

## Modelo para los ejercicios de la práctica 1 y 2

En este documento se recogen alguna de las soluciones de los ejercicios propuestos para las sesiones I y II. Puede utilizarse como apoyo y éste es su fin.

Recuerda no obstante que hay que ser cuidados con las definiciones, los paréntesis, no utilizar nada que no haya sido declarada, etc.

Desde un punto de vista práctico, resulta a menudo mucho más útil empaquetar las instrucciones en un fichero script. Así es más fácil editar para corregir errores o adaptar lo escrito a problemas similares.

La salida que devuelve Matlab está en gris claro.

Comandos utilizados en esta práctica `factor`, `simple`, `syms`, `disp`, `pretty`, `limit`, `symsum`, `sum`, `plot`

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### Elección: ans o disp

Si molesta el "|ans|" se puede utilizar `disp` para mostrar los resultados más concisos.

```
cos(pi-sin(0.5))+atan(exp(0.4))
```

```
ans =
```

```
0.093008672856389
```

```
disp(cos(pi-sin(0.5))+atan(exp(0.4)))
```

```
0.093008672856389
```

o bien

```
res=cos(pi-sin(0.5))+atan(exp(0.4)); % la variable "res" con el resultado
disp(res)
```

```
0.093008672856389
```

### Ejercicio 1.4 Qué es mayor $e^{\pi}$ o $\pi^e$ ?

definimos `e` con el número  $e=2.718182\dots$

```
e=exp(1);
```

comprobamos su valor

```
exp(pi), pi^e
```

```
ans =
```

```
23.140692632779267
```

```
ans =
```

```
22.459157718361052
```

```
exp(pi)-pi^e
```

```
ans =
```

```
0.681534914418215
```

Si se quiere más precisión utilizar `format long`. En cualquier caso concluimos que

$$e^{\pi} > \pi^e$$

### Ejercicio 1.7 Factorizaciones

Factoriza

$$x^2 - 4x + 3, \quad x^4 - 10x^2 + 9$$

Simplemente

```
syms x % definimos x como variable simbólica
factor(x^2-4*x+3)
```

```
ans =
```

```
(x-1)*(x-3)
```

```
factor(x^4-10*x^2+9)
```

```
ans =
```

```
(x-1)*(x+3)*(x-3)*(x+1)
```

### Ejercicio 1.11 Simplificaciones

Simplifica

$$\frac{x^4 + 2x^3 - 25x^2 - 2x + 24}{x^4 + 13x^3 + 46x^2 + 12x - 72}$$

$$\frac{\text{sen}(4x)}{\cos^2(2x) - \text{sen}^2(2x)}$$

```
syms x % definimos x simbólica (no es necesario si ya lo es)
simp=simple((x^4+2*x^3-25*x^2-2*x+24)/(x^4+13*x^3+46*x^2+12*x-72))
```

```
simp =
(x+1)*(x-4)/(x+6)/(x+2)
```

```
pretty(simp) % lo muestra algo más elegante
```

$$\frac{(x + 1) (x - 4)}{(x + 6) (x + 2)}$$

```
simp2= simple(sin(4*x)/(cos(2*x)^2-sin(2*x)^2)); % no queremos la salida
simp2
```

```
simp2 =
sin(4*x)/cos(4*x)
```

Observa que Matlab no se da cuenta que aún se puede simplificar más. Aplicamos una vez más `simple`

```
simple(simp2)
```

```
simplify:
```

```
sin(4*x)/cos(4*x)
```

```
radsimp:
```

```
sin(4*x)/cos(4*x)
```

```
combine(trig):
```

```
sin(4*x)/cos(4*x)
```

```
factor:
```

```
sin(4*x)/cos(4*x)
```

```
expand:
```

```
8/(8*cos(x)^4-8*cos(x)^2+1)*sin(x)*cos(x)^3-4/(8*cos(x)^4-8*cos(x)^2+1)*sin(x)*cos(x)
```

```
combine:
```

```
sin(4*x)/cos(4*x)
```

```
convert(exp):
```

```
-1/2*i*(exp(4*i*x)-1/exp(4*i*x))/(1/2*exp(4*i*x)+1/2/exp(4*i*x))
```

```
convert(sincos):
```

```
sin(4*x)/cos(4*x)
```

```
convert(tan):
```

```
tan(4*x)
```

```

collect(x):
sin(4*x)/cos(4*x)

mwcos2sin:
sin(4*x)/cos(4*x)

ans =
tan(4*x)

