Sprawozdanie obliczenia naukowe
Lista 2

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1 Zadanie 1

1.1 Wyniki

pa: -0.004296342739891585
pb: -0.004296342998713953
pc: -0.004296342842280865
pd: -0.004296342842280865
pa32: -0.4999443
pb32: -0.4543457
pc32: -0.5
pd32: -0.5
og:
pa: 1.0251881368296672e-10
pb: -1.5643308870494366e-10
pc: 0.0
pd: 0.0
pa32: -0.4999443
pb32: -0.4543457
pc32: -0.5
pd32: -0.5

1.2 Wnioski

Zadanie źle uwarunkowane — patrz wykład

2 Zadanie 2

2.1 Wyniki

//wykresy

2.2 Wnioski

dla $x \to -\infty$ lim = 0
dla $x \to \infty$ lim =1

3 Zadanie 3

3.1 Wyniki

Wyniki dla Macierzy Hilb:

N	Typ rozwiązania	Błąd względny
1	Gauss	0.0
	Inv	0.0
2	Gauss	$5.661\,048\,867\,003\,676 \times 10^{-16}$
	Inv	$1.404\,333\,387\,430\,680\,3 \times 10^{-15}$
3	Gauss	$8.022\,593\,772\,267\,726 \times 10^{-15}$
	Inv	0.0
4	Gauss	$4.137\,409\,622\,430\,382 \times 10^{-14}$
	Inv	0.0
5	Gauss	$1.682\,842\,629\,922\,719\,5 \times 10^{-12}$
	Inv	$3.354\,436\,058\,435\,963\,2 \times 10^{-12}$
6	Gauss	$2.618\,913\,302\,311\,624 \times 10^{-10}$
	Inv	$2.016\,375\,940\,434\,765\,4 \times 10^{-10}$
7	Gauss	$1.260\,686\,722\,417\,154\,8 \times 10^{-8}$
	Inv	$4.713\,280\,397\,232\,037 \times 10^{-9}$
8	Gauss	$6.124\,089\,555\,723\,088 \times 10^{-8}$
	Inv	$3.077\,483\,903\,096\,22 \times 10^{-7}$
9	Gauss	$3.875\,163\,418\,503\,247\,5 \times 10^{-6}$
	Inv	$4.541\,268\,303\,176\,643 \times 10^{-6}$
10	Gauss	$8.670\,390\,237\,096\,91 \times 10^{-5}$
	Inv	0.000 250 149 341 182 488 6
11	Gauss	0.000 158 278 081 585 904 35
	Inv	0.007 618 304 284 315 809
12	Gauss	0.133 962 083 720 853 44
	Inv	0.258 994 120 804 705
13	Gauss	0.110 397 011 178 682 64
	Inv	5.331 275 639 426 837
14	Gauss	1.455 408 712 765 964 3
	Inv	8.714 992 751 048 14
15	Gauss	4.696 668 350 857 427
	Inv	7.344 641 453 111 494
16	Gauss	54.155 189 545 646 02
	Inv	29.848 842 070 735 41
17	Gauss	13.707 236 683 836 307
	Inv	10.516 942 378 369 349
18	Gauss	10.257 619 124 632 317
	Inv	24.762 070 989 128 866
19	Gauss	102.159 834 862 708 27
	Inv	109.945 507 328 782 84
20	Gauss	108.317 773 462 062 05
	Inv	114.344 031 525 575 72

Wyniki dla macierzy Matcond:

