Wykład 3

Funkcje, definicje funkcji, funkcje bez nazwy

In[1]:=
```
ClearAll["Global`*"]
```

Funkcje

Funkcje elementarne

Mathematica has the most extensive collection of mathematical functions ever assembled. Often relying on original results and algorithms developed at Wolfram Research over the past two decades, each function supports a full range of symbolic operations, as well as efficient numerical evaluation to arbitrary precision, for all complex values of parameters.

Mathematical Constants »

Pi(π) ▪ E(e) ▪ Degree(°) ▪ EulerGamma ▪ ...

Complex Numbers »

I(i) ▪ Re ▪ Im ▪ Conjugate ▪ Abs ▪ Arg ▪ ...

Arithmetic Functions »

Plus(+) ▪ Times(×) ▪ Power(^) ▪ Sqrt ▪ Total ▪ ...

Numerical Functions »

Abs ▪ Round ▪ Floor ▪ Min ▪ Max ▪ Clip ▪ Rescale ▪ SquareWave ▪ ...

Elementary Functions »

Log ▪ Log10 ▪ Exp ▪ Sqrt ▪ Sin ▪ Cos ▪ Tan ▪ ArcTan ▪ Tanh ▪ Sinc ▪ ...

Special Functions »

Gamma ▪ Erf ▪ BesselJ ▪ BesselK ▪ AiryAi ▪ EllipticK ▪ LegendreP ▪ ChebyshevT ▪ HermiteH ▪ LaguerreL ▪ SpheroidalS1 ▪ JacobiSN ▪ WeierstrassP ▪ Zeta ▪ PolyLog ▪ EllipticTheta ▪ Hypergeometric2F1 ▪ HypergeometricPFQ ▪ MeijerG ▪ AppellF1 ▪ ...

Generalized Functions »

DiracDelta ▪ HeavisideTheta ▪ DiracComb ▪ ...

Integer Functions »

Mod ▪ Quotient ▪ Divisible ▪ GCD ▪ Factorial(!) ▪ Binomial ▪ Fibonacci ▪ BernoulliB ▪ StirlingS1 ▪ IntegerDigits ▪ DigitCount ▪ BitAnd ▪ ...

Number Theoretic Functions »

FactorInteger ▪ Prime ▪ PrimePi ▪ EulerPhi ▪ MoebiusMu ▪ DivisorSigma ▪ JacobiSymbol ▪ MultiplicativeOrder ▪ PartitionsP ▪ SquaresR ▪ DirichletL ▪ ...

Statistical Distributions »

NormalDistribution ▪ ChiSquareDistribution ▪ PoissonDistribution

Random Numbers »

RandomInteger ▪ RandomReal ▪ RandomChoice ▪ RandomPrime

Signals-Oriented Functions »

SquareWave ▪ TriangleWave ▪ UnitBox ▪ ...

N — numerical evaluation to any precision

FunctionExpand — expand in terms of simpler functions

FullSimplify — apply full symbolic simplification

Definicja funkcji

MojaFunkcja

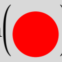
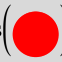
In[2]:=
```
Clear[MojaFunkcja]
```

In[3]:=
```
MojaFunkcja[x_] := x^2 - Sin[x] Cos[x]
```

In[4]:=

MojaFunkcja[]

Out[4]=

^{2} − sin() cos()

In[5]:=

FullForm[]

Out[5]//FullForm=

Graphics[List[RGBColor[1, 0, 0], Disk[List[0, 0]]], Rule[ImageSize, List[25]]]

Informacje i Atrybuty

In[6]:=
```
MojaFunkcja::usage =
  "Moja pierwsza bardziej skomplikowna funkcja, wyliczana
    dla dowolnego typu obiektu";
```

In[7]:=
```
? MojaFunkcja
```

Moja pierwsza bardziej skomplikowna funkcja, wyliczana dla dowolnego typu obiektu

In[8]:=
```
Definition[MojaFunkcja]
```

Out[8]=

MojaFunkcja(x_) := $x^2 - \sin(x)\cos(x)$

In[9]:=
```
?? MojaFunkcja
```

Moja pierwsza bardziej skomplikowna funkcja, wyliczana dla dowolnego typu obiektu

MojaFunkcja[x_] := x^2 - Sin[x] Cos[x]

In[10]:=
```
Information[MojaFunkcja]
```

Moja pierwsza bardziej skomplikowna funkcja, wyliczana dla dowolnego typu obiektu

MojaFunkcja[x_] := x^2 - Sin[x] Cos[x]

In[11]:=
```
Clear[x]
```

In[12]:=
```
Tabela = {x, G, π / 2}
```

Out[12]= $\left\{x, G, \frac{\pi}{2}\right\}$

In[13]:=
```
Sin[Tabela]
```

Out[13]= $\{\sin(x), \sin(G), 1\}$

In[14]:=
```
MojaFunkcja[Tabela]
```

Out[14]= $\left\{x^2 - \sin(x)\cos(x), G^2 - \sin(G)\cos(G), \frac{\pi^2}{4}\right\}$

In[15]:=
```
Attributes[Sin]
```

Out[15]= {Listable, NumericFunction, Protected}

In[16]:=
```
SetAttributes[MojaFunkcja, Listable]
```

In[17]:=
```
Attributes[MojaFunkcja]
```

Out[17]= {Listable}

In[18]:=
```
ClearAttributes[MojaFunkcja, Listable]
```

In[19]:=
```
Attributes[MojaFunkcja]
```

Out[19]= {}

Zawężanie dziedziny funkcji

In[20]:=
```
MojaFunkcja2[x_Real] := x^2 - Sin[x] Cos[x]
```

In[21]:=
```
MojaFunkcja2[x]
```

Out[21]= MojaFunkcja2(x)

