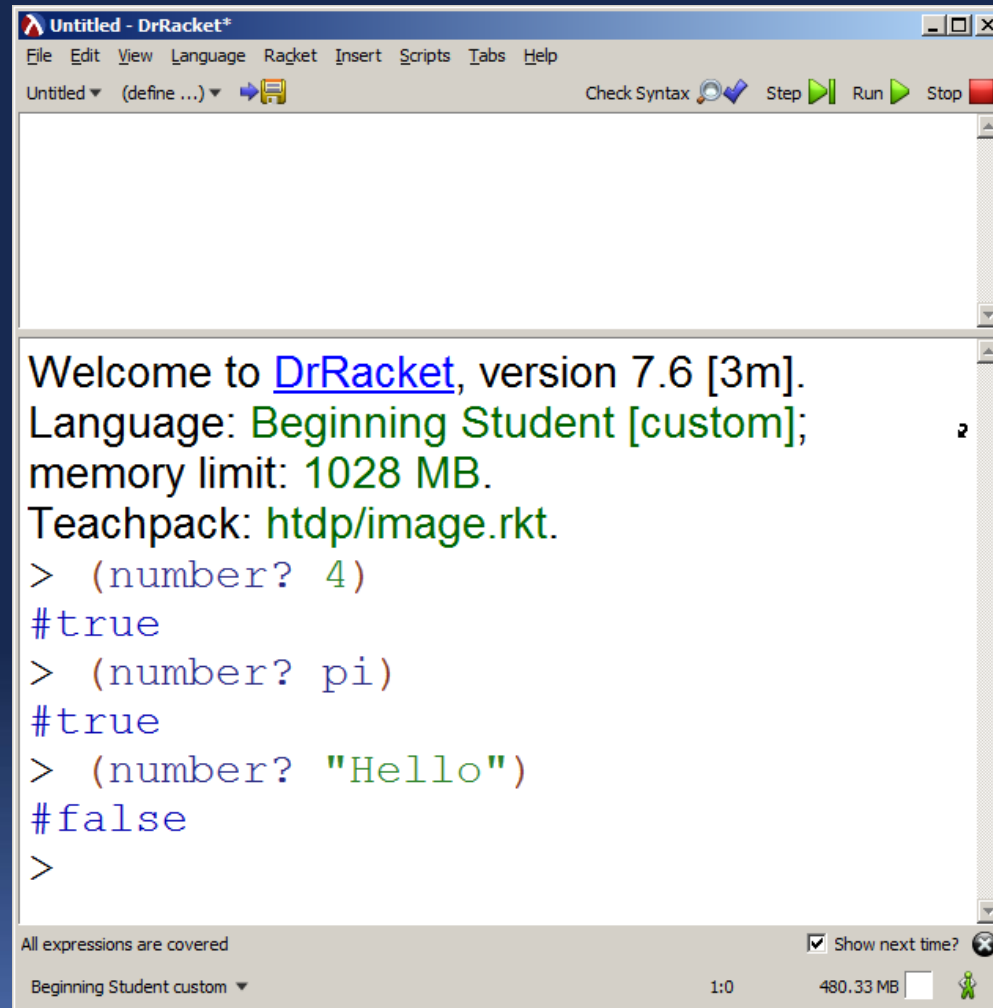
Below the editor, the Welcome message reads: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: **Beginning Student [custom]**; memory limit: 1028 MB. Teachpack: <http://image.rkt>." The interaction area shows the following commands and results:

```
> (compara_strings "USCS" "Uscs")
"Strings entrados diferentes..."
> (compara_strings "uscs" "uscs")
"Strings entrados iguais"
> |
```

The status bar at the bottom indicates "Beginning Student custom", "8:2", and "342.97 MB".

Predicados

- ✓ Um **predicado** é uma função que **consome** um valor e determina se ele **pertence** ou **não** à uma classe de dados. Por exemplo, o predicado **number?** determina se o argumento passado é ou não um número.



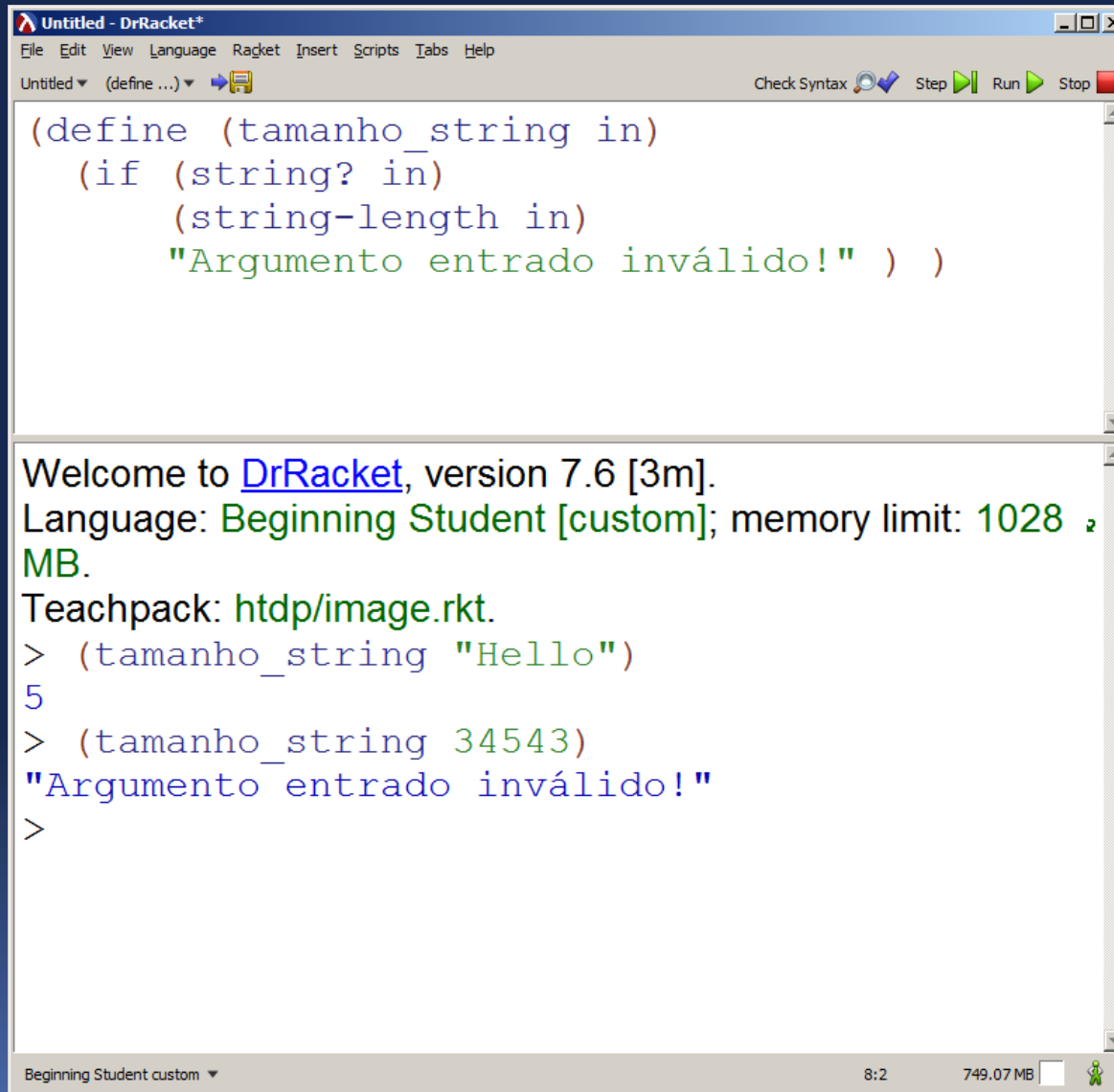
```
Untitled - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
Untitled (define ...) Check Syntax Step Run Stop

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom];
memory limit: 1028 MB.
Teachpack: htdp/image.rkt.
> (number? 4)
#true
> (number? pi)
#true
> (number? "Hello")
#false
>

All expressions are covered
Beginning Student custom 1:0 480.33 MB
```


Predicados

- ✓ O uso de **predicados** auxilia no tratamento de erros em funções.



The screenshot shows the DrRacket IDE interface. The top window, titled "Untitled - DrRacket*", contains a Racket program defining a predicate function `tamanho_string`. The program checks if the input is a string and returns its length or an error message. The bottom window shows the welcome message and the execution results of two test cases.

```
(define (tamanho_string in)
  (if (string? in)
      (string-length in)
      "Argumento entrado inválido!" ) )
```

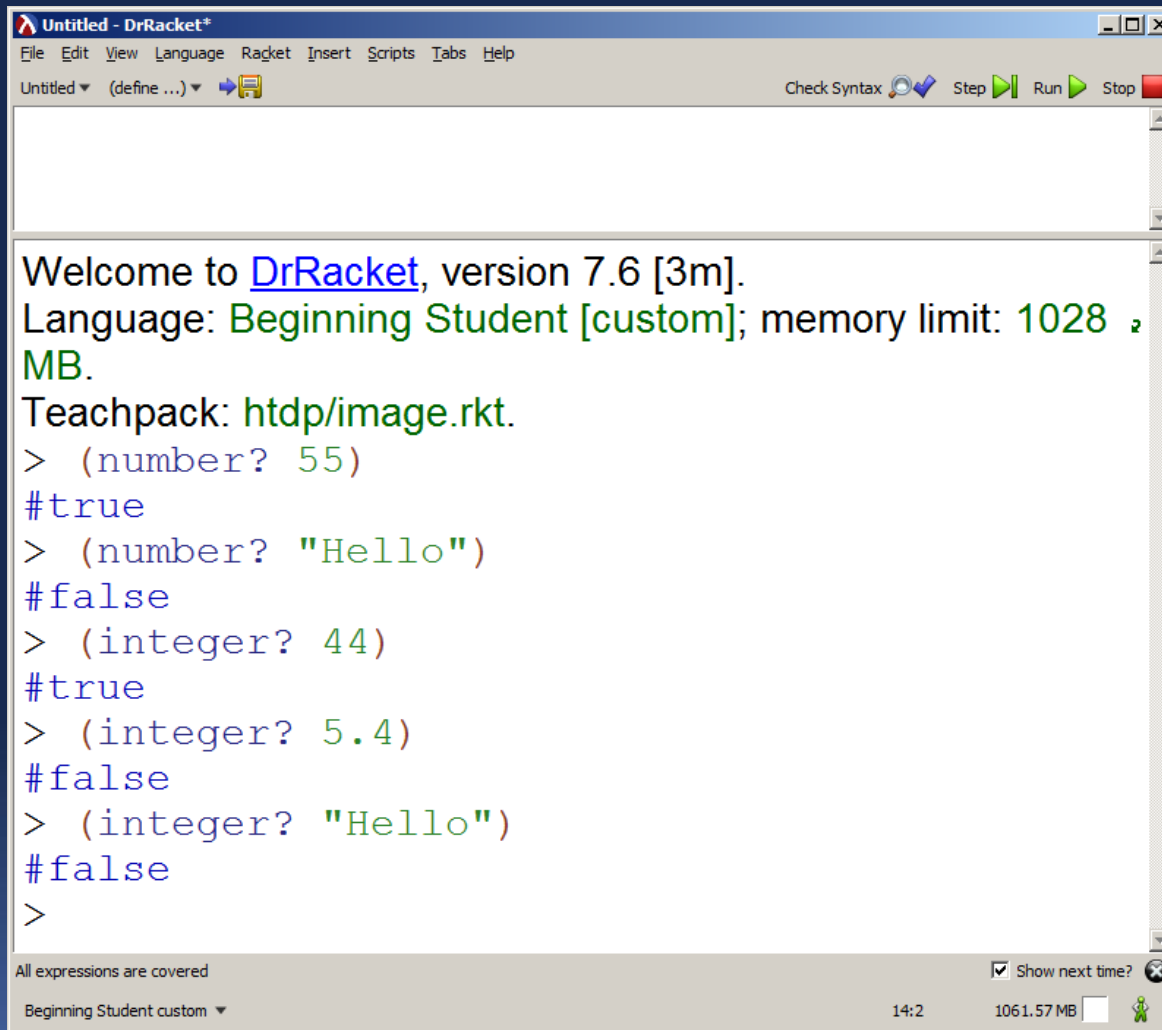
Welcome to [DrRacket](https://dracket.racket-lang.org/), version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.

```
> (tamanho_string "Hello")
5
> (tamanho_string 34543)
"Argumento entrado inválido!"
>
```

Beginning Student custom 8:2 749.07 MB

Predicados

✓ Predicado integer?