```

Ahora sí es satisfactorio

### Ejercicio 1.13 Comprobar que son polinomios

```

syms x
p=cos(2*acos(x));
simple(p)

```

```

simplify:
cos(2*acos(x))

radsimp:
cos(2*acos(x))

combine(trig):
cos(2*acos(x))

factor:
cos(2*acos(x))

expand:
2*x^2-1

combine:
cos(2*acos(x))

convert(exp):
1/2*(x+i*(1-x^2)^(1/2))^2+1/2/(x+i*(1-x^2)^(1/2))^2

convert(sincos):
cos(2*acos(x))

convert(tan):
(1-tan(acos(x))^2)/(1+tan(acos(x))^2)

collect(x):
cos(2*acos(x))

mwcos2sin:

```

```
cos(2*acos(x))
```

```
ans =
```

```
2*x^2-1
```

### Ejercicio 1.13 Algunos límites

$$\left(\frac{n^2-1}{n^2+n}\right)^{4n-3}$$

$$(n+4)\tan\left(\sin\left(\cos\left(\frac{1}{n^2}\right)-1\right)\right)$$

```
syms n
limit(((n^2-1)/(n^2+n))^(4*n-3),n,inf)
```

```
ans =
```

```
exp(-4)
```

```
limit((n+4)*tan(sin(cos(1/n^2)-1)),n,inf)
```

```
ans =
```

```
0
```

Sé bien cuidadoso con los paréntesis: cuando uno se abre, otro se cierra. Observa de que **el seno se escribe con sin**

### Ejercicio 1.14 Suma de algunas series

$$\sum_{n=1}^{\infty} n2^{1-n},$$

$$\sum_{n=1}^{\infty} \log\left(\frac{n+2}{n}\right)$$

```
syms n
suma=symsum(n*2^(1-n),n,1,inf)
pretty(suma) %mismo resultado de forma más elegante
```

```
suma =
```

```
4
```

4

```
symsum(log((n+2)/n),n,1,inf)
```

ans =

Inf

obtenemos el resultado: infinito

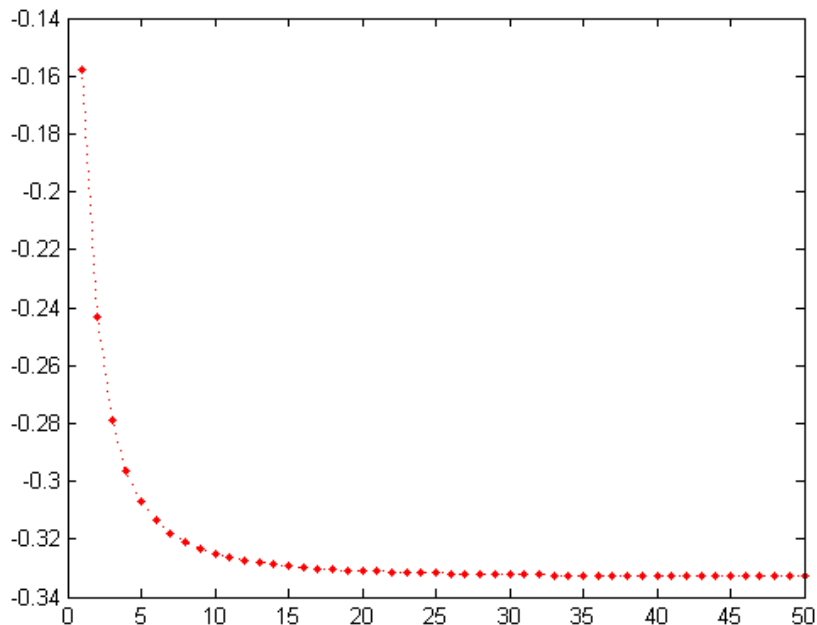
**Ejercicio 1.15: dibujo de algunas sucesiones**

$$\frac{n^2 + 3n - 1}{(n+1)^3 - (n+2)^3}, \quad \left(\frac{n^2 - 1}{n^2 + n}\right)^{4n-3}$$

```
f=vectorize(inline('(n^2+3*n-1)/((n+1)^3-(n+2)^3)'))
n=1:50; % dibujamos 50 valores
plot(f(n),'r.')
```