In[22]:=
```
MojaFunkcja2[1]
```

Out[22]= MojaFunkcja2(1)

In[23]:=
```
MojaFunkcja2[1.0]
```
Out[23]= 0.545351

In[24]:=
```
3 / 2 // FullForm
```
Out[24]//FullForm= Rational[3, 2]

In[25]:=
```
Clear[F1]
```
In[26]:=
```
F1[n_Real] := n^10
```
In[27]:=
```
F1[n_Integer] := n^2
```
In[28]:=
```
F1[n_Rational] := Numerator[n]
```
In[29]:=
```
F1[n_List] := Part[n, 2]
```
In[30]:=
```
F1[n_Symbol] := Sqrt[n]
```
In[31]:=
```
F1[2] = 3
```
Out[31]= 3

In[32]:=
```
Lista = {10., 2, 10, 3 / 2, 10 / 5, s, {A, B}}
```
Out[32]= $\left\{10., 2, 10, \frac{3}{2}, 2, s, \{A, B\}\right\}$

In[33]:=
```
F1[Lista]
```
Out[33]= 2

(* Dlaczego nie weszliśmy z działaniem na elementy listy? *)

In[34]:=
```
F1 /@ Lista
```
Out[34]= $\left\{1.\times 10^{10}, 3, 100, 3, 3, \sqrt{s}, B\right\}$

In[35]:=
```
Map[F1, Lista]
```
Out[35]= $\left\{1.\times 10^{10}, 3, 100, 3, 3, \sqrt{s}, B\right\}$

In[36]:=
```
F1[Rational[10, 5]]
```
Out[36]= 3

Przykłady funkcji z życia fizyka

Apart

In[37]:=
```
FF = 1 / (1 + Q^2 / M_V^2)^2 / (1 + 3 Q^2 / M_W^2)
```

Out[37]=

$$\frac{1}{\left(\frac{Q^2}{M_V^2}+1\right)^2\left(\frac{3Q^2}{M_W^2}+1\right)}$$

In[38]:=
```
? Apart
```

Apart[*expr*] rewrites a rational expression as a sum of terms with minimal denominators.
Apart[*expr*, *var*] treats all variables other than *var* as constants. >>

In[39]:=
```
Apart[FF]
```

Out[39]=

$$\frac{M_V^4}{\left(M_V^2+Q^2\right)^2}-\frac{3\,Q^2\,M_V^4}{\left(M_V^2+Q^2\right)^2\left(M_W^2+3\,Q^2\right)}$$

In[40]:=
```
Apart[FF, Q^2]
```

Out[40]=

$$-\frac{M_V^4\,M_W^2}{\left(M_V^2+Q^2\right)^2\left(3\,M_V^2-M_W^2\right)}+\frac{9\,M_V^4\,M_W^2}{\left(M_W^2+3\,Q^2\right)\left(3\,M_V^2-M_W^2\right)^2}-\frac{3\,M_V^4\,M_W^2}{\left(M_V^2+Q^2\right)\left(3\,M_V^2-M_W^2\right)^2}$$

In[41]:=
```
Apart[FF, M_W^2]
```

Out[41]=

$$\frac{M_V^4}{\left(M_V^2+Q^2\right)^2}-\frac{3\,Q^2\,M_V^4}{\left(M_V^2+Q^2\right)^2\left(M_W^2+3\,Q^2\right)}$$

Funkcje Specjalne: przykłady

In[42]:=
```
?? LegendreP
```

LegendreP[*n*, *x*] gives the Legendre polynomial $P_n(x)$.
LegendreP[*n*, *m*, *x*] gives the associated Legendre polynomial $P_n^m(x)$. >>

```
Attributes[LegendreP] = {Listable, NumericFunction, Protected, ReadProtected}
```

In[43]:=
```
?? HermiteH
```

HermiteH[*n*, *x*] gives the Hermite polynomial $H_n(x)$. >>

```
Attributes[HermiteH] = {Listable, NumericFunction, Protected, ReadProtected}
```

In[44]:=
```
?? BesselJ
```

BesselJ[n, z] gives the Bessel function of the first kind $J_n(z)$. >>

```
Attributes[BesselJ] = {Listable, NumericFunction, Protected, ReadProtected}
```

Lista funkcji Specjalnych

Wielomiany ortogonalne

In[45]:=
```
W1 = {LegendreP, HermiteH, LaguerreL, JacobiP, GegenbauerC,
  ChebyshevT, ChebyshevU, ZernikeR, SphericalHarmonicY, WignerD}
```

Out[45]=
```
{LegendreP, HermiteH, LaguerreL, JacobiP, GegenbauerC,
  ChebyshevT, ChebyshevU, ZernikeR, SphericalHarmonicY, WignerD}
```

In[46]:=
```
Information /@ W1
```

LegendreP[n, x] gives the Legendre polynomial $P_n(x)$.
LegendreP[n, m, x] gives the associated Legendre polynomial $P_n^m(x)$. >>

```
Attributes[LegendreP] = {Listable, NumericFunction, Protected, ReadProtected}
```