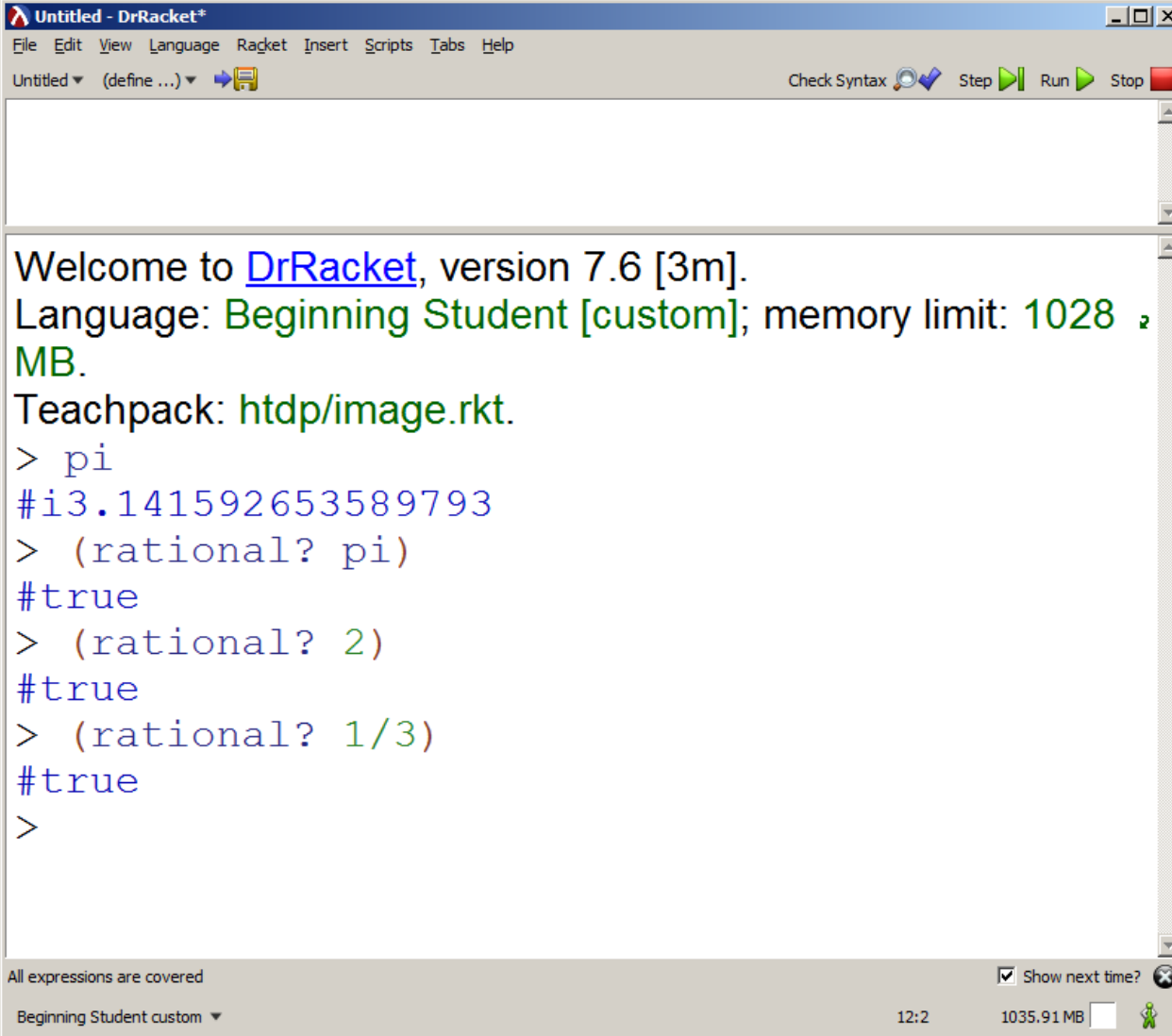
The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The main text area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
> (number? 55)  
#true  
> (number? "Hello")  
#false  
> (integer? 44)  
#true  
> (integer? 5.4)  
#false  
> (integer? "Hello")  
#false  
>
```

At the bottom of the window, there is a status bar with the text "All expressions are covered" and a checkbox for "Show next time?". The language is set to "Beginning Student custom". The time is 14:2 and the memory usage is 1061.57 MB.

Predicados

✓ Predicado **rational?**



Untitled - DrRacket*

File Edit View Language Racket Insert Scripts Tabs Help

Untitled (define ...) Check Syntax Step Run Stop

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student [custom]**; memory limit: 1028 MB.
Teachpack: **htdp/image.rkt**.

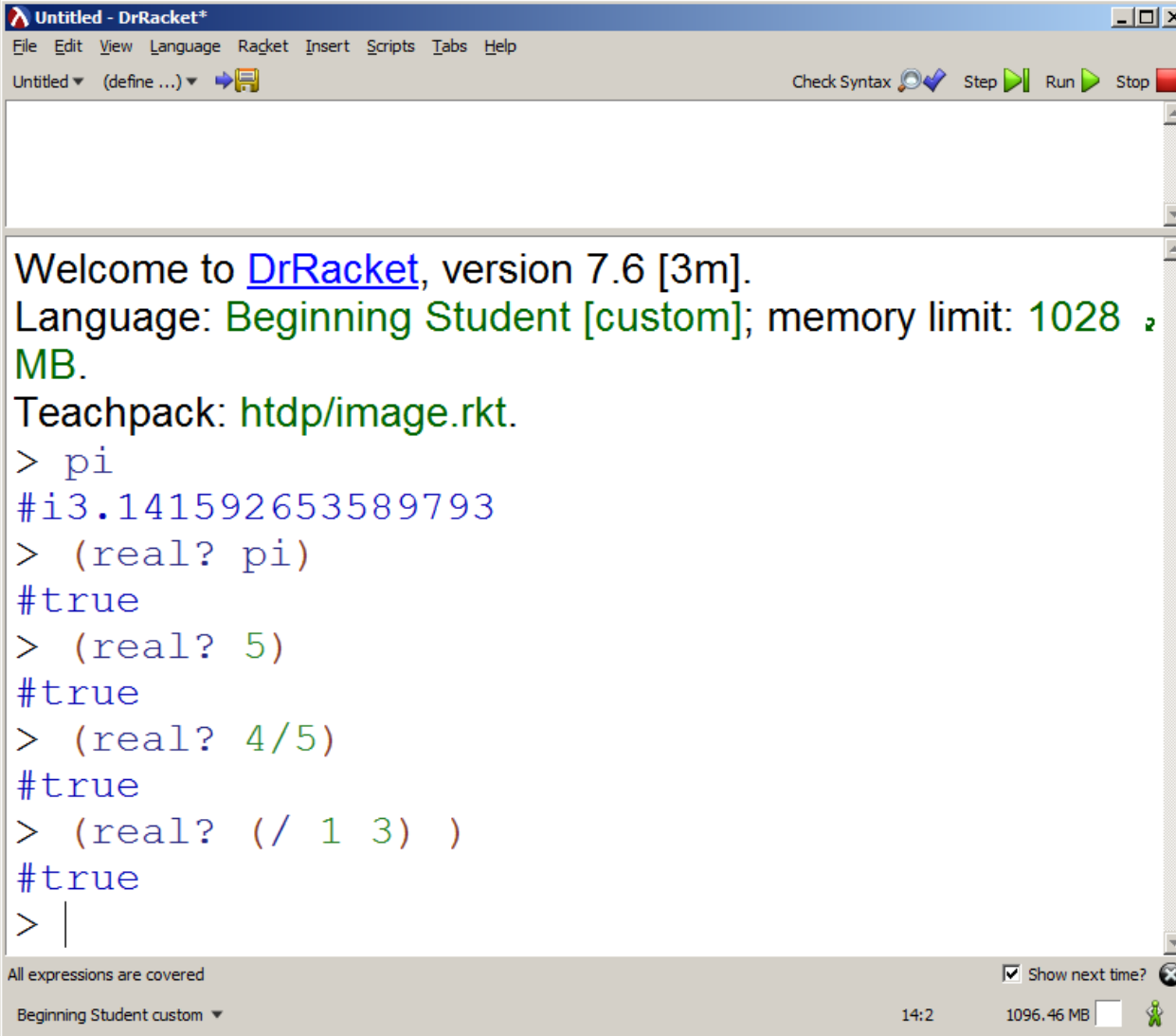
```
> pi
#i3.141592653589793
> (rational? pi)
#true
> (rational? 2)
#true
> (rational? 1/3)
#true
>
```

All expressions are covered ☒ Show next time?

Beginning Student custom 12:2 1035.91 MB

Predicados

✓ Predicado real?



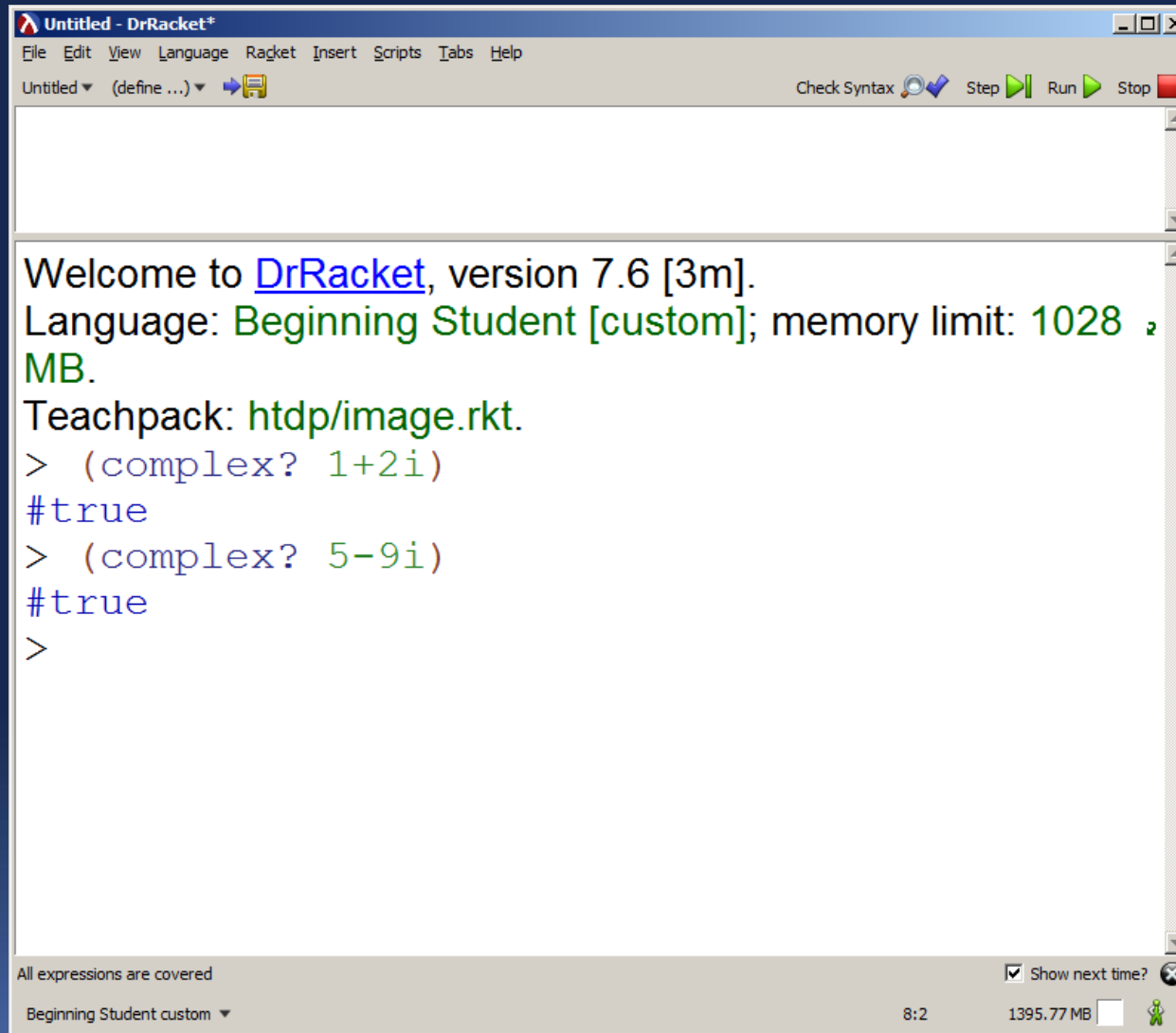
The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The main text area displays the following Racket code and output:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> pi  
#i3.141592653589793  
> (real? pi)  
#true  
> (real? 5)  
#true  
> (real? 4/5)  
#true  
> (real? (/ 1 3))  
#true  
> |
```

At the bottom of the window, the status bar shows "All expressions are covered", "Beginning Student custom", a time of 14:2, and a memory usage of 1096.46 MB.

Predicados

✓ Predicado complex?



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The main text area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> (complex? 1+2i)  
#true  
> (complex? 5-9i)  
#true  
>
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", "8:2", "1395.77 MB", and a "Show next time?" checkbox.

Funções e Programas em Racket

- ✓ No Paradigma **Funcional** de Programação **funções** são **programas**;
- ✓ Como funções, **programas** consomem **entradas** e produzem **saídas**;
- ✓ Programas trabalham com diferentes tipos de dados;
- ✓ Programas em Racket consistem de diversas definições, geralmente seguidas por uma expressão que envolve essas definições. Existem 2 tipos de definições:

➡ ❖ Definições de Constantes

➡ ❖ Definições de Funções

Definição de Constantes

- ✓ Variáveis **NÃO** são dados; elas representam dados;
- ✓ Por exemplo:

→ (define x 3)

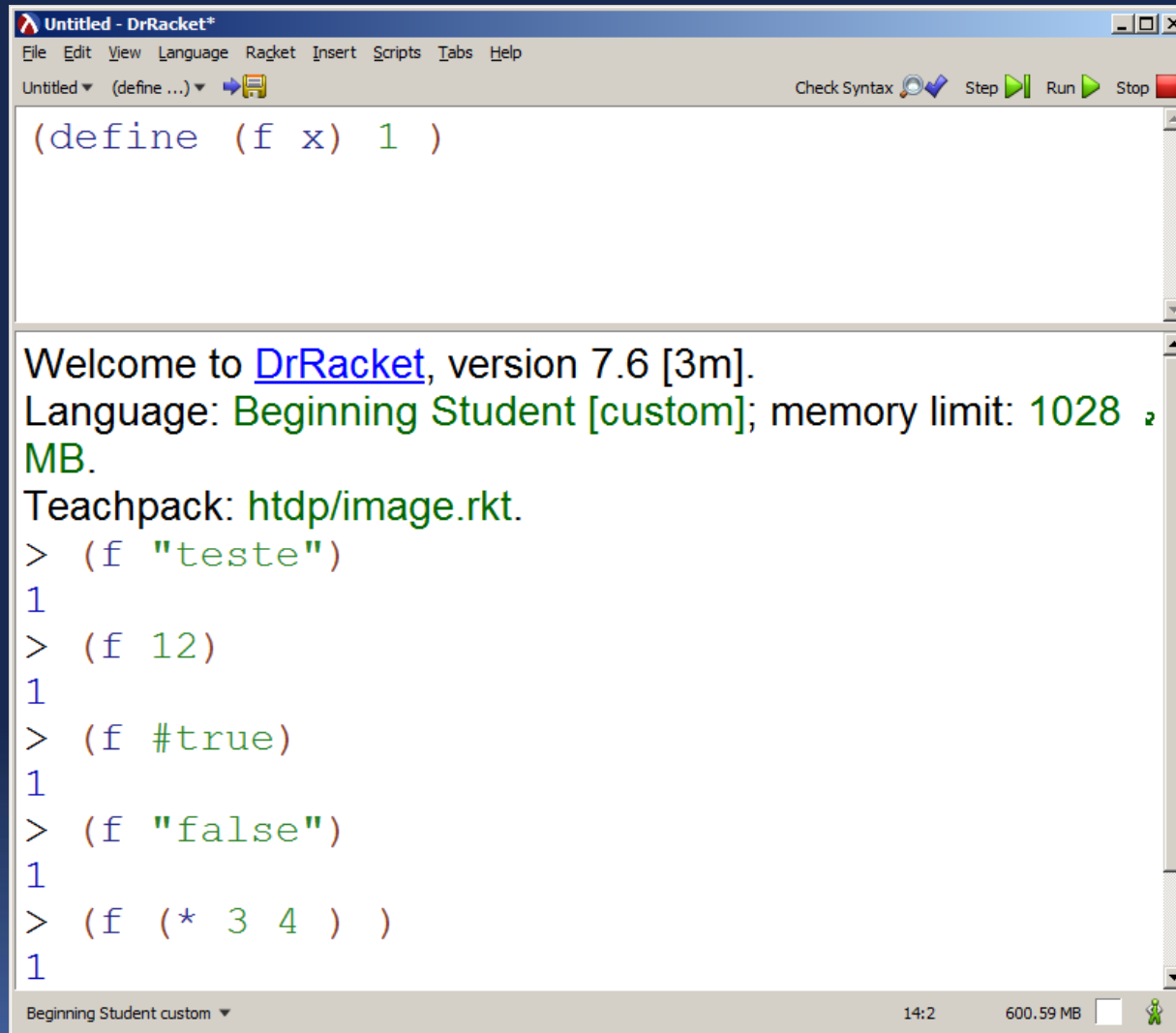
- ✓ Essa definição diz que x sempre estará associado ao valor numérico 3;

Definição de Funções

✓ Para se **definir** uma **função**, escrevemos:

- ❖ "(define ("
- ❖ O **nome** da Função
- ❖ Seguido por diversas **variáveis**, separadas por **espaço** e terminadas com ")".
- ❖ E uma expressão seguida por ")".