f =

```
Inline function:
f(n) = (n.^2+3.*n-1)./((n+1).^3-(n+2).^3)
```

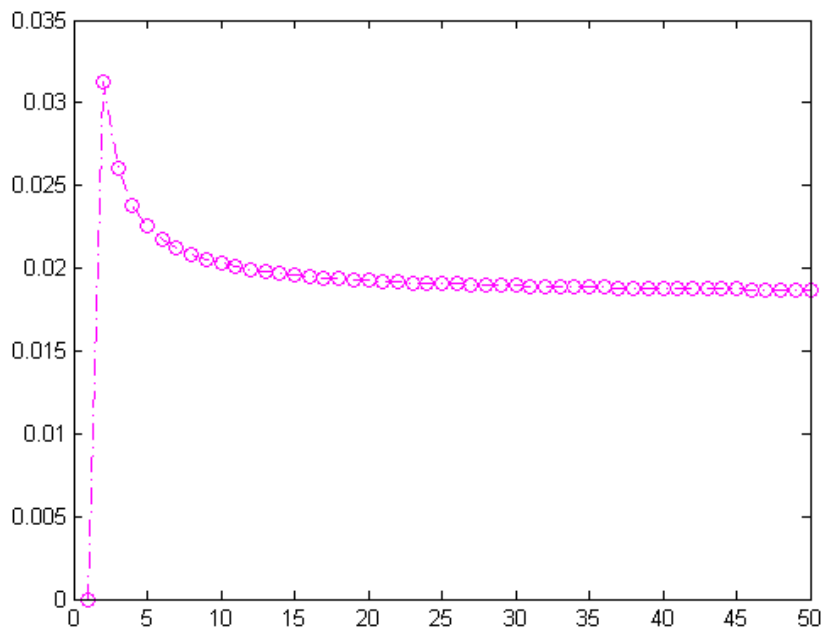


vemos que el límite parece ser -0.333... que es 1/3

```
g=vectorize(inline('((n^2-1)/(n^2+n))^(4*n-3)'))
n=1:50; % dibujamos 50 valores
plot(g(n),'mo-')
```

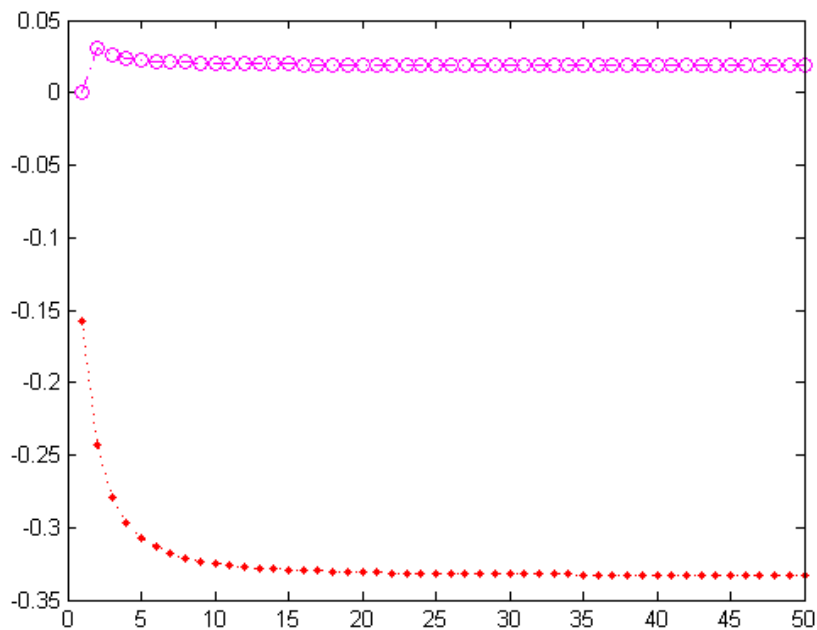
g =

```
Inline function:
g(n) = ((n.^2-1)./(n.^2+n)).^(4.*n-3)
```



si queremos las podemos ver juntas. Simplemente hay que "añadir" n en el el comando `plot` para indicar donde se mueve la variable

```
plot(n,f(n),'r.:',n,g(n),'mo-.')
```



### Ejercicio 1.16: dibujo de algunas series

$$\sum_{n=1}^{\infty} \frac{(-1)^n}{\sqrt{(n)}}, \quad \sum_{n=1}^{\infty} n^9 3^{-n}$$

```
f=vectorize(inline('(-1)^n/sqrt(n)','n'))
n=1:100; % dibujamos 100 sumas parciales primera
plot(cumsum(f(n)), 'k.:')
f2=vectorize(inline('n^9*3^(-n)','n'))
n=1:100; % dibujamos 100 sumas parciales primeras
plot(cumsum(f2(n)), 'k.:')
```