HermiteH[n, x] gives the Hermite polynomial $H_n(x)$. >>

```
Attributes[HermiteH] = {Listable, NumericFunction, Protected, ReadProtected}
```

LaguerreL[n, x] gives the Laguerre polynomial $L_n(x)$.
LaguerreL[n, a, x] gives the generalized Laguerre polynomial $L_n^a(x)$. >>

```
Attributes[LaguerreL] = {Listable, NumericFunction, Protected, ReadProtected}
```

JacobiP[n, a, b, x] gives the Jacobi polynomial $P_n^{(a,b)}(x)$. >>

```
Attributes[JacobiP] = {Listable, NumericFunction, Protected, ReadProtected}
```

GegenbauerC[n, m, x] gives the Gegenbauer polynomial $C_n^{(m)}(x)$.
GegenbauerC[n, x] gives the renormalized form $\lim_{m\to 0} C_n^{(m)}(x)/m$. >>

```
Attributes[GegenbauerC] = {Listable, NumericFunction, Protected, ReadProtected}
```

ChebyshevT[n, x] gives the Chebyshev polynomial of the first kind $T_n(x)$. >>

```
Attributes[ChebyshevT] = {Listable, NumericFunction, Protected, ReadProtected}
```

ChebyshevU[n, x] gives the Chebyshev polynomial of the second kind $U_n(x)$. >>

```
Attributes[ChebyshevU] = {Listable, NumericFunction, Protected, ReadProtected}
```

ZernikeR[n, m, r] gives the radial Zernike polynomial $R_n^m(r)$. >>

```
Attributes[ZernikeR] = {Listable, NumericFunction, Protected, ReadProtected}
```

SphericalHarmonicY[l, m, θ, ϕ] gives the spherical harmonic $Y_l^m(\theta, \phi)$. >>

```
Attributes[SphericalHarmonicY] = {Listable, NumericFunction, Protected, ReadProtected}
```

WignerD[{j, m_1, m_2}, ψ, θ, ϕ] gives the Wigner D–function $D^j_{m_1,m_2}(\psi, \theta, \phi)$.
WignerD[{j, m_1, m_2}, θ, ϕ] gives the Wigner D–function $D^j_{m_1,m_2}(0, \theta, \phi)$.
WignerD[{j, m_1, m_2}, θ] gives the Wigner D–function $D^j_{m_1,m_2}(0, \theta, 0)$. >>

```
Attributes[WignerD] = {NHoldFirst, Protected, ReadProtected}
```

Out[46]=
```
{Null, Null, Null, Null, Null, Null, Null, Null, Null, Null}
```

zobacz w helpie: guide/SpecialFunctions

Mechanika Kwantowa i funkcje Hermite'a

In[47]:=
```
WolframAlpha["Hermite Polynomials"]
```

Assuming “Hermite Polynomials” is a math function

| Use as referring to a mathematical definition instead

Input:

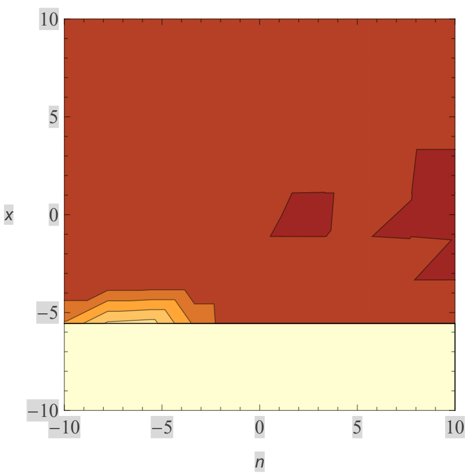
$H_n(x)$

$H_n(x)$ is the n^{th} Hermite polynomial in x »

Values:

n	
0	1
1	$2x$
2	$4x^2 - 2$
3	$8x^3 - 12x$

Contour plot:

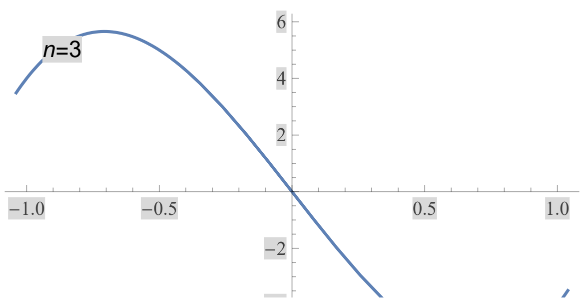


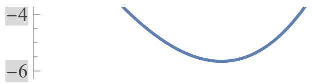
n_{min} n_{max}

x_{min} x_{max}

Interactive plot:

Out[47]=





n integer *n* only ✓

More controls

Series expansion at x=0:

$$\frac{\sqrt{\pi}\ 2^n}{\Gamma\left(\frac{1-n}{2}\right)} + \frac{\sqrt{\pi}\ 2^n\, n\, x}{\Gamma\left(1-\frac{n}{2}\right)} + \frac{\sqrt{\pi}\ 2^{n-1}\,(n-1)\,n\,x^2}{\Gamma\left(\frac{3-n}{2}\right)} + \frac{\sqrt{\pi}\ 2^{n-1}\,(n-2)\,(n-1)\,n\,x^3}{3\,\Gamma\left(2-\frac{n}{2}\right)} + \frac{\sqrt{\pi}\ 2^{n-3}\,(n-3)\,(n-2)\,(n-1)\,n\,x^4}{3\,\Gamma\left(\frac{5-n}{2}\right)} + O\left(x^5\right)$$

(Taylor series)