Exemplos de Definição de Funções



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The editor window is titled "Untitled - DrRacket*" and contains the following Racket code:

```
(define (f x) 1 )
```

Below the editor, the Welcome message and execution results are displayed:

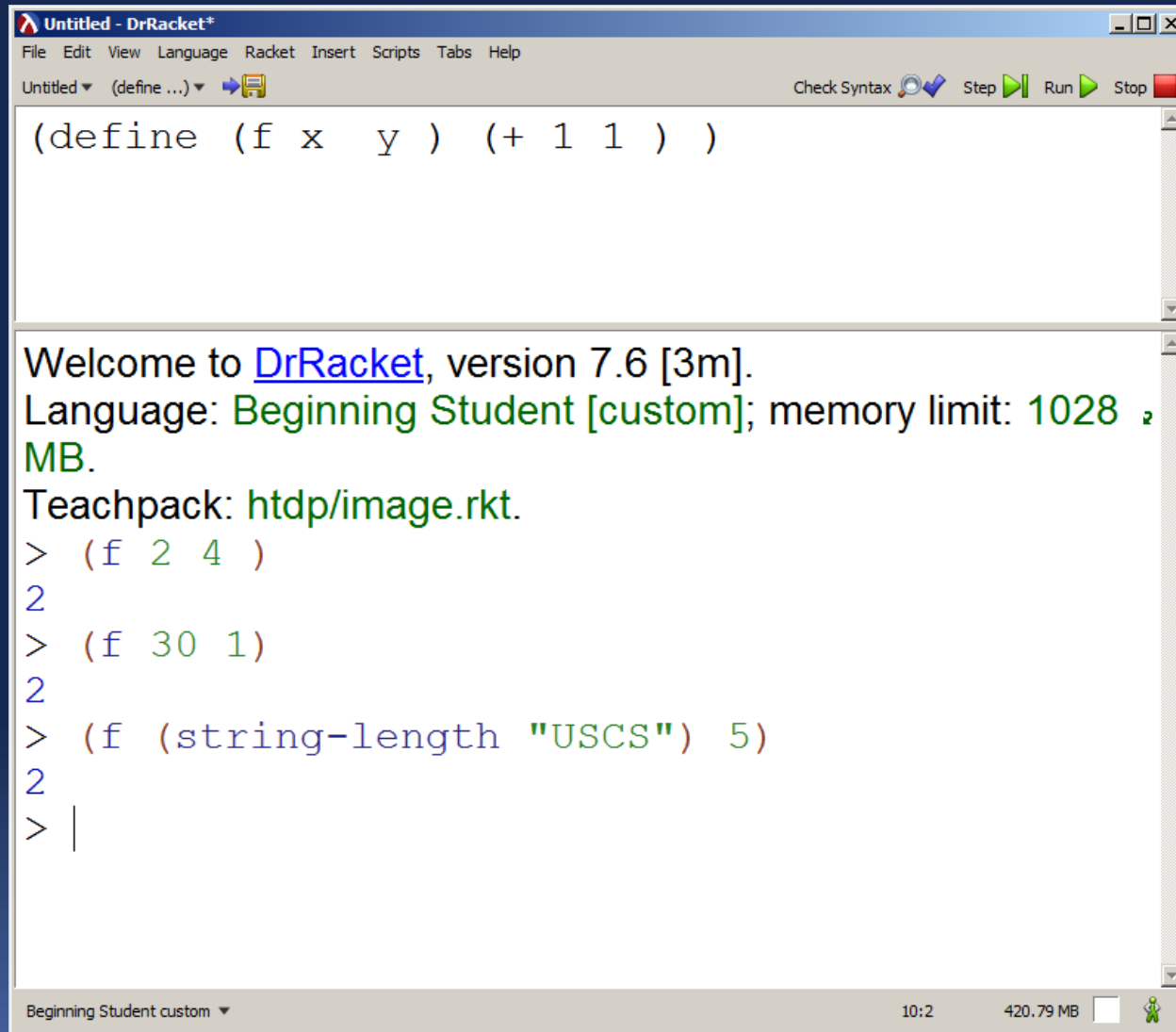
Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](#).

Execution results:

```
> (f "teste")  
1  
> (f 12)  
1  
> (f #true)  
1  
> (f "false")  
1  
> (f (* 3 4) )  
1
```

The status bar at the bottom shows "Beginning Student custom", the time "14:2", and the memory usage "600.59 MB".

Exemplos de Definição de Funções



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The editor area contains the following Racket code:

```
(define (f x y) (+ 1 1) )
```

The output area displays the following text:

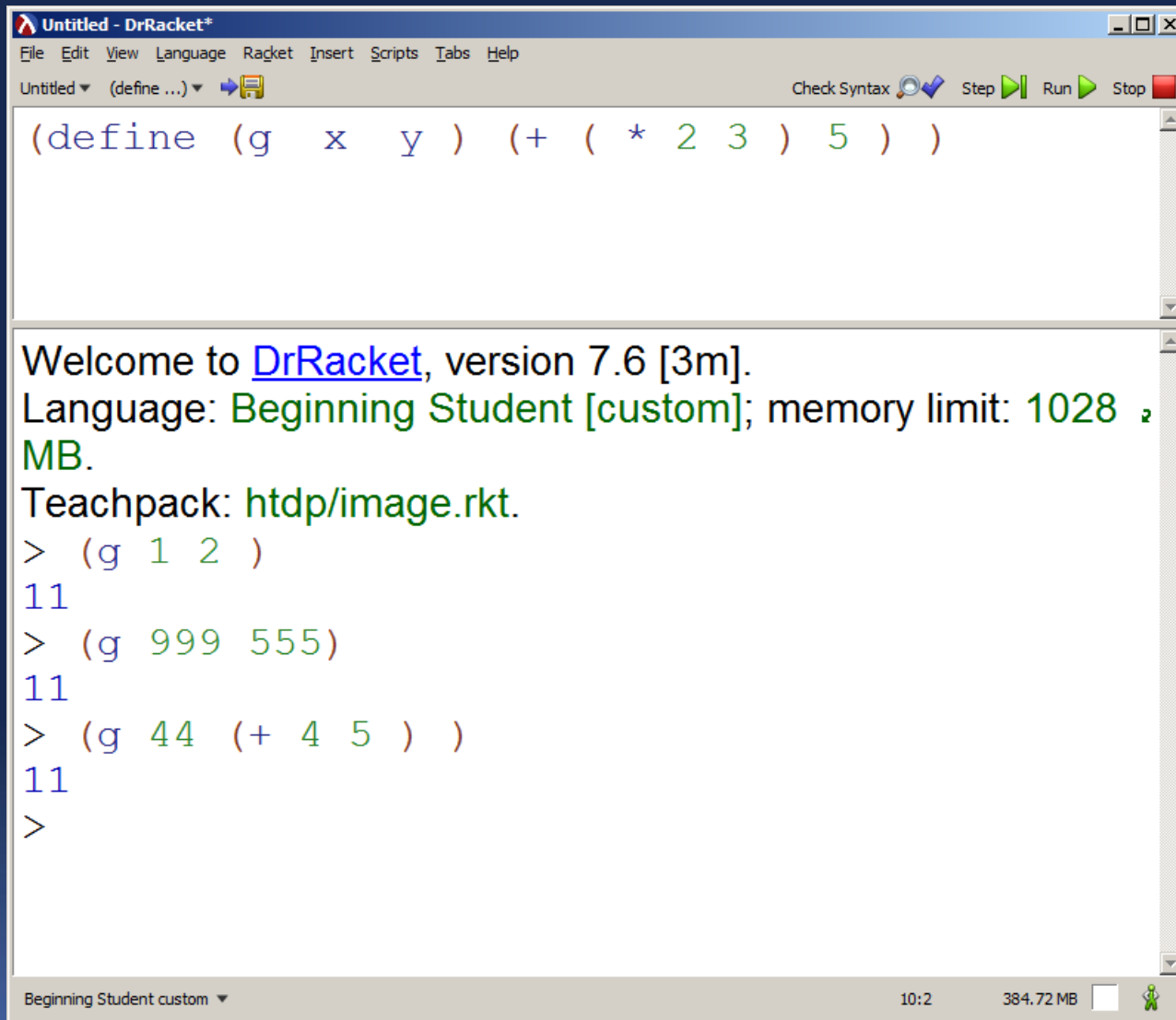
Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http://image.rkt](#).

The interactive prompt shows the following sequence of inputs and outputs:

```
> (f 2 4 )  
2  
> (f 30 1)  
2  
> (f (string-length "USCS") 5)  
2  
> |
```

The status bar at the bottom indicates the language is "Beginning Student custom", the time is 10:2, and the memory usage is 420.79 MB.

Exemplos de Definição de Funções



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. Below the menu bar is a toolbar with buttons for 'Check Syntax', 'Step', 'Run', and 'Stop'. The main text area contains the following Racket code:

```
(define (g x y) (+ ( * 2 3 ) 5 ) )
```

Below the code area, the output window displays the following text:

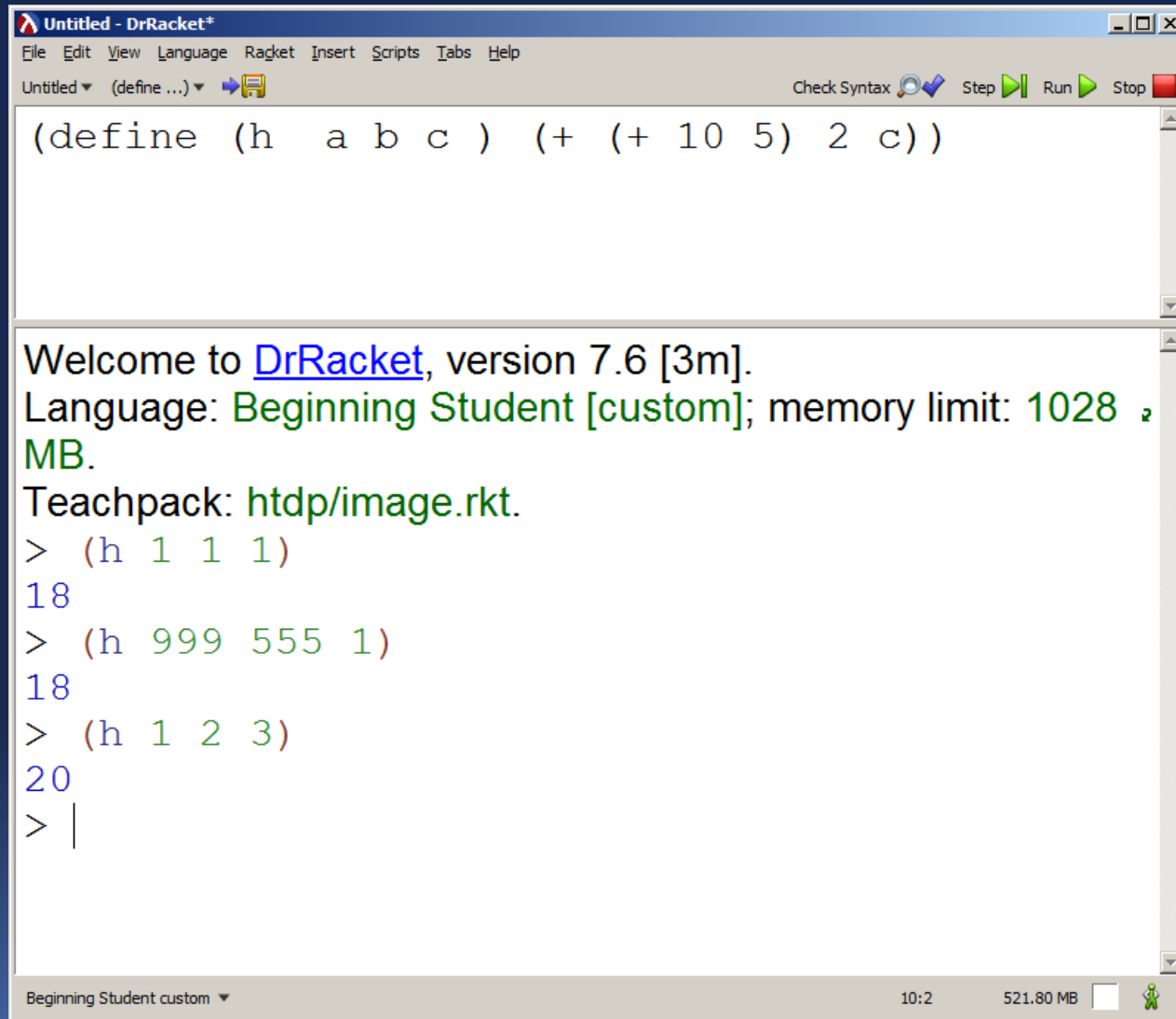
Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](#).

The output window also shows the results of three function calls:

```
> (g 1 2 )  
11  
> (g 999 555)  
11  
> (g 44 (+ 4 5 ) )  
11  
>
```

The status bar at the bottom of the window shows 'Beginning Student custom', '10:2', and '384.72 MB'.

Exemplos de Definição de Funções



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The editor area contains the following Racket code:

```
(define (h a b c) (+ (+ 10 5) 2 c))
```

The output area displays the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [htdp/image.rkt](#).