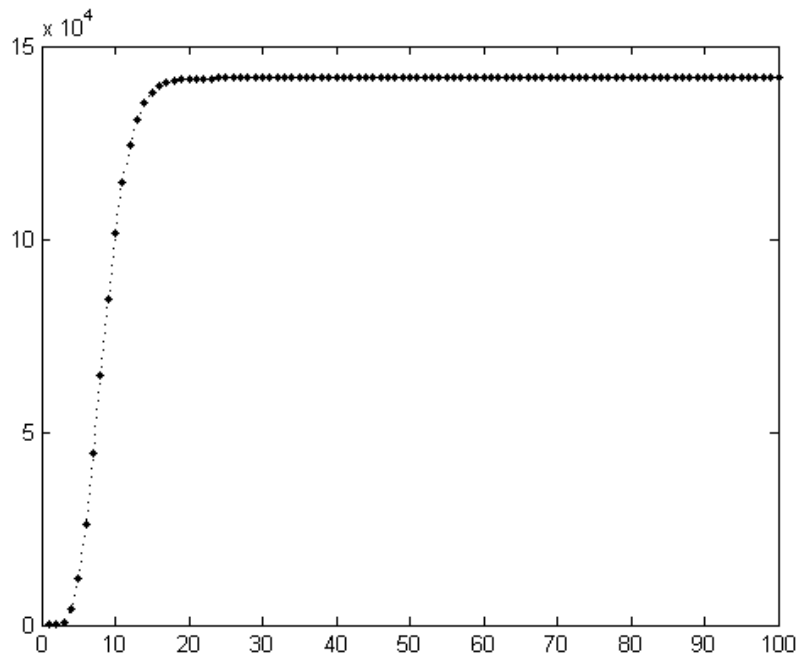
```
% Observa que en el último ejemplo la suma es considerable, pero se
% estabiliza pronto ( $3^{-n}$  decrece a cero mucho más rápidamente que el
% crecimiento a infinito de  $n^9$ ).
```

```
f =
```

```
Inline function:
f(n) = (-1).^n./sqrt(n)
```

```
f2 =
```

```
Inline function:
f2(n) = n.^9.*3.^(-n)
```

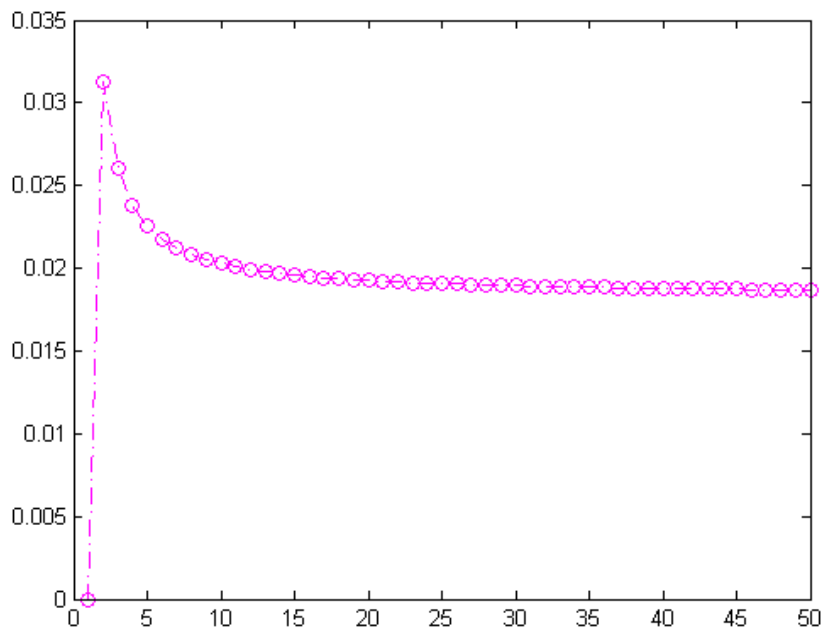


vemos que el límite parece ser  $-0.333\dots$  que es  $1/3$

```
g=vectorize(inline('((n^2-1)/(n^2+n))^(4*n-3)'))
n=1:50; % dibujamos 50 valores
plot(g(n), 'mo-.')
%
```

```
g =
```

```
Inline function:
g(n) = ((n.^2-1)./(n.^2+n)).^(4.*n-3)
```