Γ(*x*) is the gamma function »

Big- O notation »

Series expansion at x=∞:

$$x^n\left((2\,i)^n\left(\cos\left(\frac{n\,\pi}{2}\right) - i\sin\left(\frac{n\,\pi}{2}\right)\right) - \frac{1}{x^2}\,i^n\,2^{n-3}\,(n-1)\,n\left(\csc\left(\frac{n\,\pi}{2}\right) - i\sec\left(\frac{n\,\pi}{2}\right)\right)\sin(n\,\pi) + \frac{1}{x^4}\,i^n\,2^{n-6}\,n\left(n^3-6\,n^2+11\,n-6\right)\left(\csc\left(\frac{n\,\pi}{2}\right) - i\sec\left(\frac{n\,\pi}{2}\right)\right)\sin(n\,\pi) + O\left(\left(\frac{1}{x}\right)^6\right)\right)$$

csc(*x*) is the cosecant function »

sec(*x*) is the secant function »

Big- O notation »

Derivative:

Step–by–step solution

$$\frac{\partial}{\partial x}\left(H_n(x)\right) = 2\,n\,H_{n-1}(x)$$

Indefinite integral:

$$\int H_n(x)\,dx = \frac{H_{n+1}(x)}{2\,n+2} + \text{constant}$$

WolframAlpha

In[48]:=

```
ψ[n_Integer, x_] := (HermiteH[n, x] e^(-x²/2)) / (√(2ⁿ n! √π))
```

In[49]:=

```
Integrate[ψ[10, x]^2, {x, -Infinity, Infinity}]
```

Integrate::idiv : Integral of $e^{-x^2}\left(-32x^{10}+720x^8-5040x^6+12600x^4-9450x^2+945\right)^2$ does not converge on {−∞, ∞}. ≫

Out[49]=

$$\int_{-\infty}^{\infty}\left(\left(e^{-x^2}\left(1024x^{10}-23\,040x^8+161\,280x^6-403\,200x^4+302\,400x^2-30\,240\right)^2\right)\Big/\left(3\,715\,891\,200\sqrt{\pi}\right)\right)dx$$

In[50]:=

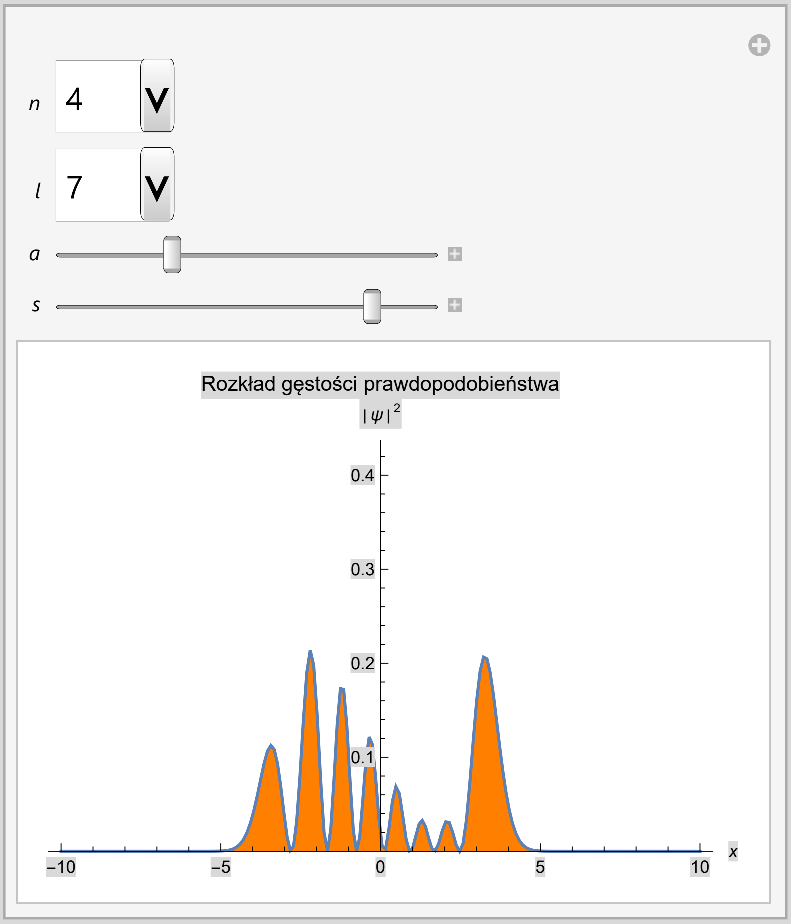
```
Integrate[ψ[10, x] ψ[3, x], {x, -Infinity, Infinity}]
```

Out[50]= 0

In[51]:=

```
Manipulate[
 Plot[(a ψ[n, x] + (1 - a) ψ[l, x])^2, {x, -10, 10},
  PlotRange → {0, 0.5 s}, Filling → Bottom, AxesLabel → {x, |ψ|^2},
  PlotLabel → "Rozkład gęstości prawdopodobieństwa",
  Filling → Axis, FillingStyle → Orange],
 {n, Range[10]}, {l, Range[20]}, {a, 0, 1}, {s, 0.1, 1}]
```