The interactive prompt shows the following sequence of inputs and outputs:

```
> (h 1 1 1)
18
> (h 999 555 1)
18
> (h 1 2 3)
20
> |
```

The status bar at the bottom indicates the language is "Beginning Student custom", the time is 10:2, and the memory usage is 521.80 MB.

Funções – Observações

- ✓ Uma **definição** de uma **nova função** introduz no ambiente uma **nova operação** nos dados;
- ✓ Como uma **função primitiva**, uma **nova** função **consome** entradas;
- ✓ O **número** de variáveis definidas na função determina quantas **entradas** (**argumentos** ou **parâmetros**) a função **consome**;
- ✓ Se **f** é uma função de **um-argumento**, dizemos que ela é **unária**;
- ✓ Em contraste, uma função com definida com **2 argumentos**, é **binária**, e assim, por diante;
- ✓ A expressão definida na função determina o seu **corpo** (**body**)

Funções – Observações

- ✓ O **corpo** da função **pode** não envolver variáveis. Nesse caso, a função **sempre retorna o mesmo valor**, resultado da avaliação.



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket code:

```
(define (func x) "Hello World...." )
```

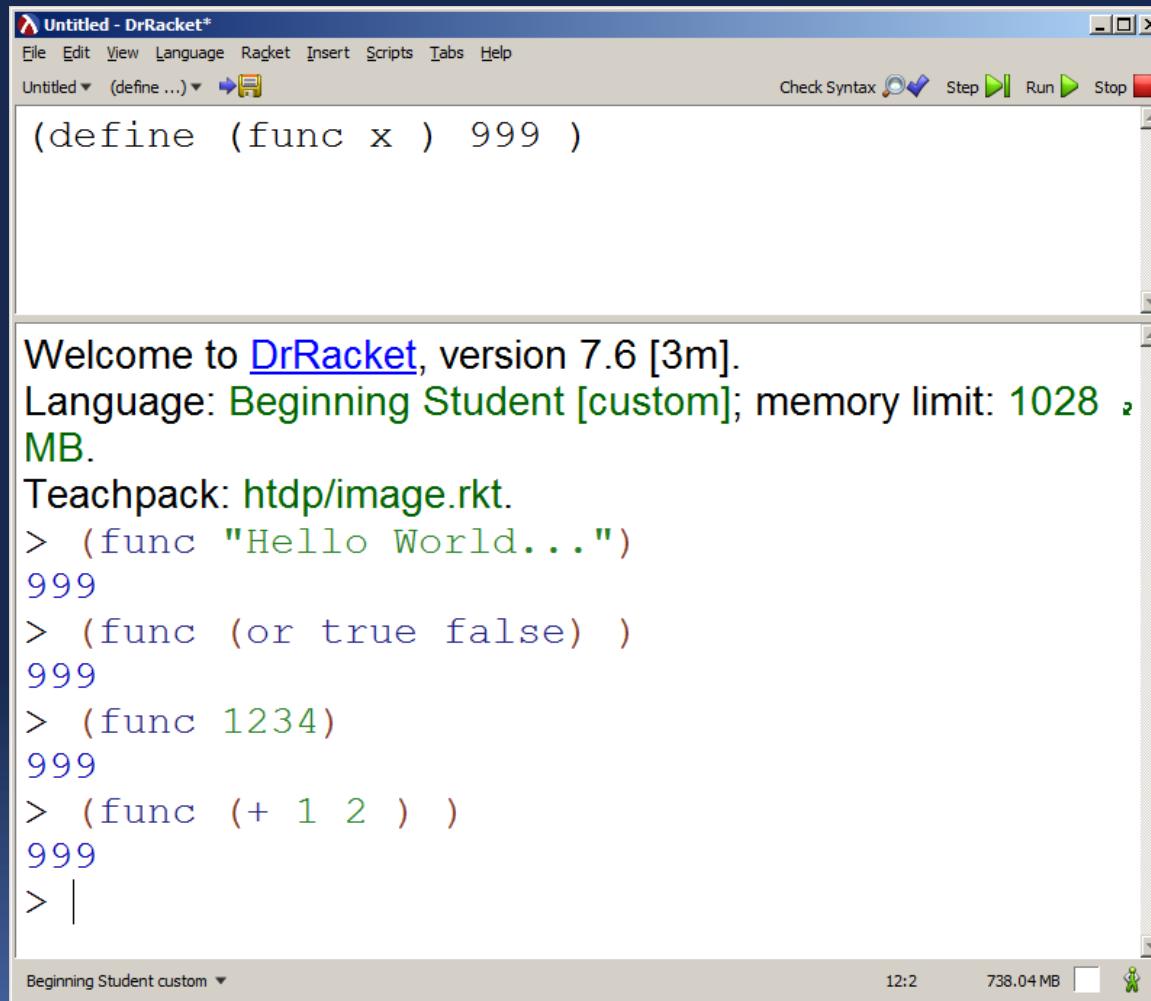
Below the code, the output area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> (func 3)  
"Hello World...."  
> (func 10)  
"Hello World...."  
> (func "USCS")  
"Hello World...."  
>
```

The status bar at the bottom shows "Beginning Student custom", "10:2", and "423.73 MB".

Funções – Observações

- ✓ O **corpo** da função **pode** não envolver variáveis. Nesse caso, a função **sempre retorna o mesmo valor**, resultado da avaliação.



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar has buttons for Check Syntax, Step, Run, and Stop. The editor area contains the following code:

```
(define (func x ) 999 )
```

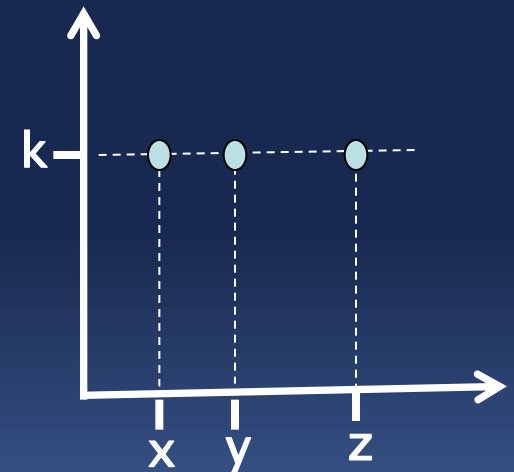
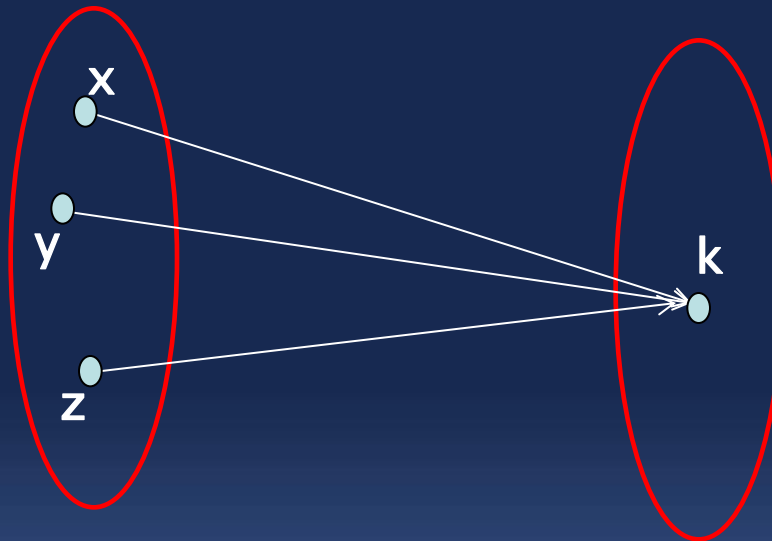
Below the editor, the Welcome message is displayed: "Welcome to [DrRacket](#), version 7.6 [3m]. Language: **Beginning Student [custom]**; memory limit: 1028 MB. Teachpack: [http/image.rkt](#)." The interaction log shows the following commands and results:

```
> (func "Hello World...")
999
> (func (or true false) )
999
> (func 1234)
999
> (func (+ 1 2 ) )
999
> |
```

The status bar at the bottom indicates "Beginning Student custom", the time "12:2", and the memory usage "738.04 MB".

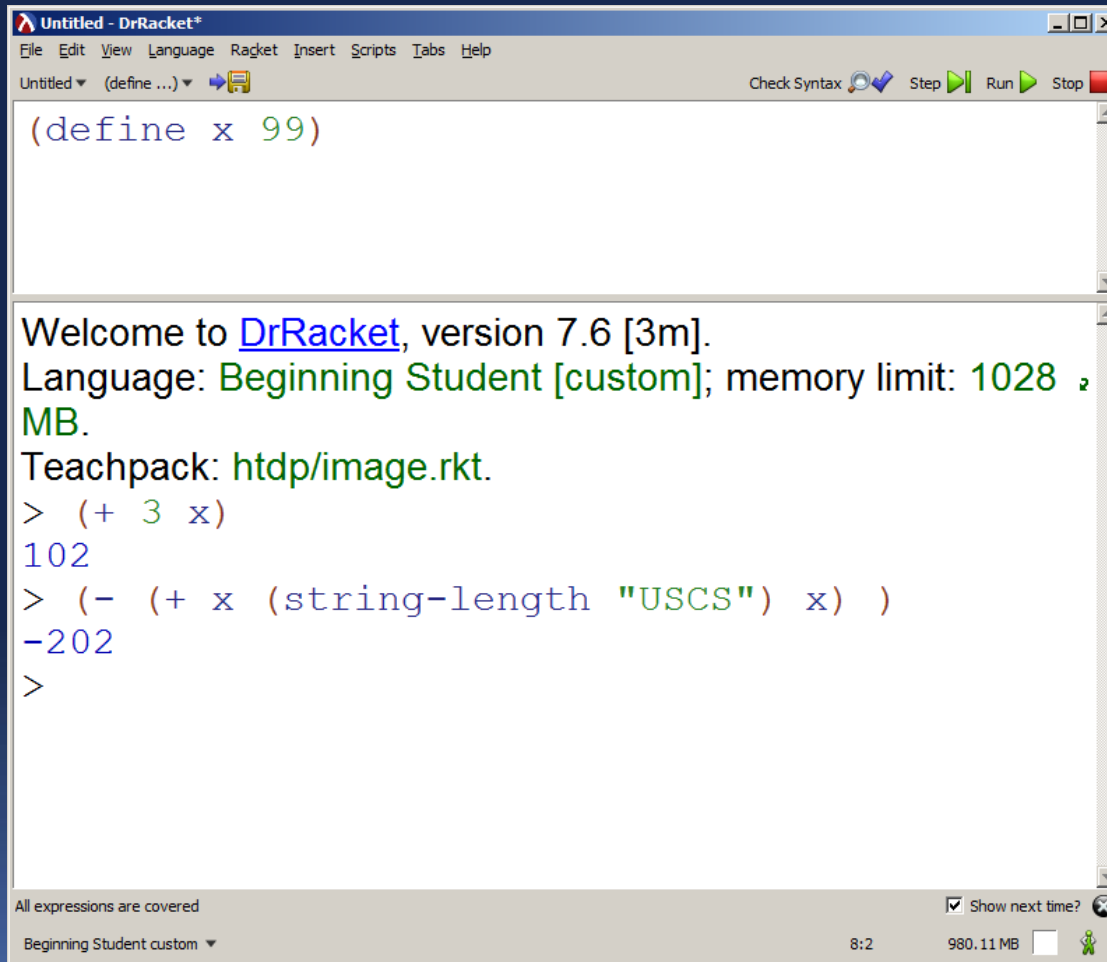
Funções – Observações

- ✓ Variáveis **não** são dados;
- ✓ **Variáveis** apenas **representam entradas** (inputs) ;
- ✓ Quando as variáveis **não** são mencionadas no corpo da função (expressão) significa que a saída da função é **independente** das entradas e, portanto a função sempre retornará, nesse caso, o **mesmo valor** (**constante**).



Define para definir constantes

- ✓ **define** pode ser usado para definir **constantes**;
- ✓ Por exemplo: **(define x 99)** diz que **x** representa o valor constante **99**;



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The editor area contains the code `(define x 99)`. The output area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> (+ 3 x)  
102  
> (- (+ x (string-length "USCS") x) )  
-202  
>
```

At the bottom of the window, there is a status bar with the text "All expressions are covered", a dropdown menu showing "Beginning Student custom", a checkbox for "Show next time?", the time "8:2", the memory usage "980.11 MB", and a small green icon.

Funções – Observações

- ✓ As variáveis na definição da função (header) são peças de dados **desconhecidas** (as entradas da função) ;
- ✓ Mencionar variáveis no corpo da função é a forma pela qual usamos essas peças de dados no instante de aplicação da função;
- ✓ No instante de aplicação da função, os valores dessas peças de dados (variáveis) são conhecidas
- ✓ Ou seja, em tempo de definição da função os valores das variáveis (inputs) não são conhecidos;
- ✓ Por exemplo, se definimos:

```
(define (ff a)  
  (* 10 a))
```

- ✓ Estamos dizendo no corpo da função que a saída da função é 10 vezes a sua entrada.