### Ejercicio 1.17 Constante de Euler-Macheroni

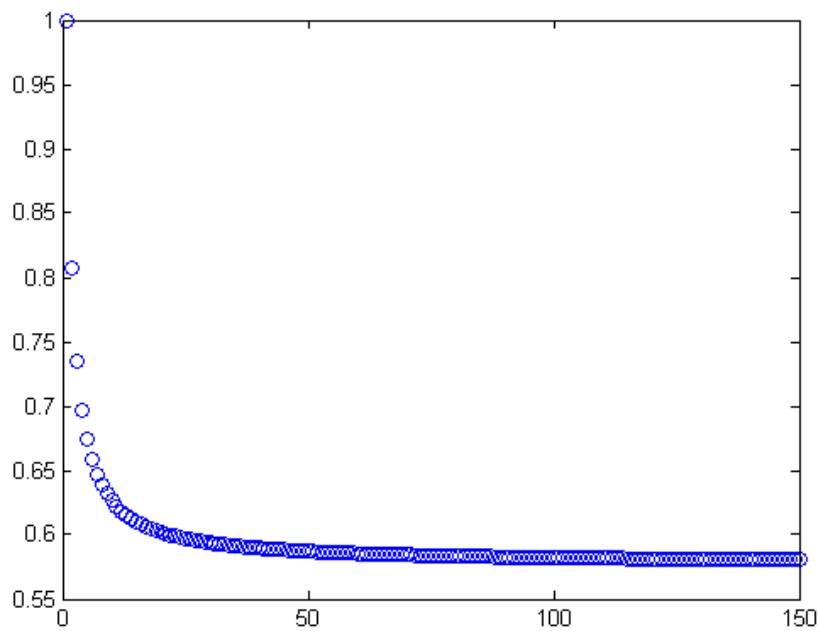
Evaluamos  $\sum_{j=1}^n \frac{1}{j^2} - \log(n)$  para varios valores de  $n$

```
f=vectorize(inline('1/n','n'));
format long % vemos todos los dígitos posibles
n=10; gamma10=sum(f(1:n))-log(n);
disp('Aprox para n=100')
disp(gamma10)
n=1000; gamma10000=sum(f(1:n))-log(n);
disp('Aprox para n=1000')
disp(gamma10000)
n=100000; gamma100000=sum(f(1:n))-log(n);
disp('Aprox para n=10000')
disp(gamma100000)
%
% Podemos dibujar una gráfica con esos valores
%
% Definimos la funcion
f2=vectorize(inline('cumsum(1/n)-log(n)','n'));
n=1:150;
plot(f2(n),'o')
% vemos en la gráfica claramente que la diferencia entre suma parcial
% y logaritmo tiende a un número fijo que es aprox 0.57721566490153...
```

```
Aprox para n=100
0.626383160974208
```

```
Aprox para n=1000
0.577715581568206
```

```
Aprox para n=10000
0.577220664893106
```



### Ejercicio 1.18 calculamos la serie de forma numérica

$$\sum_{n=1}^{\infty} (101/100)^n \sum_{n=1}^{\infty} \frac{\log(n)}{n^2}$$

```
s1=vectorize(inline('(101/100)^n'));
n=1:50; % tomamos 5 términos
sum(s1(n)) % los sumamos
```

ans =

```
65.107814006232090
```

Parece que es infinito. Nos aseguramos

```
n=1:200; % 200 terminos
sum(s1(n)) % los sumamos
```

ans =

```
6.379178030348247e+002
```

Si queremos podemos ver la suma acumulativa, es decir, la sucesión de sus sumas parciales

```
cumsum(s1(n))
```

ans =

```
1.0e+002 *
```

```
Columns 1 through 5
```

```
0.0101000000000000 0.0203010000000000 0.0306040100000000 0.0410100501000000 0.051520150601000
```

```
Columns 6 through 10
```

```
0.062135352107010 0.072856705628080 0.083685272684361 0.094622125411205 0.105668346665317
```

```
Columns 11 through 15
```