Out[51]=



In[52]:=

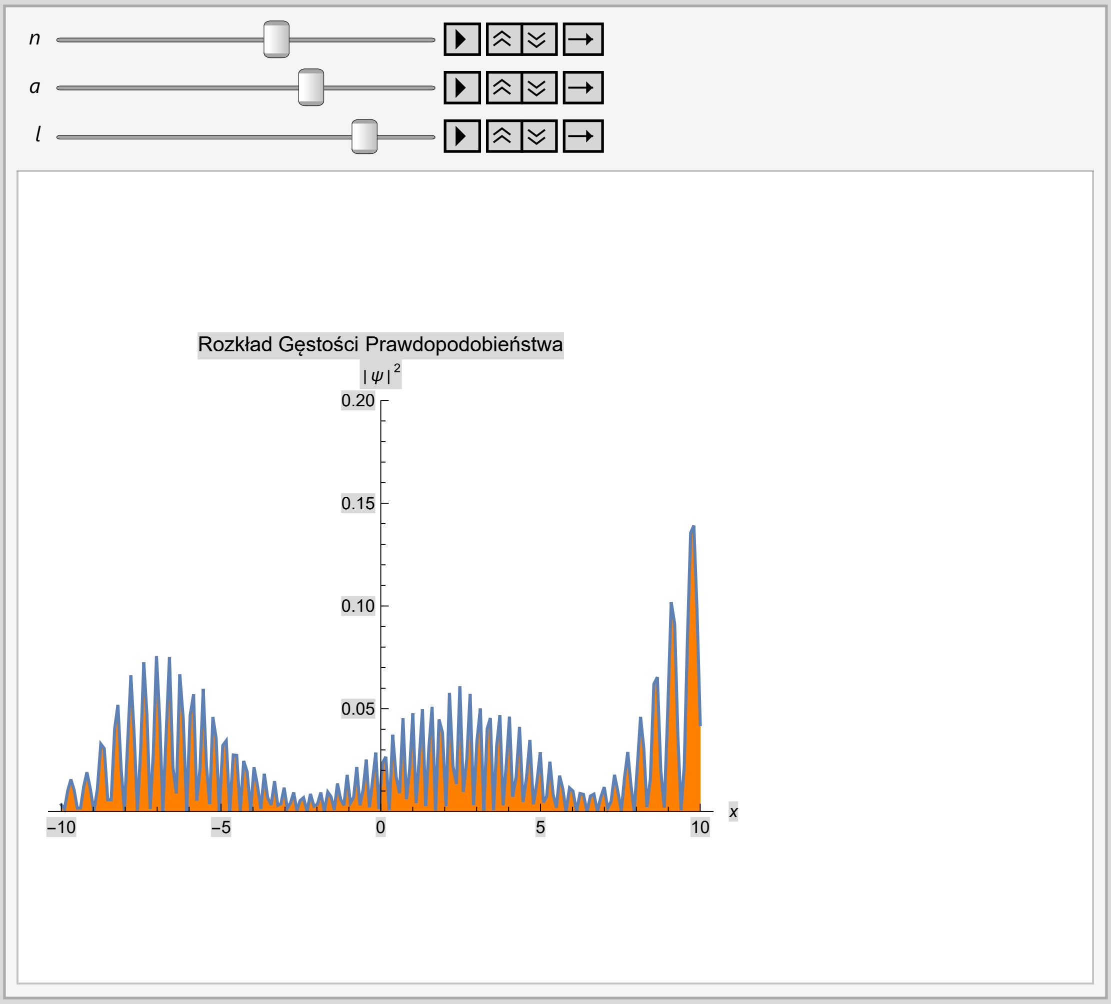
```
? Animate
```

Animate[*expr*, {*u*, u_{min}, u_{max}}] generates an animation of *expr* in which *u* varies continuously from u_{min} to u_{max}.
Animate[*expr*, {*u*, u_{min}, u_{max}, *du*}] takes *u* to vary in steps *du*.
Animate[*expr*, {*u*, {u_1, u_2, …}}] makes *u* take on discrete values u_1, u_2, ….
Animate[*expr*, {*u*, …}, {*v*, …}, …] varies all the variables *u*, *v*, …. ≫

In[53]:=

```
Animate[
 Plot[(a ψ[Floor[n], x] + (a - 1) ψ[Floor[l] + 9, x])^2, {x, -10, 10},
  PlotRange → {0, 0.2}, Filling → Bottom, AxesLabel → {x, |ψ|^2},
  PlotLabel → "Rozkład Gęstości Prawdopodobieństwa", Filling → Axis,
  FillingStyle → Orange], {n, 1, 100}, {a, 0, 1}, {l, 1, 50}]
```

Out[53]=



Funkcje bez nazwy - funkcje prymitywne - pure functions

Podstawy

In[54]:=

```
? Function
```

Function[*body*] or *body* & is a pure function. The formal parameters are # (or #1), #2, etc.
Function[*x*, *body*] is a pure function with a single formal parameter *x*.
Function[{x_1, x_2, …}, *body*] is a pure function with a list of formal parameters. >>

In[55]:=
```
Function[zmienna, ciało]
```
Out[55]= zmienna ⟼ ciało

In[56]:=
```
Function[var, var^3]
```
Out[56]= var ⟼ var^3

In[57]:=
```
Function[var, var^3][Slonce]
```
Out[57]= Slonce^3

In[58]:=
```
Function[x, x^2]
```
Out[58]= $x \longmapsto x^2$

In[59]:=
```
esc fn esc
```
Out[59]= $\text{esc}^2\ \text{fn}$

In[60]:=
```
x ↦ x^3
```
Out[60]= $x \longmapsto x^3$

In[61]:=
```
x ↦ Sin[x]
```
Out[61]= $x \longmapsto \sin(x)$

In[62]:=
```
Function[x, x^2][A]
```
Out[62]= A^2

In[63]:=
```
Function[{u, y}, Log[u + I y]]
```
Out[63]= $\{u,\ y\} \longmapsto \log(u + i\ y)$