Aplicação de uma função

- ✓ Uma aplicação de uma função a coloca para trabalhar;
- ✓ A forma como se define a aplicação é semelhante à definição da função:

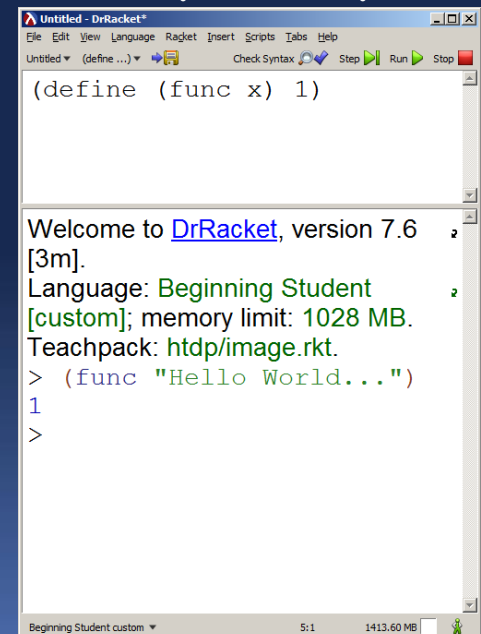
❖ "("

❖ seguido do nome da função f

❖ seguido de tantos **argumentos** quantos f **consome**, separados por espaços

❖ e finalmente, um ")"

- ✓ Exemplo:
 - > (define (func x) 1) => definição da função
 - > (f "Hello World") => aplicação da função

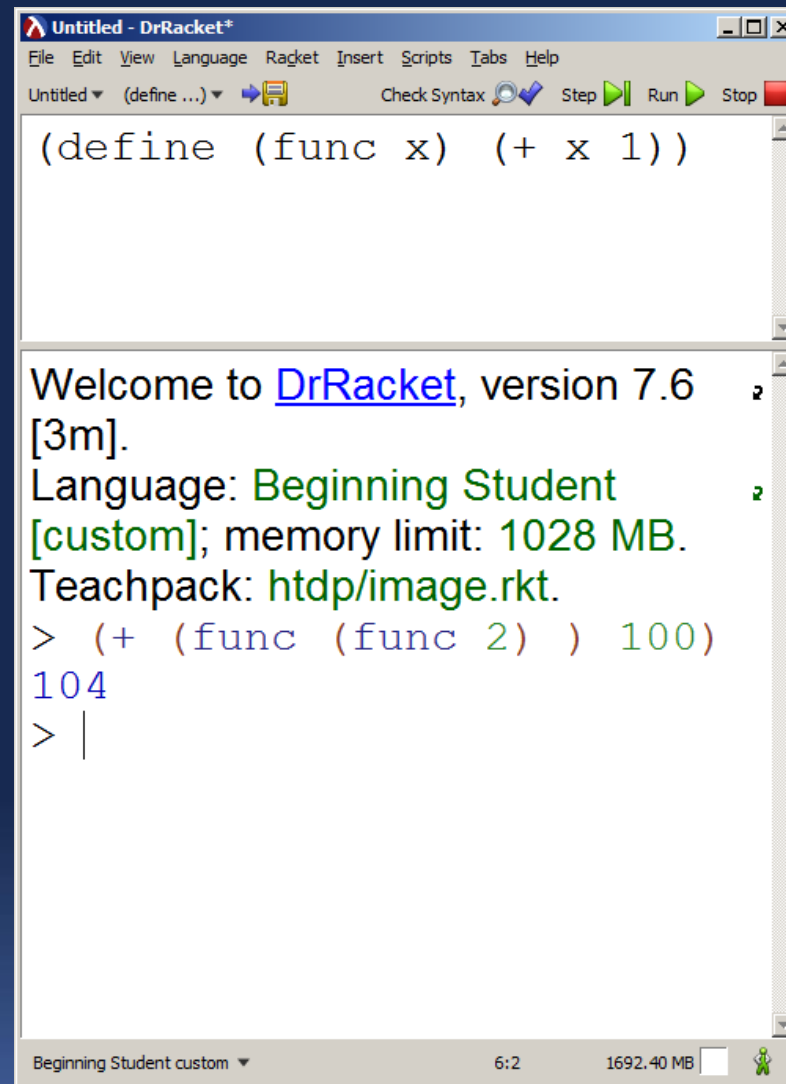


```
(define (func x) 1)
```

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.

```
> (func "Hello World...")  
1  
>
```

Aplicações nested



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows buttons for (define ...), Check Syntax, Step, Run, and Stop. The editor contains the following Racket code:

```
(define (func x) (+ x 1))
```

The output window displays the following text:

```
Welcome to DrRacket, version 7.6  
[3m].  
Language: Beginning Student  
[custom]; memory limit: 1028 MB.  
Teachpack: htdp/image.rkt.  
> (+ (func (func 2) ) 100)  
104  
> |
```

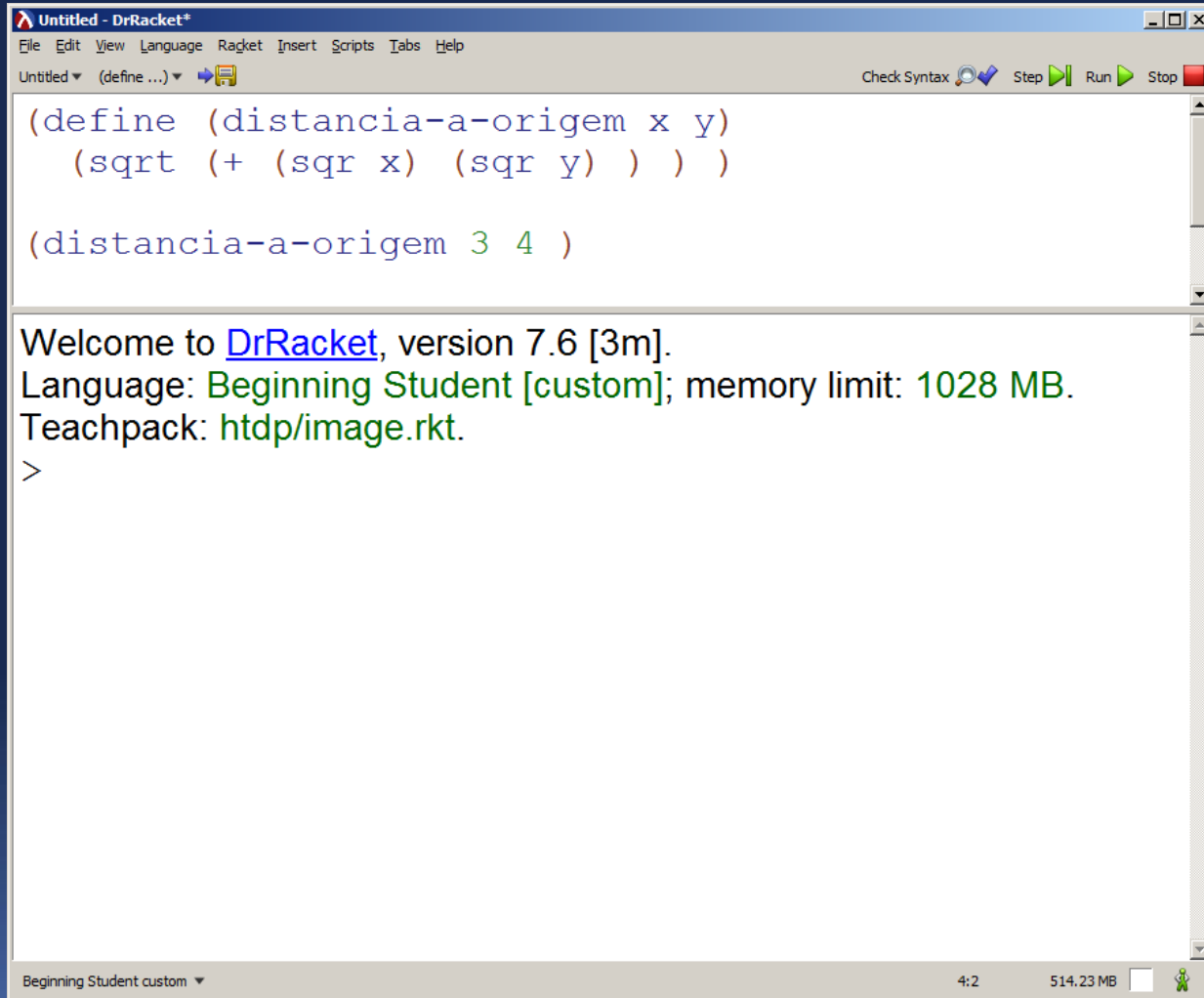
The status bar at the bottom shows "Beginning Student custom", "6:2", and "1692.40 MB".

Computações

- ✓ **Definição** de função e **aplicação** de função caminham juntas;
- ✓ A aplicação de uma função envolve **3 etapas**:
 1. Racket determina os **valores** das **expressões** dos **argumentos**;
 2. Racket **checa** se o **número** de **argumentos** **coincide** com o **número** de **parâmetros** na definição da função;
 3. Se **sim**, Racket **computa** o valor no corpo da função (avaliação da expressão), com todos os parâmetros **substituídos** pelos correspondentes valores dos argumentos.

Exercício 1

Qual o resultado ?



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains buttons for Check Syntax, Step, Run, and Stop. The editor window displays the following Racket code:

```
(define (distancia-a-origem x y)
  (sqrt (+ (sqr x) (sqr y) ) ) )

(distancia-a-origem 3 4 )
```

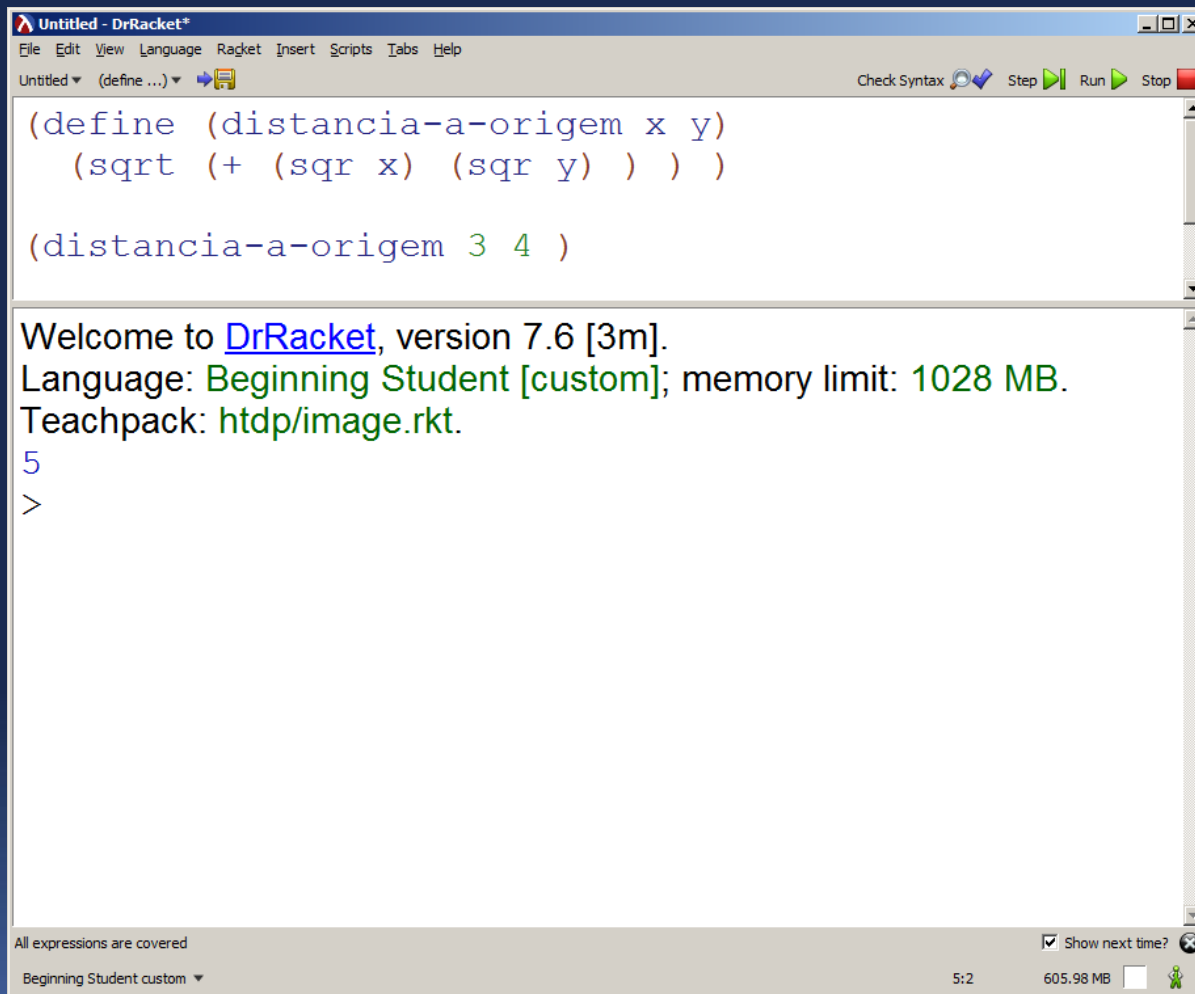
The output window below the editor shows the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: 1028 MB.
Teachpack: [http/image.rkt](http://image.rkt).
>

The status bar at the bottom indicates the language is "Beginning Student custom", the zoom level is "4:2", and the memory usage is "514.23 MB".

Exercício 1

Resposta:



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket code:

```
(define (distancia-a-origem x y)
  (sqrt (+ (sqr x) (sqr y) ) ) )

(distancia-a-origem 3 4 )
```

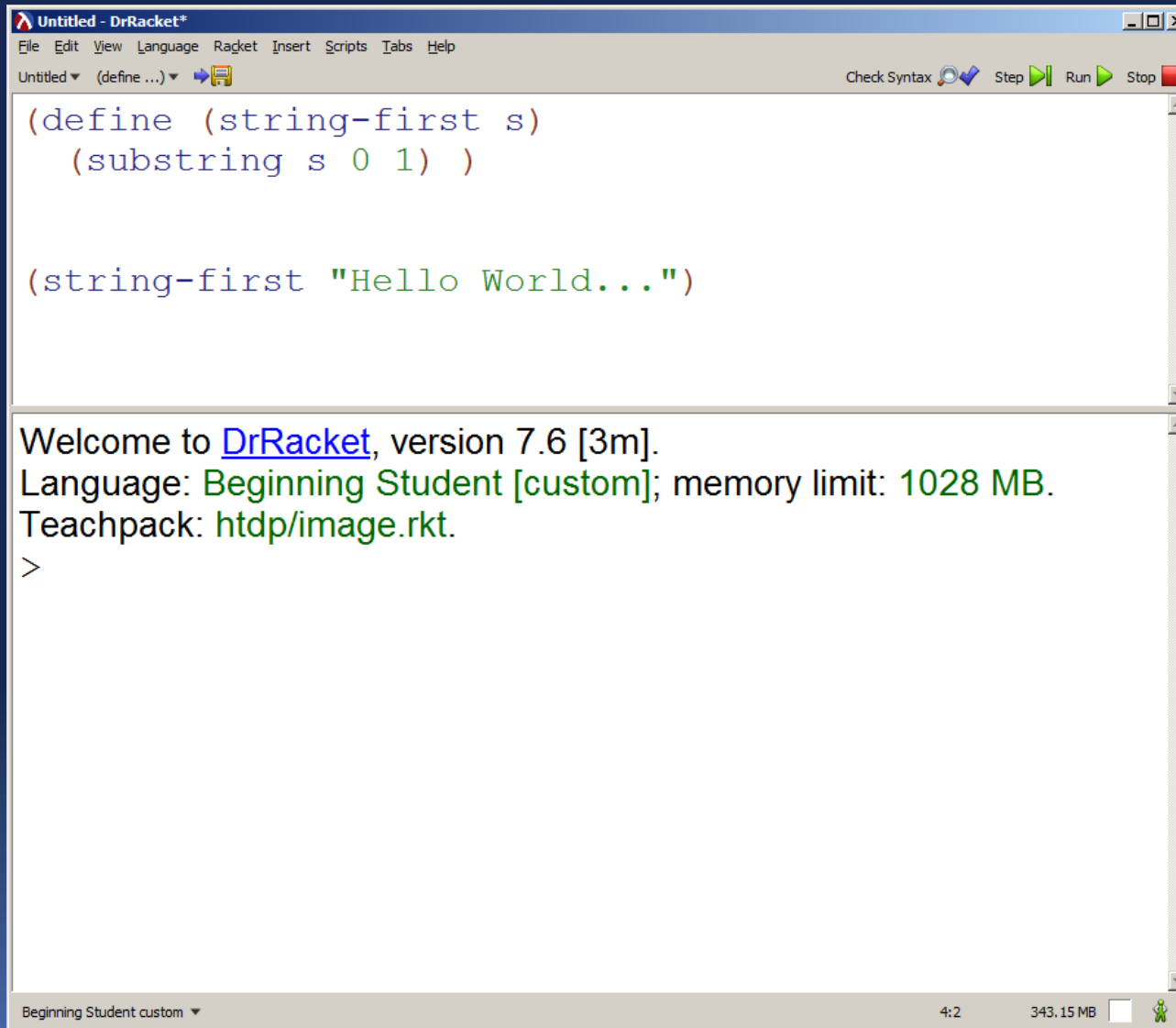
Below the code, the output area displays the following text:

Welcome to [DrRacket](#), version 7.6 [3m].
Language: **Beginning Student** [custom]; memory limit: **1028 MB**.
Teachpack: [htdp/image.rkt](#).
5
>

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", "5:2", and "605.98 MB".