0.116825030131970	0.128093280433289	0.139474213237622	0.150968955369999	0.162578644923699
Columns 16 through 20				
0.174304431372936	0.186147475686665	0.198108950443532	0.210190039947967	0.222391940347447
Columns 21 through 25				
0.234715859750921	0.247163018348430	0.259734648531915	0.272431995017234	0.285256314967406
Columns 26 through 30				
0.298208878117080	0.311290966898251	0.324503876567233	0.337848915332906	0.351327404486235
Columns 31 through 35				
0.364940678531097	0.378690085316408	0.392576986169572	0.406602756031268	0.420768783591581
Columns 36 through 40				
0.435076471427496	0.449527236141771	0.464122508503189	0.478863733588221	0.493752370924103
Columns 41 through 45				
0.508789894633344	0.523977793579678	0.539317571515474	0.554810747230629	0.570458854702935
Columns 46 through 50				
0.586263443249965	0.602226077682465	0.618348338459289	0.634631821843882	0.651078140062321
Columns 51 through 55				
0.667688921462944	0.684465810677574	0.701410468784349	0.718524573472193	0.735809819206915
Columns 56 through 60				
0.753267917398984	0.770900596572974	0.788709602538703	0.806696698564091	0.824863665549731
Columns 61 through 65				
0.843212302205229	0.861744425227281	0.880461869479554	0.899366488174349	0.918460153056093
Columns 66 through 70				
0.937744754586654	0.957222202132520	0.976894424153846	0.996763368395384	1.016831002079338
Columns 71 through 75				
1.037099312100131	1.057570305221133	1.078246008273344	1.099128468356077	1.120219753039638
Columns 76 through 80				
1.141521950570035	1.163037170075735	1.184767541776492	1.206715217194257	1.228882369366200
Columns 81 through 85				
1.251271193059862	1.273883904990460	1.296722744040365	1.319789971480769	1.343087871195577
Columns 86 through 90				
1.366618749907532	1.390384937406608	1.414388786780674	1.438632674648480	1.463119001394965
Columns 91 through 95				
1.487850191408915	1.512828693323004	1.538056980256234	1.563537550058796	1.589272925559384
Columns 96 through 100				
1.615265654814978	1.641518311363128	1.668033494476759	1.694813829421527	1.721861967715742
Columns 101 through 105				
1.749180587392899	1.776772393266829	1.804640117199497	1.832786518371492	1.861214383555207
Columns 106 through 110				
1.889926527390759	1.918925792664666	1.948215050591313	1.977797201097226	2.007675173108199
Columns 111 through 115				
2.037851924839281	2.068330444087673	2.099113748528550	2.130204886013836	2.161606934873974

Columns 116 through 120

2.193323004222714	2.225356234264941	2.257709796607590	2.290386894573666	2.323390763519403
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 121 through 125

2.356724671154597	2.390391917866143	2.424395837044805	2.458739795415253	2.493427193369405
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 126 through 130

2.528461465303099	2.563846079956131	2.599584540755692	2.635680386163249	2.672137190024881
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 131 through 135

2.708958561925130	2.746148147544381	2.783709629019825	2.821646725310024	2.859963192563123
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 136 through 140

2.898662824488755	2.937749452733643	2.977226947260979	3.017099216733589	3.057370208900925
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 141 through 145

3.098043910989934	3.139124350099833	3.180615593600832	3.222521749536840	3.264846967032208
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 146 through 150

3.307595436702530	3.350771391069556	3.394379104980251	3.438422896030054	3.482907124990355
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 151 through 155

3.527836196240259	3.573214558202661	3.619046703784688	3.665337170822535	3.712090542530760
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 156 through 160

3.759311447956068	3.807004562435628	3.855174608059985	3.903826354140584	3.952964617681991
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 161 through 165

4.002594263858811	4.052720206497399	4.103347408562373	4.154480882647997	4.206125691474476
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 166 through 170

4.258286948389221	4.310969817873113	4.364179516051845	4.417921311212363	4.472200524324487
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 171 through 175

4.527022529567732	4.582392754863409	4.638316682412042	4.694799849236163	4.751847847728524
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 176 through 180

4.809466326205810	4.867660989467868	4.926437599362546	4.985801975356171	5.045759995109734
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 181 through 185

5.106317595060831	5.167480771011440	5.229255578721554	5.291648134508770	5.354664615853858
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 186 through 190

5.418311262012396	5.482594374632519	5.547520318378845	5.613095521562633	5.679326476778259
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 191 through 195