In[64]:=
```
Function[{u, y}, Log[u + I y]][A, B]
```
Out[64]= $\log(A + i\ B)$

In[65]:=
```
Function[Cos[#]]
```
Out[65]= cos(#1) &

In[66]:=
```
Function[Cos[#]][A]
```
Out[66]= $\cos(A)$

Zapis alternatywny skrótowy

In[67]:=
```
Function[zmienna, ciało]  === cialo &
```
Out[67]= (zmienna ⟼ ciało) === cialo &

In[68]:=
```
#^3 & // FullForm
```
Out[68]//FullForm= Function[Power[Slot[1], 3]]

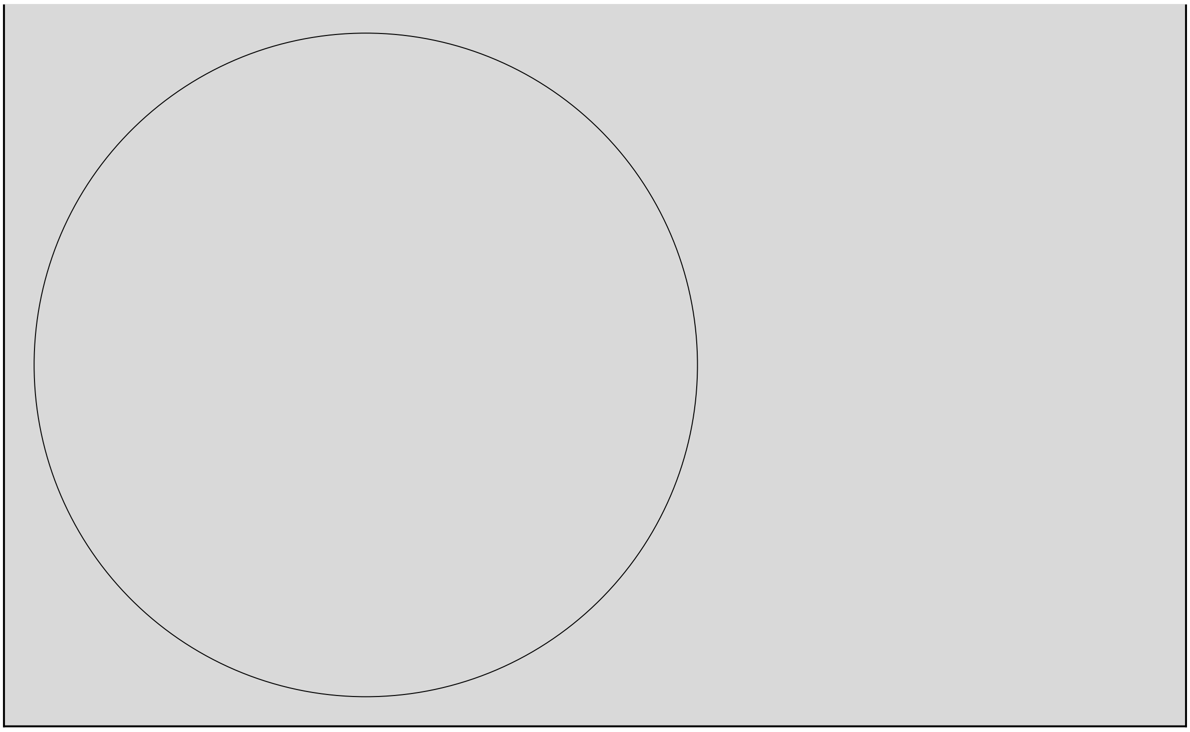
In[69]:=
```
#^3 &[y]
```
Out[69]= y^3

In[70]:=
```
#^3 &@ y
```
Out[70]= y^3

In[71]:=
```
Function[x, Circle[x]][Graczyk]
```
Out[71]= Circle[Graczyk]

In[72]:=
```
Function[x, Circle[x]][{1, 1}]
Graphics@%
```
Out[72]= Circle[{1, 1}]

Out[73]=



In[74]:=
```
? Circle
```

Circle[{x, y}, r] represents a circle of radius r centered at {x, y}.
Circle[{x, y}] gives a circle of radius 1.
Circle[{x, y}, {r_x, r_y}] gives an axis–aligned ellipse with semi–axes lengths r_x and r_y.
Circle[{x, y}, …, {θ_1, θ_2}] gives a circular or ellipse arc from angle θ_1 to θ_2. >>

Przykład z Select

In[75]:=
```
? Select
```

Select[*list*, *crit*] picks out all elements e_i of *list* for which *crit*[e_i] is True.
Select[*list*, *crit*, *n*] picks out the first *n* elements for which *crit*[e_i] is True.
Select[*crit*] represents an operator form of Select that can be applied to an expression. >>

In[76]:=
```
Select[{1, a, x^2, 3, 5, 1 + x, 7}, # > 4 &]
```

Out[76]= {5, 7}

In[77]:=
```
test[expr_] := PolynomialQ[expr, x]
```

In[78]:=
```
1 + x + 2 x^2 + 1 / x + 3 x^3 + Sin[x]
Select[%, test]
```

Out[78]= $3x^3 + 2x^2 + x + \frac{1}{x} + \sin(x) + 1$

Out[79]= $3x^3 + 2x^2 + x + 1$

Można bez definiowania funkcji test

In[80]:=
```
1 + x + 2 x^2 + 1 / x + 3 x^3 + Sin[x]
Select[%, Function[var, PolynomialQ[var, x]]]
```