N	C	Typ rozwiązania	Błąd względny
5	1.0	Gauss	$2.220\,446\,049\,250\,313 \times 10^{-16}$
		Inv	$1.110\,223\,024\,625\,156\,5 \times 10^{-16}$
	10.0	Gauss	$7.818\,997\,388\,068\,909 \times 10^{-16}$
		Inv	$4.965\,068\,306\,494\,546 \times 10^{-16}$
	10 000.0	Gauss	$1.404\,333\,387\,430\,680\,4 \times 10^{-16}$
		Inv	$1.374\,858\,882\,450\,988\,2 \times 10^{-13}$
	1.0×10^{8}	Gauss	$6.804\,459\,704\,896\,332 \times 10^{-10}$
		Inv	$6.333\,678\,266\,375\,997 \times 10^{-10}$
	1.0×10^{13}	Gauss	0.000 229 351 120 107 414 82
		Inv	$8.631\,674\,575\,031\,098 \times 10^{-5}$
	1.0×10^{17}	Gauss	3.188 349 061 503 315
		Inv	0.418 184 085 885 032 2
10	1.0	Gauss	$1.755\,416\,734\,288\,350\,4 \times 10^{-16}$
		Inv	$2.937\,374\,022\,976\,103 \times 10^{-16}$
	10.0	Gauss	$4.168\,883\,761\,650\,163 \times 10^{-16}$
		Inv	$3.349\,121\,675\,321\,943 \times 10^{-16}$
	10 000.0	Gauss	$1.986\,945\,058\,591\,428 \times 10^{-13}$
		Inv	$3.540\,793\,478\,199\,175 \times 10^{-14}$
	1.0×10^{8}	Gauss	$2.021\,580\,377\,196\,233\,3 \times 10^{-9}$
		Inv	$1.539\,149\,683\,065\,564\,3 \times 10^{-9}$
	1.0×10^{13}	Gauss	0.000 223 663 581 473 606 63
		Inv	0.000 172 903 020 925 479 66
	1.0×10^{17}	Gauss	1.088 156 894 260 934 8
		Inv	0.225 164 480 489 098 84
20	1.0	Gauss	$5.484\,097\,192\,022\,683 \times 10^{-16}$
		Inv	$4.198\,346\,204\,284\,728 \times 10^{-16}$
	10.0	Gauss	$4.927\,689\,594\,407\,735 \times 10^{-16}$
		Inv	$5.376\,277\,206\,893\,598 \times 10^{-16}$
	10 000.0	Gauss	$1.782\,301\,417\,701\,839\,7 \times 10^{-13}$
		Inv	$1.315\,834\,155\,549\,535\,5 \times 10^{-13}$
	1.0×10^{8}	Gauss	$4.606\,463\,401\,416\,786 \times 10^{-9}$
		Inv	$3.980\,420\,992\,607\,652\,3 \times 10^{-10}$
	1.0×10^{13}	Gauss	$4.376\,080\,773\,842\,657\,5 \times 10^{-5}$
		Inv	$1.378\,710\,965\,614\,410\,5 \times 10^{-5}$
	1.0×10^{17}	Gauss	3.089 472 405 210 816 7
		Inv	0.254 242 565 725 258 7

Wyniki cond dla macierzy rzędu 6 (oraz c = 10^7)
Cond A hilb: $1.4951058642254665 * 10^7$
Cond A matcond: $1.000000003815985 * 10^8$

3.2 Wnioski

4 Zadanie 4

4.1 Wyniki

A)