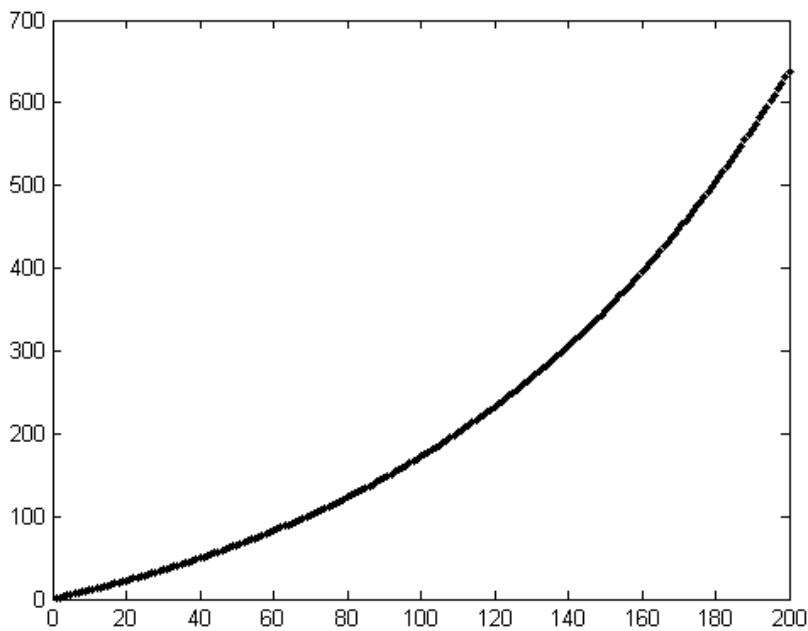
5.746219741546042	5.813781938961503	5.882019758351118	5.950939955934628	6.020549355493976
-------------------	-------------------	-------------------	-------------------	-------------------

Columns 196 through 200

6.090854849048916	6.161863397539405	6.233582031514799	6.306017851829947	6.379178030348247
-------------------	-------------------	-------------------	-------------------	-------------------

Mejor si lo dibujamos

```
plot(cumsum(s1(n)), 'k.')
```



Puedes hacer zooms para observar la figura más de cerca. Para el segundo ejemplo procedemos igual

```
s2=vectorize(inline('log(n)/n^2'));
n=1:200; % tomamos 200 terminos
sum(s2(n)) % los sumamos
```

ans =

```
0.906122796485680
```

Observamos la sucesión de sus sumas parciales

```
cumsum(s2(n))
```

ans =

Columns 1 through 5

```
0 0.173286795139986 0.295354827214221 0.381998224784214 0.446375741281578
```

Columns 6 through 10

```
0.496146837649024 0.535859289670561 0.568350563759308 0.595476793109138 0.618502644039079
```

Columns 11 through 15

```
0.638319960343197 0.655576256522281 0.670753471655189 0.684218049867512 0.696253828539077
```

Columns 16 through 20

```
0.707084253235326 0.716887759616144 0.725808660103478 0.733965000765989 0.741454331449874
```

Columns 21 through 25

```
0.748358010446979 0.754744461796893 0.760671672034944 0.766189126601520 0.771339327921310
```

Columns 26 through 30

```
0.776158997356253 0.780680035581224 0.784930296436040 0.788934215377759 0.792713323579606
```

Columns 31 through 35

```
0.796286671347021 0.799671179064598 0.802881929809747 0.805932414692633 0.808834739640787
```

Columns 36 through 40

0.811599800550090 0.814237432334344 0.816756536323074 0.819165189607841 0.821470739266662

Columns 41 through 45

0.823679883863155 0.825798744190980 0.827832924891734 0.829787568297683 0.831667401625965

Columns 46 through 50

0.833476778467406 0.835219715362702 0.836899924134798 0.838520840543840 0.840085649746011

Columns 51 through 55

0.841597308966590 0.843058567738254 0.844471986005806 0.845839950356480 0.847164688599532

Columns 56 through 60

0.848448282888669 0.849692681555285 0.850899709798610 0.852071079360203 0.853208397294154

Columns 61 through 65

0.854313173930588 0.855386830118165 0.856430703820960 0.857446056136233 0.858434076791830

Columns 66 through 70

0.859395889175215 0.860332554940283 0.861245078232925 0.862134409571845 0.863001449417161

Columns 71 through 75

0.863847051455852 0.864672025630045 0.865477140931443 0.866263127982795 0.867030681425201

Columns 76 through 80

0.867780462128159 0.868513099237597 0.869229192075646 0.869929311904594 0.870614003566262

Columns 81 through 85

0.871283787006998 0.871939158697549 0.872580592956193 0.873208543182787 0.873823443010674

Columns 86 through 90

0.874425707382802 0.875015733557812 0.875593902051417 0.876160577517865 0.876716109575931

Columns 91 through 95

0.877260833583480 0.877795071364322 0.878319131890759 0.878833311924968 0.879337896622098