Out[80]= $3x^3 + 2x^2 + x + \frac{1}{x} + \sin(x) + 1$

Out[81]= $3x^3 + 2x^2 + x + 1$

I najkrócej

In[82]:=
```
1 + x + 2 x^2 + 1 / x + 3 x^3 + Sin[x]
Select[%, PolynomialQ[#, x] &]
```

Out[82]= $3x^3 + 2x^2 + x + \frac{1}{x} + \sin(x) + 1$

Out[83]= $3x^3 + 2x^2 + x + 1$

In[84]:=
```
{2.2, 1, 0, -1, 1 / 2, 4 + I 5}
Select[%, IntegerQ]
```
Out[84]= $\left\{2.2, 1, 0, -1, \frac{1}{2}, 4+5\,i\right\}$

Out[85]= $\{1, 0, -1\}$

In[86]:=
```
Select[%%, Element[#, Rationals] &]
```
Out[86]= $\left\{1, 0, -1, \frac{1}{2}\right\}$

Kolejne przykłady

In[87]:=
```
Sin[#^2] &[x]
```
Out[87]= $\sin(x^2)$

In[88]:=
```
Integrate[#1^2, #2] &[x^2, x]
```
Out[88]= $\frac{x^5}{5}$

In[89]:=
```
Integrate[#1^2, #2] &@@ {x^2, x}
```
Out[89]= $\frac{x^5}{5}$

In[90]:=
```
#1^3 + Sin[#2] &[x, y]
```
Out[90]= $x^3 + \sin(y)$

Funkcja zagnieżdżona Nest

In[91]:=
```
WolframAlpha["Nest"]
```

Assuming "Nest" is a word | Use as

referring to a Wolfram Language symbol or a stadium or more | ▾ instead

Input interpretation:

nest (English word)

Definitions: Show all More

1	noun	a structure in which animals lay eggs or give birth to their young
2	noun	a kind of gun emplacement
3	noun	a cosy or secluded retreat
4	noun	a gang of people (criminals or spies or terrorists) assembled in one locality
5	noun	furniture pieces made to fit close together
6	verb	inhabit a nest, usually after building
7	verb	fit together or fit inside
8	verb	move or arrange oneself in a comfortable and cozy position
9	verb	gather nests

(9 meanings)

American pronunciation:

n'est (IPA: n▯▯st)

Hyphenation:

nest (no hyphenation) (4 letters | 1 syllable)

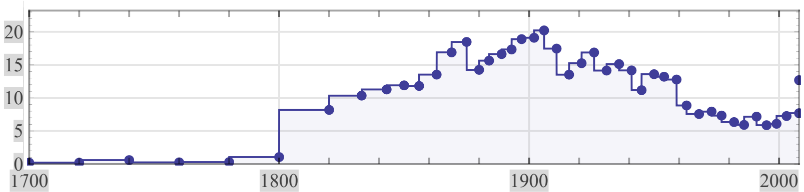
First known use in English:

1700 (European Renaissance) (317 years ago)

Word origins:

Old English |

Word frequency history: Linear scale | Binned |



(from 1719 to 2007) (in occurrences per million words per year)

+ Definitions

Inflected forms:

nests | nested | nesting

Synonyms: Show synonym network

cuddle | draw close | nestle | nuzzle | snuggle (total: 5)

Narrower terms: Meanings combined |

beehive | bird nest | birdnest | bird's nest | drey | hive | mouse nest | mouse's nest | nidus | sleeper nest (total: 10)

Out[91]=

Broader terms: Meanings combined | More

natural object | gun emplacement | weapons emplacement | retreat | gang | mob | pack | ring | article of furniture | furniture | piece of furniture | dwell | inhabit | live | populate | … (total: 28)

Rhymes: Sorted alphabetically | More

abreast | acquiesced | addressed | arrest | assessed | attest | behest | bequest | best | blessed | blest | breast | chest | coalesced | compressed | … (total: 67)

(based on typical American pronunciation)

Lexically close words: 1–letter difference

best | Best | fest | jest | lest | neat | nett | newt | next | pest | rest | test | vest | west | West | yest | zest | Zest (total: 18)

Anagrams:

nets | sent | tens

Phrases: More

bird- nest | bird's nest fern | bird's- nest fungus | climbing bird's nest fern | crow's nest | cuckoo's nest | feather one's nest | hornet's nest | hornets' nest | mare's nest | … (total: 13)

Translations: More

Polish:	gniazdo (noun)
German:	Nest (birds)
Mandarin:	□□ (noun)
Hindi:	□□□□□□□□(noun)
Spanish:	nido (birds)

Other notable uses:

Surnames:

Nest (US population: 500 people, white: 77%)

Administrative divisions:

Crow's Nest (Queensland, Australia)

Cities:

Eagle Nest (New Mexico, United States, 257 people) | Crows Nest (Indiana, United States, 75 people) | Hawkes Nest (Turks and Caicos Islands, 4 people) | North Crows Nest (Indiana, United States, 47 people)

Books:

Hornet's Nest (Patricia Cornwell) | One Flew Over the Cuckoo's Nest (Ken Kesey) | The Girl Who Kicked The Hornets' Nest (Stieg Larsson)