Obliczone miejsce zerowe	Operacja	Wynik
0.9999999999996989	$\lvert P(Z_k)\rvert$	35 696.509 647 882 57
	$\lvert p(Z_k)\rvert$	36 626.425 482 422 805
	$\lvert k - z_k\rvert$	$3.010\,924\,842\,783\,424\,5 \times 10^{-13}$
2.0000000000283182	$\lvert P(Z_k)\rvert$	176 252.600 266 684 05
	$\lvert p(Z_k)\rvert$	181 303.933 672 576 62
	$\lvert k - z_k\rvert$	$2.831\,823\,664\,450\,894\,3 \times 10^{-11}$
2.9999999995920965	$\lvert P(Z_k)\rvert$	279 157.696 882 408 7
	$\lvert p(Z_k)\rvert$	290 172.285 889 168 6
	$\lvert k - z_k\rvert$	$4.079\,034\,887\,638\,499\,6 \times 10^{-10}$
3.9999999837375317	$\lvert P(Z_k)\rvert$	$3.027\,109\,298\,899\,108\,5 \times 10^{6}$
	$\lvert p(Z_k)\rvert$	$2.041\,537\,290\,275\,090\,1 \times 10^{6}$
	$\lvert k - z_k\rvert$	$1.626\,246\,826\,091\,915 \times 10^{-8}$
5.000000665769791	$\lvert P(Z_k)\rvert$	$2.291\,747\,375\,656\,707\,6 \times 10^{7}$
	$\lvert p(Z_k)\rvert$	$2.089\,462\,500\,696\,218\,8 \times 10^{7}$
	$\lvert k - z_k\rvert$	$6.657\,697\,912\,970\,661 \times 10^{-7}$
5.999989245824773	$\lvert P(Z_k)\rvert$	$1.290\,241\,728\,420\,509\,5 \times 10^{8}$
	$\lvert p(Z_k)\rvert$	$1.125\,048\,457\,756\,299\,5 \times 10^{8}$
	$\lvert k - z_k\rvert$	$1.075\,417\,522\,677\,923\,9 \times 10^{-5}$
7.000102002793008	$\lvert P(Z_k)\rvert$	$4.805\,112\,754\,602\,064 \times 10^{8}$
	$\lvert p(Z_k)\rvert$	$4.572\,908\,642\,730\,946 \times 10^{8}$
	$\lvert k - z_k\rvert$	0.000 102 002 793 007 649 47
7.999355829607762	$\lvert P(Z_k)\rvert$	$1.637\,952\,021\,896\,113\,6 \times 10^{9}$
	$\lvert p(Z_k)\rvert$	$1.555\,645\,937\,735\,738\,3 \times 10^{9}$
	$\lvert k - z_k\rvert$	0.000 644 170 392 238 407 9
9.002915294362053	$\lvert P(Z_k)\rvert$	$4.877\,071\,372\,550\,003 \times 10^{9}$
	$\lvert p(Z_k)\rvert$	$4.687\,816\,175\,648\,389 \times 10^{9}$
	$\lvert k - z_k\rvert$	0.002 915 294 362 052 734
9.990413042481725	$\lvert P(Z_k)\rvert$	$1.363\,863\,819\,545\,812\,8 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$1.263\,460\,189\,694\,920\,5 \times 10^{10}$
	$\lvert k - z_k\rvert$	0.009 586 957 518 274 986
11.025022932909318	$\lvert P(Z_k)\rvert$	$3.585\,631\,295\,130\,865 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$3.300\,128\,474\,498\,415 \times 10^{10}$
	$\lvert k - z_k\rvert$	0.025 022 932 909 317 674
11.953283253846857	$\lvert P(Z_k)\rvert$	$7.533\,332\,360\,358\,197 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$7.388\,525\,665\,404\,988 \times 10^{10}$
	$\lvert k - z_k\rvert$	0.046 716 746 153 142 81