Columns 96 through 100

0.879833160097735 0.880319365962174 0.880796767823760 0.881265609763371 0.881726126781970

Columns 101 through 105

0.882178545222990 0.882623083171210 0.883059950829635 0.883489350875783 0.883911478798700

Columns 106 through 110

0.884326523217898 0.884734666185359 0.885136083471636 0.885530944837028 0.885919414288746

Columns 111 through 115

0.886301650324889 0.886677806166032 0.887048029975156 0.887412465066600 0.887771250104661

Columns 116 through 120

0.888124519292466 0.888472402551638 0.888815025693297 0.889152510580884 0.889484975285244

Columns 121 through 125

0.889812534232419 0.890135298344535 0.890453375174158 0.890766869032483 0.891075881111671

Columns 126 through 130

0.891380509601652 0.891680849801693 0.891976994226981 0.892269032710508 0.892557052500475

Columns 131 through 135

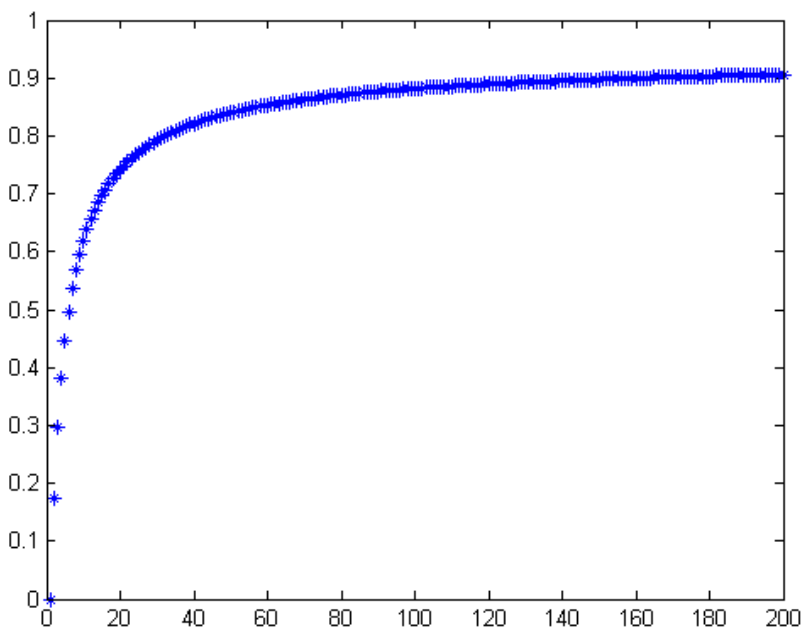
0.892841138353468 0.893121372623589 0.893397835347780 0.893670604327506 0.893939755206981

Columns 136 through 140

0.894205361548121	0.894467494902367	0.894726224879533	0.894981619213839	0.895233743827238
Columns 141 through 145				
0.895482662890181	0.895728438879945	0.895971132636621	0.896210803416886	0.896447508945657
Columns 146 through 150				
0.896681305465723	0.896912247785440	0.897140389324600	0.897365782158524	0.897588477060484
Columns 151 through 155				
0.897808523542516	0.898025969894700	0.898240863222966	0.898453249485507	0.898663173527835
Columns 156 through 160				
0.898870679116561	0.899075808971945	0.899278604799257	0.899479107319024	0.899677356296181
Columns 161 through 165				
0.899873390568199	0.900067248072209	0.900258965871178	0.900448580179173	0.900636126385744
Columns 166 through 170				
0.900821639079472	0.901005152070702	0.901186698413510	0.901366310426917	0.901544019715396
Columns 171 through 175				
0.901719857188687	0.901893853080953	0.902066036969306	0.902236437791714	0.902405083864331
Columns 176 through 180				
0.902572002898262	0.902737222015776	0.902900767766006	0.903062666140146	0.903222942586161
Columns 181 through 185				
0.903381622023030	0.903538728854545	0.903694286982672	0.903848319820503	0.904000850304800
Columns 186 through 190				
0.904151900908156	0.904301493650781	0.904449650111930	0.904596391440982	0.904741738368188
Columns 191 through 195				
0.904885711215096	0.905028329904659	0.905169613971047	0.905309582569173	0.905448254483928
Columns 196 through 200				
0.905585648139156	0.905721781606360	0.905856672613163	0.905990338551516	0.906122796485680

Y nuevamente, es mejor si lo dibujamos

```
plot(cumsum(s2(n)), 'b*')
```



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