Exercício 2

Qual o resultado ?



The screenshot shows the DrRacket IDE interface. The title bar reads "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows "Check Syntax", "Step", "Run", and "Stop" buttons. The editor window contains the following Racket code:

```
(define (string-first s)
  (substring s 0 1) )

(string-first "Hello World...")
```

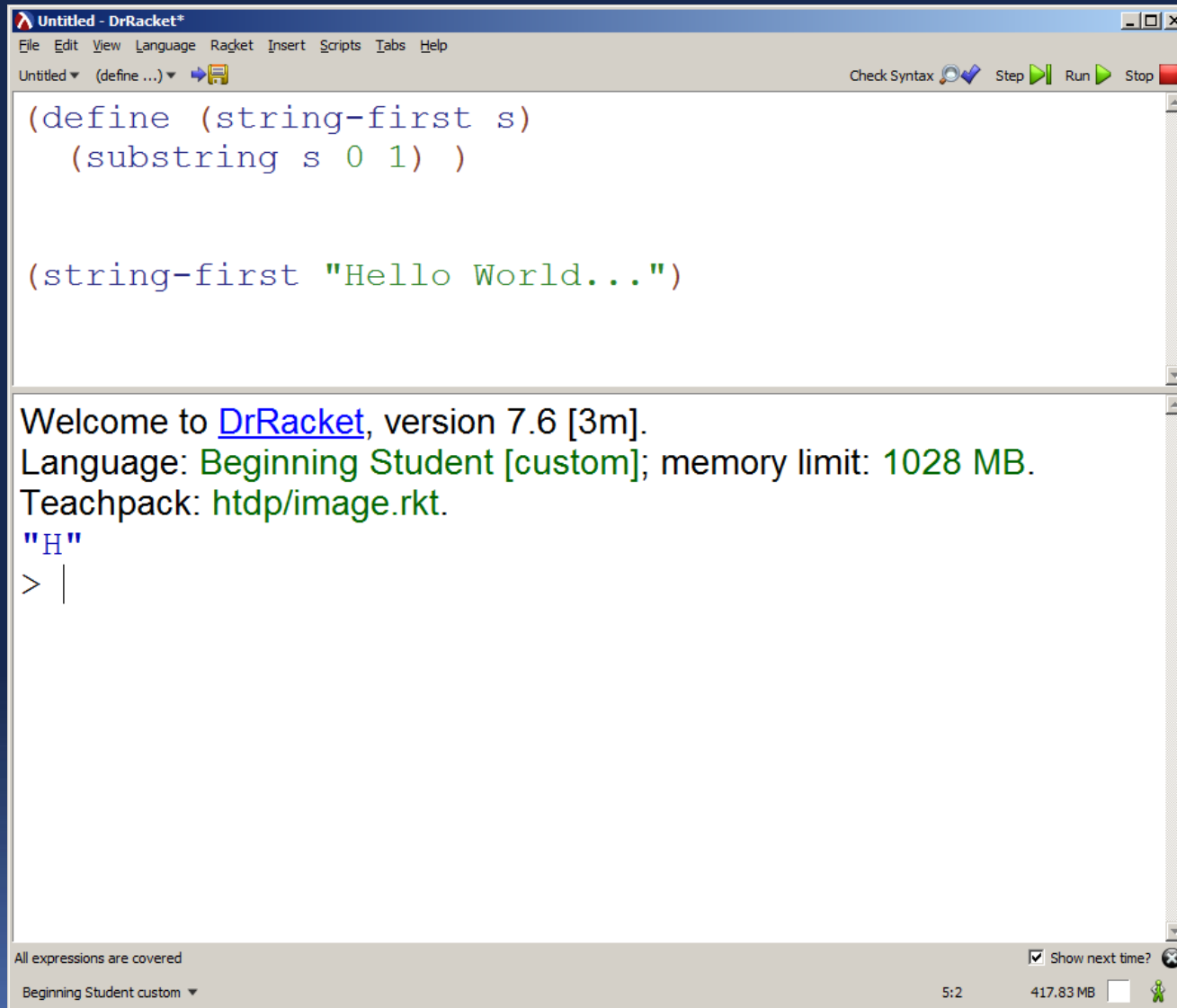
The output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http://image.rkt.
>
```

The status bar at the bottom indicates "Beginning Student custom", "4:2", and "343.15 MB".

Exercício 2

Resposta:



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket+". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar shows icons for opening a file, saving, and running. The code editor contains the following Racket code:

```
(define (string-first s)
  (substring s 0 1) )

(string-first "Hello World...")
```

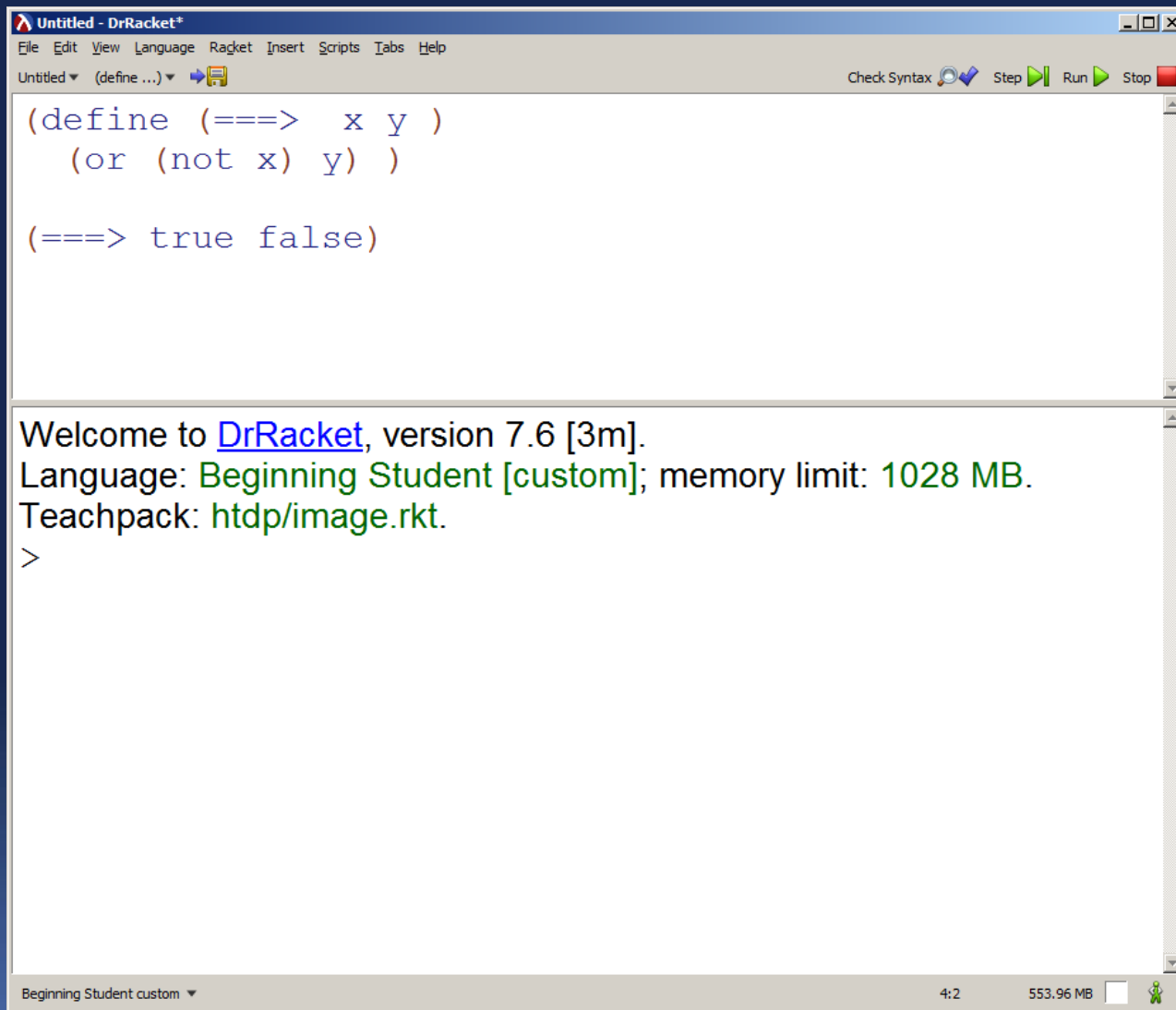
The output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http/image.rkt.
"H"
> |
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "5:2 417.83 MB".

Exercício 3

Qual o resultado?



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The code editor contains the following Racket code:

```
(define (==> x y)
  (or (not x) y) )

(==> true false)
```

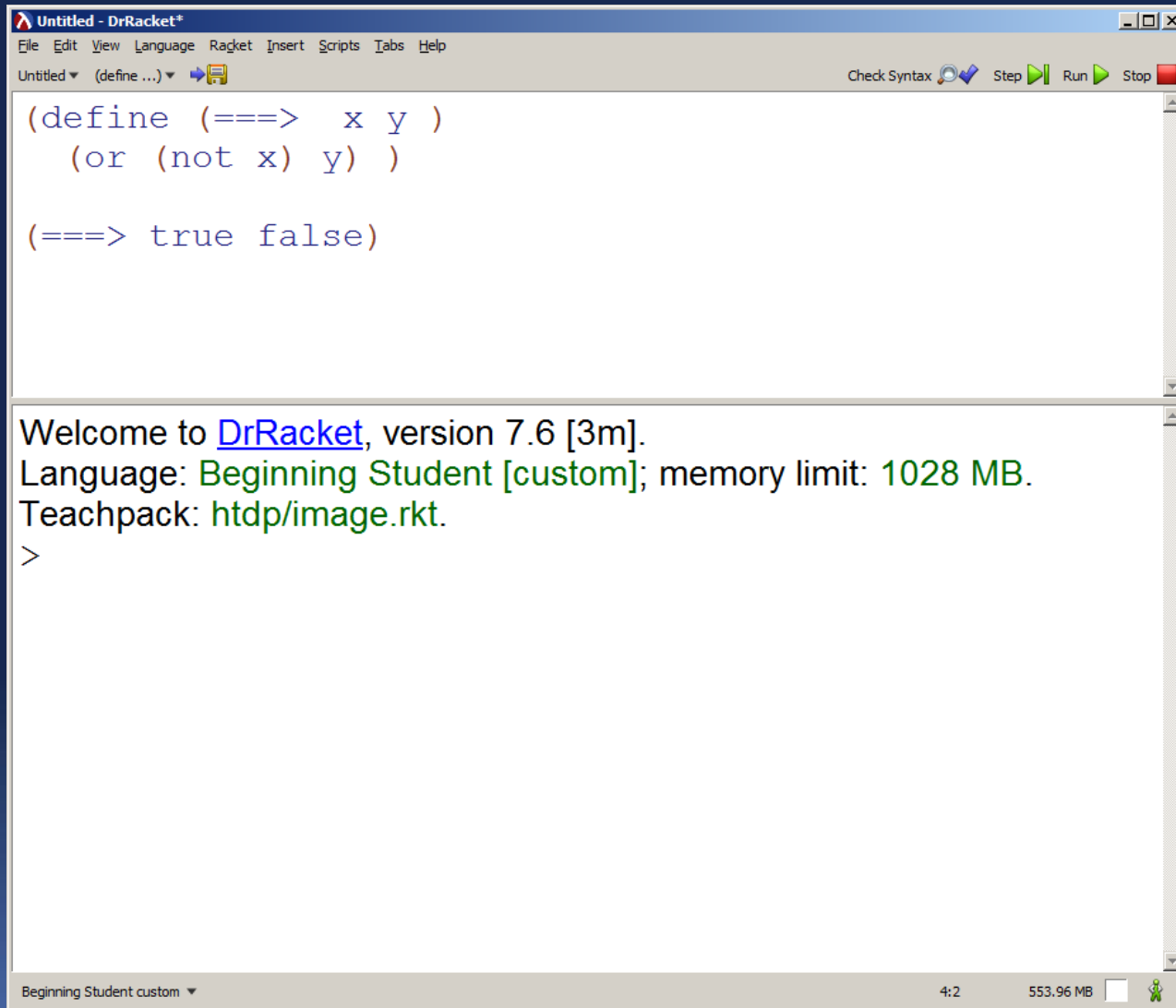
The output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http/image.rkt.
>
```

The status bar at the bottom shows "Beginning Student custom", "4:2", and "553.96 MB".

Exercício 3

Qual o resultado?