Obliczone miejsce zerowe	Operacja	Wynik
13.07431403244734	$\lvert P(Z_k)\rvert$	$1.960\,598\,812\,433\,081\,7 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$1.847\,621\,509\,314\,419\,3 \times 10^{11}$
	$\lvert k - z_k\rvert$	$0.074\,314\,032\,447\,340\,14$
13.914755591802127	$\lvert P(Z_k)\rvert$	$3.575\,134\,782\,310\,431\,5 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$3.551\,427\,752\,842\,084\,4 \times 10^{11}$
	$\lvert k - z_k\rvert$	$0.085\,244\,408\,197\,873\,16$
15.075493799699476	$\lvert P(Z_k)\rvert$	$8.216\,271\,236\,455\,97 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$8.423\,201\,558\,964\,254 \times 10^{11}$
	$\lvert k - z_k\rvert$	$0.075\,493\,799\,699\,476\,23$
15.946286716607972	$\lvert P(Z_k)\rvert$	$1.551\,497\,888\,049\,406\,7 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$1.570\,728\,736\,625\,802 \times 10^{12}$
	$\lvert k - z_k\rvert$	$0.053\,713\,283\,392\,028\,19$
17.025427146237412	$\lvert P(Z_k)\rvert$	$3.694\,735\,918\,486\,229 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$3.316\,978\,223\,889\,236\,3 \times 10^{12}$
	$\lvert k - z_k\rvert$	$0.025\,427\,146\,237\,412\,046$
17.99092135271648	$\lvert P(Z_k)\rvert$	$7.650\,109\,016\,515\,867 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$6.344\,853\,141\,791\,28 \times 10^{12}$
	$\lvert k - z_k\rvert$	$0.009\,078\,647\,283\,519\,814$
19.00190981829944	$\lvert P(Z_k)\rvert$	$1.143\,527\,374\,972\,119\,5 \times 10^{13}$
	$\lvert p(Z_k)\rvert$	$1.228\,571\,736\,671\,966 \times 10^{13}$
	$\lvert k - z_k\rvert$	$0.001\,909\,818\,299\,438\,370\,6$
19.999809291236637	$\lvert P(Z_k)\rvert$	$2.792\,410\,639\,368\,072\,7 \times 10^{13}$
	$\lvert p(Z_k)\rvert$	$2.318\,309\,535\,271\,638 \times 10^{13}$
	$\lvert k - z_k\rvert$	$0.000\,190\,708\,763\,362\,579\,25$

B)

Obliczone miejsce zerowe	Operacja	Wynik
0.9999999999998357 + 0.0im	$\lvert P(Z_k)\rvert$	$20\,259.872\,313\,418\,207$
	$\lvert p(Z_k)\rvert$	$19\,987.872\,313\,406\,835$
	$\lvert k - z_k\rvert$	$1.643\,130\,076\,445\,231\,7 \times 10^{-13}$
2.0000000000550373 + 0.0im	$\lvert P(Z_k)\rvert$	$346\,541.413\,759\,383\,6$
	$\lvert p(Z_k)\rvert$	$352\,369.413\,808\,795\,8$
	$\lvert k - z_k\rvert$	$5.503\,730\,804\,434\,781 \times 10^{-11}$
2.99999999660342 + 0.0im	$\lvert P(Z_k)\rvert$	$2.258\,059\,700\,119\,700\,7 \times 10^{6}$
	$\lvert p(Z_k)\rvert$	$2.416\,241\,558\,251\,843\,3 \times 10^{6}$
	$\lvert k - z_k\rvert$	$3.396\,579\,906\,222\,996\,2 \times 10^{-9}$
4.000000089724362 + 0.0im	$\lvert P(Z_k)\rvert$	$1.054\,263\,179\,039\,547\,8 \times 10^{7}$
	$\lvert p(Z_k)\rvert$	$1.126\,370\,230\,029\,202\,3 \times 10^{7}$
	$\lvert k - z_k\rvert$	$8.972\,436\,216\,225\,788 \times 10^{-8}$
4.99999857388791 + 0.0im	$\lvert P(Z_k)\rvert$	$3.757\,830\,916\,585\,153 \times 10^{7}$
	$\lvert p(Z_k)\rvert$	$4.475\,744\,423\,806\,908 \times 10^{7}$
	$\lvert k - z_k\rvert$	$1.426\,112\,089\,752\,962\,2 \times 10^{-6}$