Movies:

The Girl Who Kicked the Hornets' Nest |

One Flew Over the Cuckoo's Nest | OSS 117: Cairo, Nest of Spies

Internet domains:

nest.com | nest.net | nest.org | nest.info | nest.biz (total: 5)

Crossword puzzle clues: Less More

"Cheep" accommodations? | "___–ce pas?" | Airy home | Arbor abode | Arboreal abode | Avian haunt | Bird pad | Bird sanctuary | Bird's home | Birth place | Branch headquarters? | Breeding place | Brood | Build a tree house? | Cardinal point? | Cardinal's home | Catbird seat? | … (total: 100)

(based on all New York Times crossword puzzles 1994 to 2009)

Scrabble score:

4 (International English) | 4 (North American English)

WolframAlpha

In[92]:=
```
? Nest
```

Nest[f, $expr$, n] gives an expression with f applied n times to $expr$. ≫

In[93]:=
```
f[x_] := 1 / (1 + x)
```

In[94]:=
```
Nest[f, x, 4]
```

Out[94]=

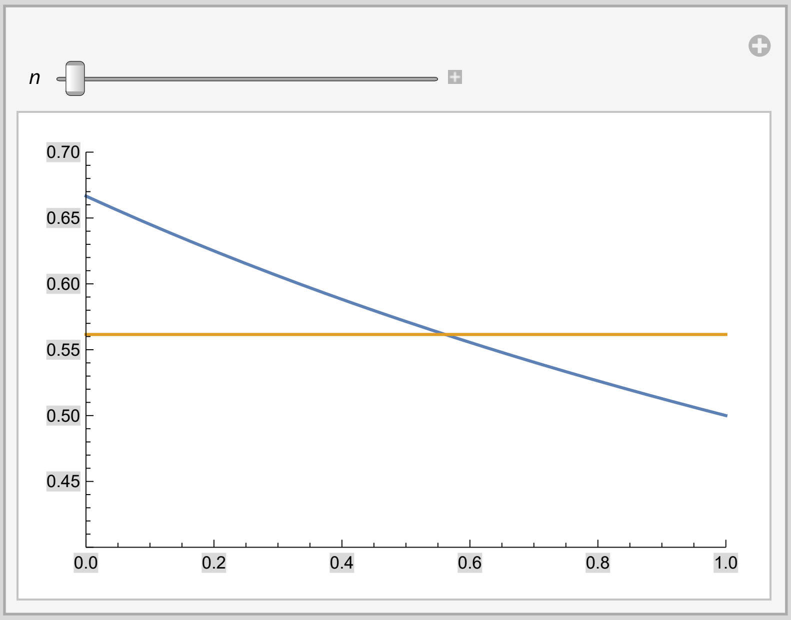
$$\frac{1}{\frac{1}{\frac{1}{\frac{1}{x+1}+1}+1}+1}$$

In[95]:=
```
Nest[2 / (3 + #) &, x, 10]
```

Out[95]=

$$\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{\frac{2}{x+3}+3}+3}+3}+3}+3}+3}+3}+3}+3}$$

In[96]:=
```
Manipulate[Plot[{Nest[2 / (3 + #) &, x, n], Nest[2 / (3 + #) &, x, 20]},
  {x, 0, 1}, PlotRange → {{0, 1}, {0.4, 0.7}}], {n, 1, 20, 1}]
```

Out[96]=


Więcej argumentów

In[97]:=
```
Function[3 #1 + #2^2][y, zz]
```

Out[97]= $3\,y + zz^2$

In[98]:=
```
3 #1 + #2^2 &[y, zz]
```

Out[98]= $3\,y + zz^2$

In[99]:=
```
{#3, #2, #1} &[A, B, C]
```

Out[99]= {C, B, A}

In[100]:=
```
## (* Ciąg wszystkich zmiennych w funkcji bez nazwy *)
```

Out[100]= ##1

In[101]:=
```
##n (* reprezentuje ciąg zmiennych począwszy od n-tej
```

In[101]:=
```
Clear[mojafun]
mojafun[x__] := {x}
```

In[103]:=
```
mojafun[{a, b, c}]
```

Out[103]= (a b c)

In[104]:=
```
{##} &[a, b, c, f, g, h, i, f]
```
Out[104]= $\{a, b, c, f, g, h, i, f\}$

In[105]:=
```
{##2} &[a, b, c]
```
Out[105]= $\{b, c\}$

In[106]:=
```
Function[x, p[x]][{a, b, c}]
Function[x, p[x], Listable][{a, b, c}]
```
Out[106]= $p(\{a, b, c\})$

Out[107]= $\{p(a), p(b), p(c)\}$

Operator Gradientu i Dywergencja -- Geometria 3D

Zdefinujmy operator gradientu

In[108]:=
```
Clear[x, y, z]
```

In[109]:=
```
{D[#, x], D[#, y], D[#, z]} &
```
Out[109]= $\left\{\frac{\partial \#1}{\partial x}, \frac{\partial \#1}{\partial y}, \frac{\partial \#1}{\partial z}\right\} \&$

In[110]:=
```
{D[#, x], D[#, y], D[#, z]} &@ff[x, y, z]
```
Out[110]= $\left\{\text{ff}^{(1,0,0)}(x, y, z), \text{ff}^{(0,1,0)}(x, y, z), \text{ff}^{(0,0,1)}(x, y, z)\right\}$

Zdefiniujmy operator dywergencji?