The screenshot shows the DrRacket IDE window titled "Untitled - DrRacket*". The menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The code editor contains the following Racket code:

```
(define (==> x y )  
  (or (not x) y) )  
  
(==> true false)
```

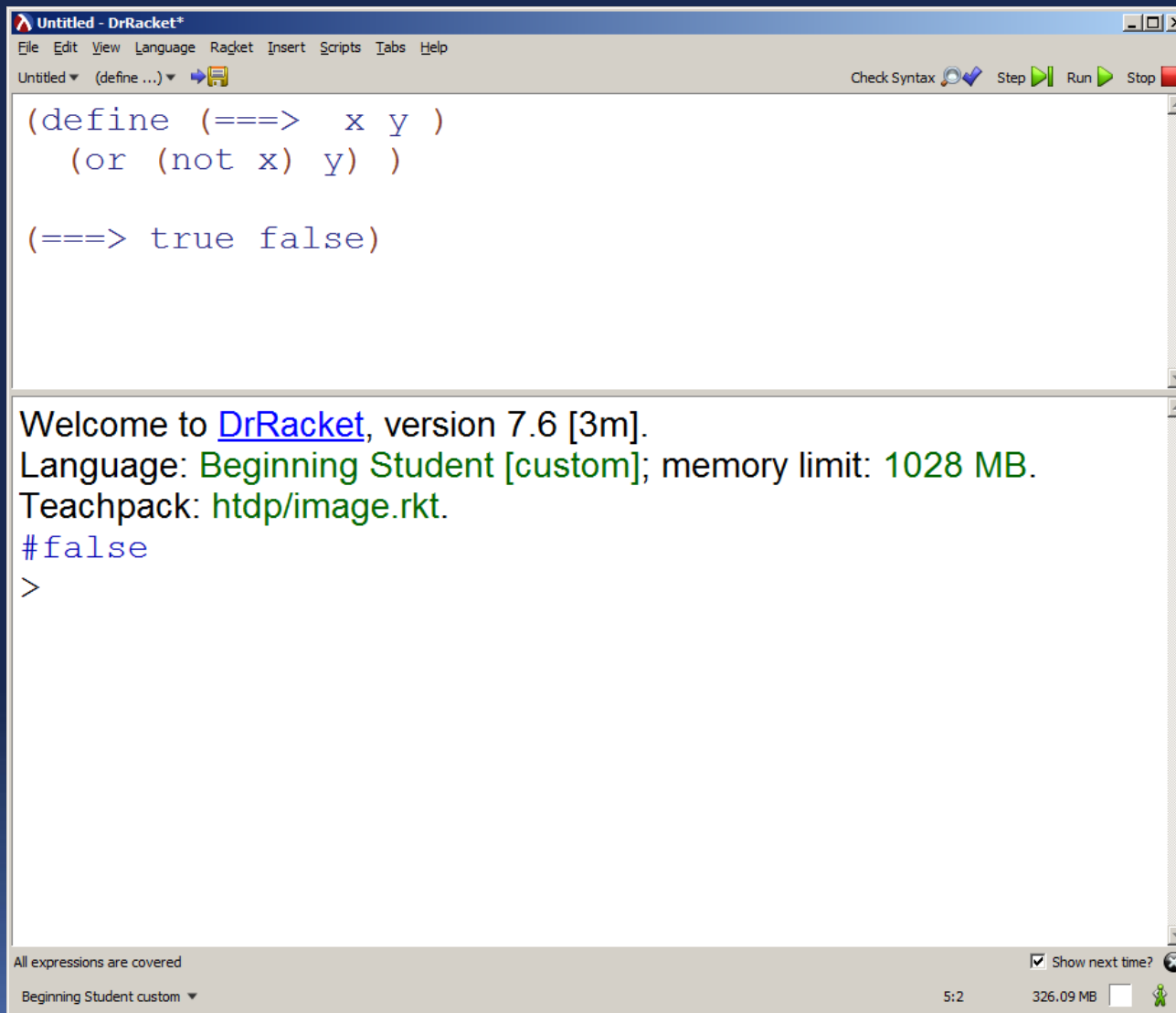
The output window displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
>
```

The status bar at the bottom shows "Beginning Student custom", "4:2", and "553.96 MB".

Exercício 3

Qual o resultado?



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The main text area contains the following Racket code:

```
(define (==> x y )  
  (or (not x) y) )  
  
(==> true false)
```

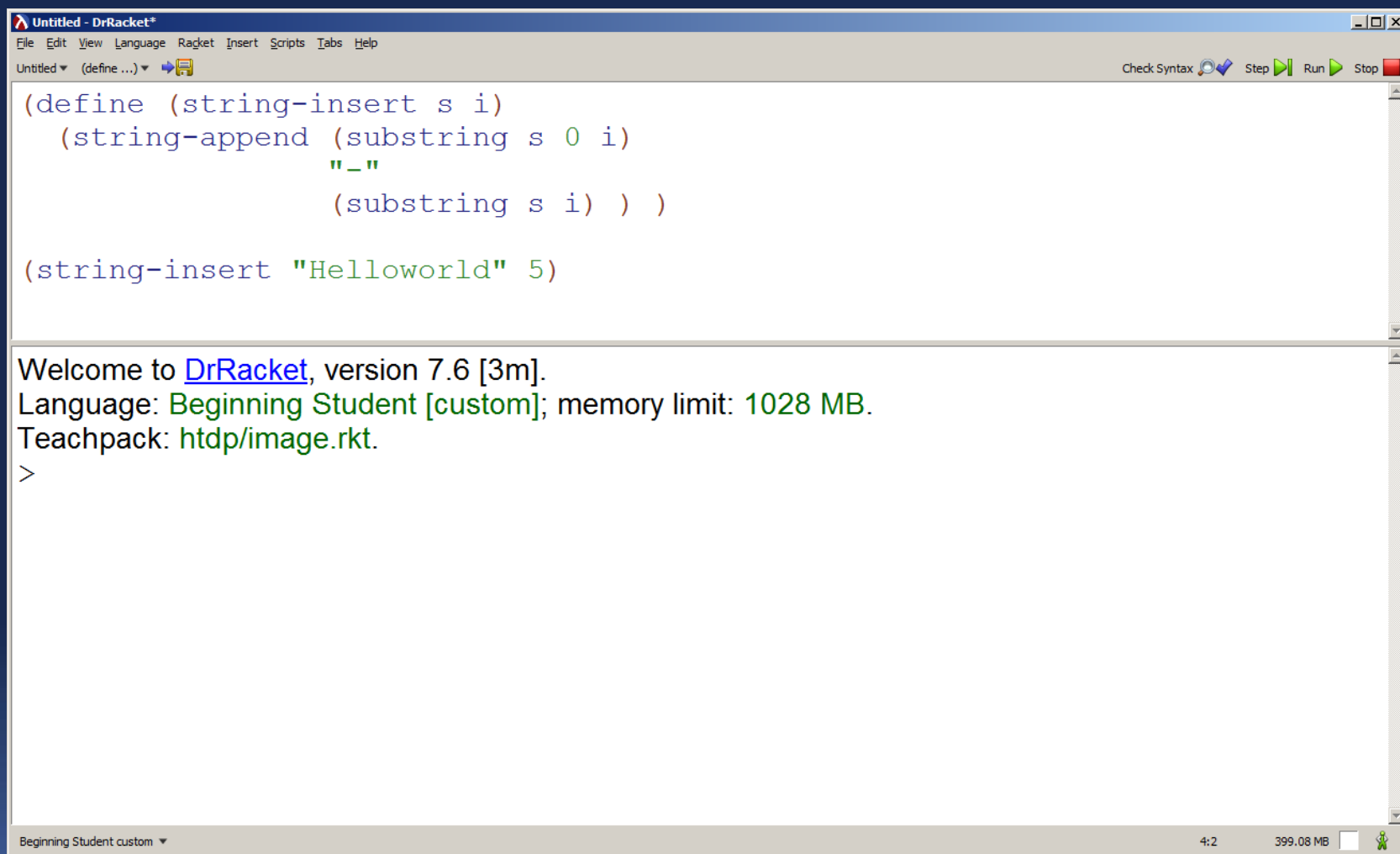
Below the code, the output area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].  
Language: Beginning Student [custom]; memory limit: 1028 MB.  
Teachpack: http/image.rkt.  
#false  
>
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "5:2 326.09 MB".

Exercício 4

Qual o resultado?



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for opening files, saving, and running code. The main text area contains the following Racket code:

```
(define (string-insert s i)
  (string-append (substring s 0 i)
                 "_"
                 (substring s i) ) )

(string-insert "Helloworld" 5)
```

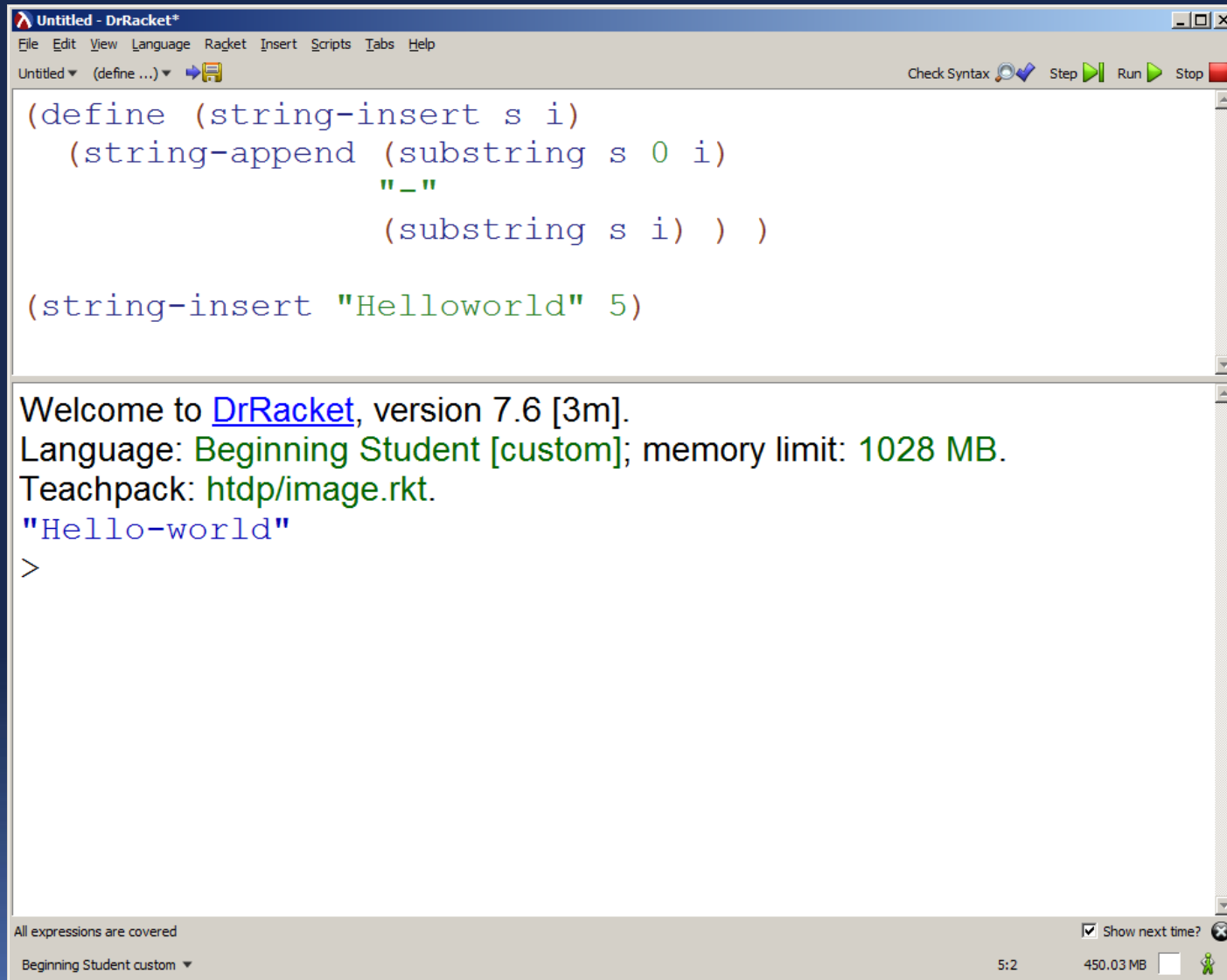
The bottom output area displays the following text:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: httpd/image.rkt.
>
```

The status bar at the bottom indicates the language is 'Beginning Student custom' and shows a memory usage of 399.08 MB.

Exercício 4

Resposta:



The screenshot shows the DrRacket IDE interface. The top menu bar includes File, Edit, View, Language, Racket, Insert, Scripts, Tabs, and Help. The toolbar contains icons for Check Syntax, Step, Run, and Stop. The main editor window displays the following Racket code:

```
(define (string-insert s i)
  (string-append (substring s 0 i)
                 "_"
                 (substring s i) ) )

(string-insert "Hello-world" 5)
```

Below the code editor, the output area shows the following text:

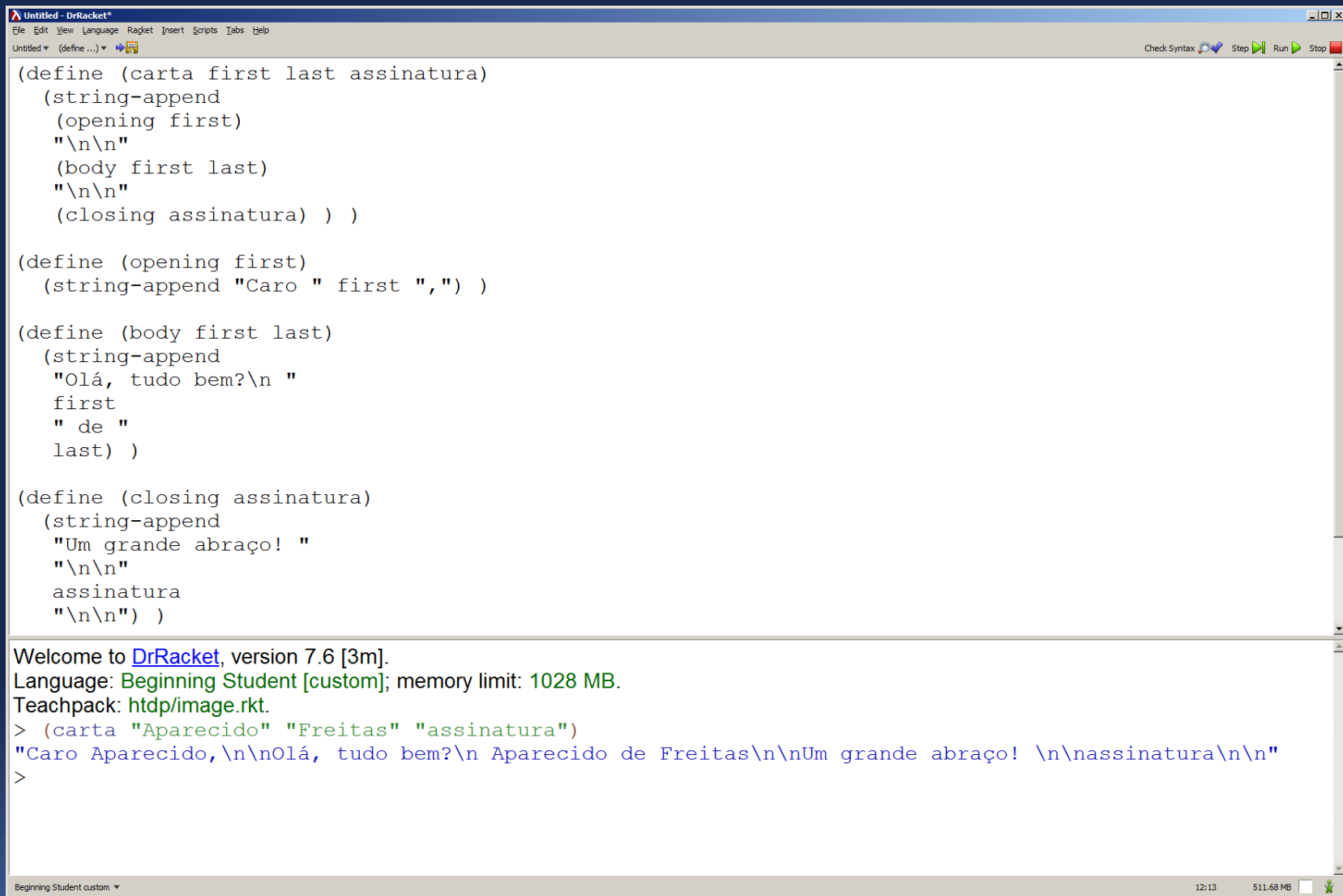
```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http/image.rkt.
"Hello-world"
>
```

The status bar at the bottom indicates "All expressions are covered", "Beginning Student custom", and "Show next time?". The bottom right corner shows the time "5:2" and memory usage "450.03 MB".

Composição de Funções

- ✓ Um programa tipicamente consiste de uma definição principal (**main**) de função e diversas **outras funções**;
- ✓ A computação tipicamente ocorre no processamento de uma função, no qual a **saída** dela será canalizada (entrada) para a **entrada** de outra função e assim, **sucessivamente**, até completar-se a computação;
- ✓ Essa forma de computação é **conhecida** por **composição de funções** e as funções adicionais são conhecidas por funções **auxiliares** (helpers);

Composição de Funções – Exemplo



```
(define (carta first last assinatura)
  (string-append
    (opening first)
    "\n\n"
    (body first last)
    "\n\n"
    (closing assinatura) ) )

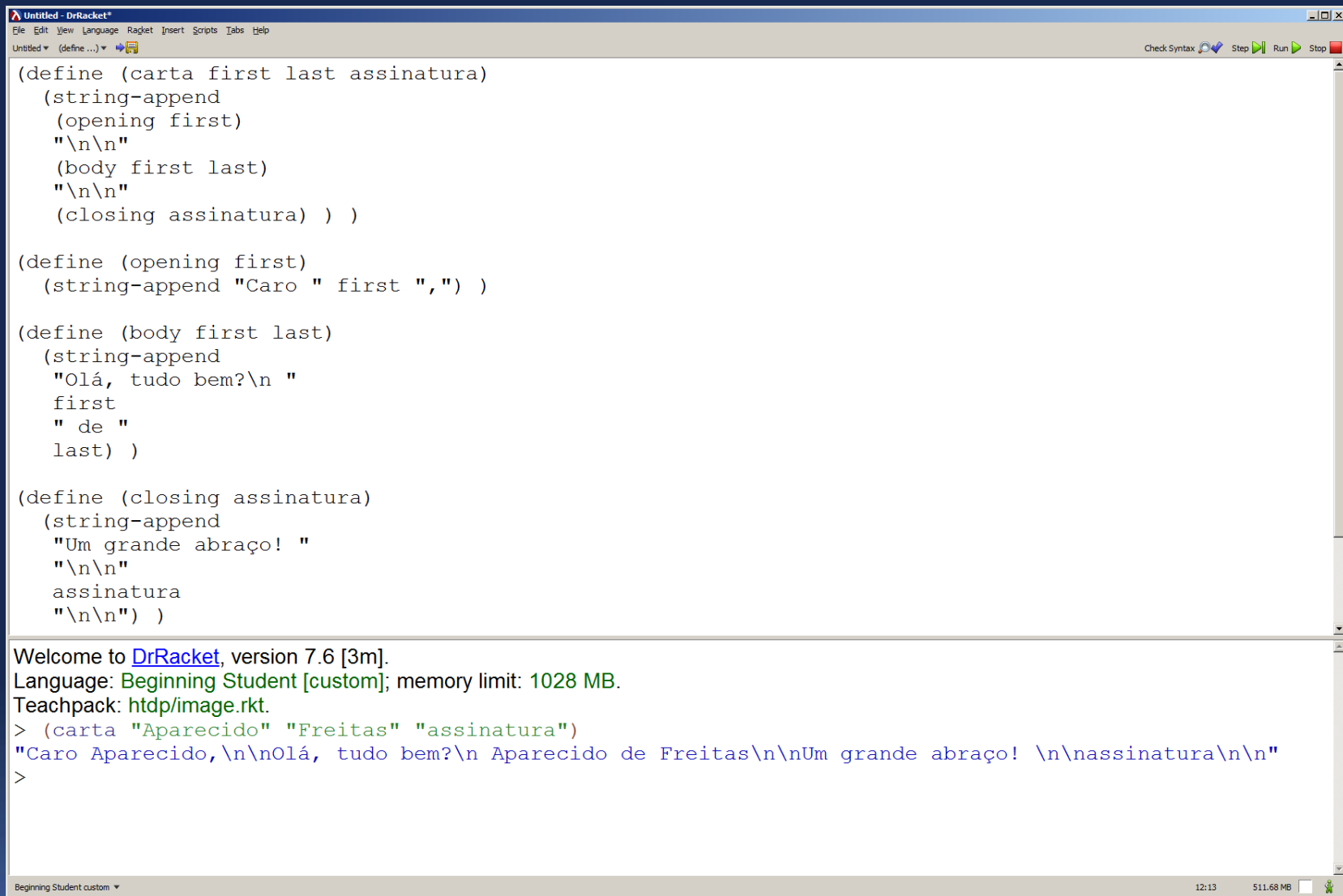
(define (opening first)
  (string-append "Caro " first ",") )

(define (body first last)
  (string-append
    "Olá, tudo bem?\n "
    first
    " de "
    last) )

(define (closing assinatura)
  (string-append
    "Um grande abraço! "
    "\n\n"
    assinatura
    "\n\n") )

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: http://image.rkt.
> (carta "Aparecido" "Freitas" "assinatura")
"Caro Aparecido,\n\nOlá, tudo bem?\n Aparecido de Freitas\n\nUm grande abraço! \n\nassinatura\n\n"
>
```


Composição de Funções – Exemplo



The screenshot shows the DrRacket IDE with a file named "Untitled - DrRacket". The code defines four functions: `carta`, `opening`, `body`, and `closing`, which are used to compose a signature block. The `carta` function takes `first` and `last` names and appends them to a template string. The `opening` function adds a greeting, the `body` function adds the main message, and the `closing` function adds a closing phrase and the signature itself. The bottom panel shows the welcome message and the result of evaluating the `carta` function with the arguments "Aparecido" and "Freitas".

```
(define (carta first last assinatura)
  (string-append
    (opening first)
    "\n\n"
    (body first last)
    "\n\n"
    (closing assinatura) ) )

(define (opening first)
  (string-append "Caro " first ",") )

(define (body first last)
  (string-append
    "Olá, tudo bem?\n "
    first
    " de "
    last) )

(define (closing assinatura)
  (string-append
    "Um grande abraço! "
    "\n\n"
    assinatura
    "\n\n") )
```


Welcome to [DrRacket](#), version 7.6 [3m].
Language: [Beginning Student](#) [custom]; memory limit: 1028 MB.
Teachpack: <http://image.rkt>.

```
> (carta "Aparecido" "Freitas" "assinatura")
"Caro Aparecido,\n\nOlá, tudo bem?\n Aparecido de Freitas\n\nUm grande abraço! \n\nassinatura\n\n"
>
```

Beginning Student custom 12:13 511.68 MB

Adicionando para console

- ✓ No programa anterior, adicione na primeira linha: **(require 2htdp/batch-io)**
- ✓ Para adicionar a função **(write-file)** em nosso repertório de funções.



```
Untitled - DrRacket*
File Edit View Language Racket Insert Scripts Tabs Help
Untitled (define...) Check Syntax Step Run Stop

(require 2htdp/batch-io)

(define (carta first last assinatura)
  (string-append
    (opening first)
    "\n\n"
    (body first last)
    "\n\n"
    (closing assinatura) ) )

(define (opening first)
  (string-append "Caro " first ",") )

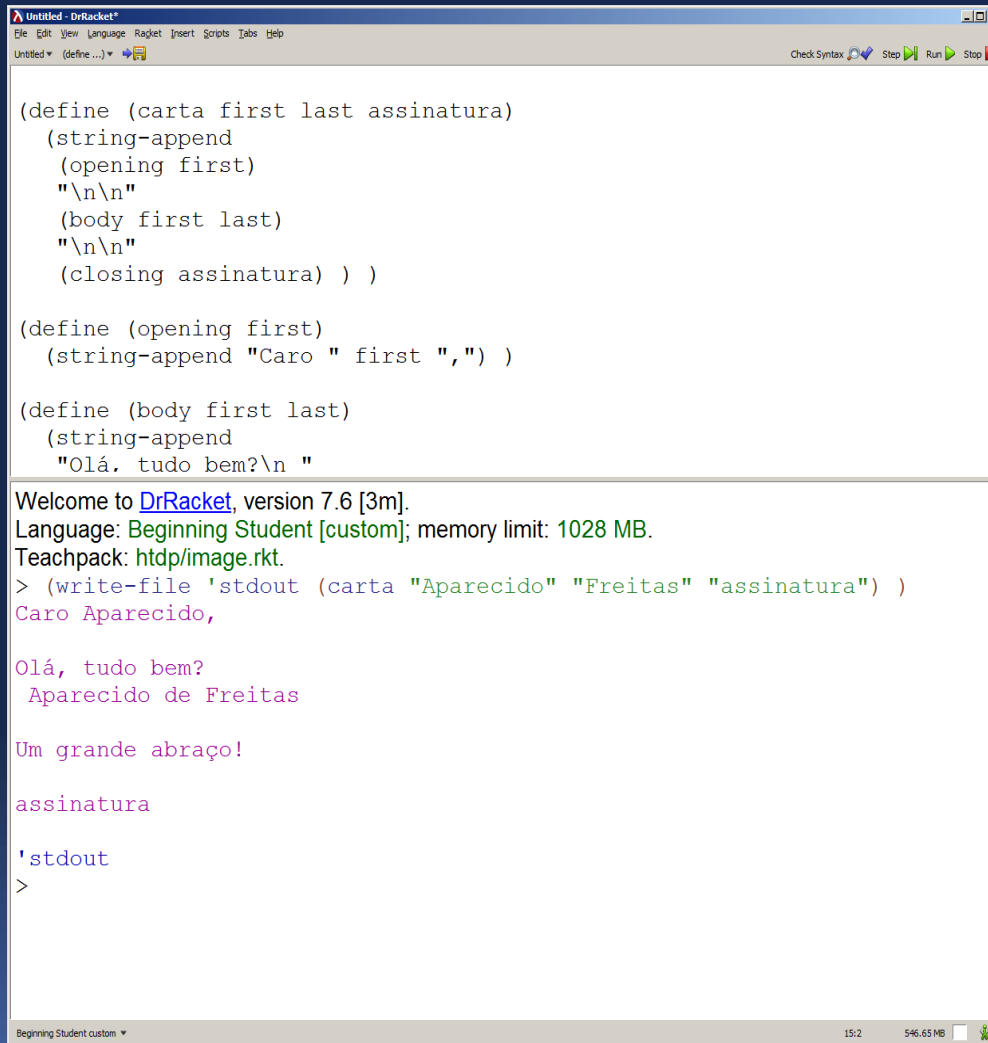
(define (body first last)
  (string-append
    "Olá, tudo bem?\n "
    first
    " de "
    last) )

(define (closing assinatura)
  (string-append
    "Um grande abraço! "

Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit:
1028 MB.
Teachpack: http/image.rkt.
>
```

Adicionando para console

- ✓ Agora na área de Interação: **(write-file 'stdout (carta "Aparecido" "Freitas"))**



The screenshot shows the DrRacket IDE with a file named 'Untitled - DrRacket'. The code editor contains the following Racket code:

```
(define (carta first last assinatura)
  (string-append
    (opening first)
    "\n\n"
    (body first last)
    "\n\n"
    (closing assinatura) ) )

(define (opening first)
  (string-append "Caro " first ",") )

(define (body first last)
  (string-append
    "Olá, tudo bem?\n "
    (closing first last) ) )

(define (closing first last)
  (string-append
    "Um grande abraço!\n "
    assinatura ) )
```

The output window shows the results of running the code:

```
Welcome to DrRacket, version 7.6 [3m].
Language: Beginning Student [custom]; memory limit: 1028 MB.
Teachpack: htdp/image.rkt.
> (write-file 'stdout (carta "Aparecido" "Freitas" "assinatura") )
Caro Aparecido,

Olá, tudo bem?
Aparecido de Freitas

Um grande abraço!

assinatura

'stdout
>
```

The status bar at the bottom indicates the language is 'Beginning Student custom', the time is 15:2, and the memory usage is 546.65 MB.

Boa prática



- ✓ Defina uma função para cada **tarefa** (task);
- ✓ Em geral, quando um problema se refere à distintas tarefas de computação, um programa deveria consistir de **uma função para cada tarefa** e uma função principal (**main**) que efetua a composição;
- ✓ Essa estratégia favorece a compreensão do programa, uma vez que funções razoavelmente pequenas são mais fáceis de serem entendidas e, por consequência, a composição também será mais fácil de ser compreendida;
- ✓ Além disso, esta estratégia favorece a manutenção (**Software muda!!!**)