Obliczone miejsce zerowe	Operacja	Wynik
6.000020476673031 + 0.0im	$\lvert P(Z_k)\rvert$	$1.314\,094\,332\,556\,944\,6 \times 10^{8}$
	$\lvert p(Z_k)\rvert$	$2.142\,103\,165\,803\,931\,7 \times 10^{8}$
	$\lvert k - z_k\rvert$	$2.047\,667\,303\,095\,579\,4 \times 10^{-5}$
6.99960207042242 + 0.0im	$\lvert P(Z_k)\rvert$	$3.939\,355\,874\,647\,618 \times 10^{8}$
	$\lvert p(Z_k)\rvert$	$1.784\,617\,342\,786\,064\,4 \times 10^{9}$
	$\lvert k - z_k\rvert$	$0.000\,397\,929\,577\,579\,780\,87$
8.007772029099446 + 0.0im	$\lvert P(Z_k)\rvert$	$1.184\,986\,961\,371\,896 \times 10^{9}$
	$\lvert p(Z_k)\rvert$	$1.868\,697\,217\,000\,985\,7 \times 10^{10}$
	$\lvert k - z_k\rvert$	$0.007\,772\,029\,099\,445\,632$
8.915816367932559 + 0.0im	$\lvert P(Z_k)\rvert$	$2.225\,522\,123\,307\,770\,7 \times 10^{9}$
	$\lvert p(Z_k)\rvert$	$1.374\,630\,977\,514\,299\,3 \times 10^{11}$
	$\lvert k - z_k\rvert$	$0.084\,183\,632\,067\,441\,4$
10.095455630535774 - 0.6449328236240688im	$\lvert P(Z_k)\rvert$	$1.067\,792\,123\,293\,015\,7 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$1.490\,069\,535\,200\,058 \times 10^{12}$
	$\lvert k - z_k\rvert$	$0.651\,958\,683\,038\,040\,7$
10.095455630535774 + 0.6449328236240688im	$\lvert P(Z_k)\rvert$	$1.067\,792\,123\,293\,015\,7 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$1.490\,069\,535\,200\,058 \times 10^{12}$
	$\lvert k - z_k\rvert$	$1.110\,918\,027\,271\,656\,1$
11.793890586174369 - 1.6524771364075785im	$\lvert P(Z_k)\rvert$	$3.140\,196\,234\,442\,948\,5 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$3.296\,279\,235\,571\,714\,5 \times 10^{13}$
	$\lvert k - z_k\rvert$	$1.665\,281\,290\,598\,479$
11.793890586174369 + 1.6524771364075785im	$\lvert P(Z_k)\rvert$	$3.140\,196\,234\,442\,948\,5 \times 10^{10}$
	$\lvert p(Z_k)\rvert$	$3.296\,279\,235\,571\,714\,5 \times 10^{13}$
	$\lvert k - z_k\rvert$	$2.045\,820\,276\,678\,427\,7$
13.992406684487216 - 2.5188244257108443im	$\lvert P(Z_k)\rvert$	$2.157\,665\,405\,951\,858 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$9.546\,022\,365\,750\,216 \times 10^{14}$
	$\lvert k - z_k\rvert$	$2.518\,835\,871\,190\,904$
13.992406684487216 + 2.5188244257108443im	$\lvert P(Z_k)\rvert$	$2.157\,665\,405\,951\,858 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$9.546\,022\,365\,750\,216 \times 10^{14}$
	$\lvert k - z_k\rvert$	$2.712\,880\,531\,284\,709\,7$
16.73074487979267 - 2.812624896721978im	$\lvert P(Z_k)\rvert$	$4.850\,110\,893\,921\,027 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$2.742\,106\,076\,928\,478 \times 10^{16}$
	$\lvert k - z_k\rvert$	$2.906\,001\,873\,537\,510\,6$
16.73074487979267 + 2.812624896721978im	$\lvert P(Z_k)\rvert$	$4.850\,110\,893\,921\,027 \times 10^{11}$
	$\lvert p(Z_k)\rvert$	$2.742\,106\,076\,928\,478 \times 10^{16}$
	$\lvert k - z_k\rvert$	$2.825\,483\,521\,349\,608$
19.5024423688181 - 1.940331978642903im	$\lvert P(Z_k)\rvert$	$4.557\,199\,223\,869\,993 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$4.252\,485\,876\,520\,372\,5 \times 10^{17}$
	$\lvert k - z_k\rvert$	$2.454\,021\,446\,312\,976\,4$
19.5024423688181 + 1.940331978642903im	$\lvert P(Z_k)\rvert$	$4.557\,199\,223\,869\,993 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$4.252\,485\,876\,520\,372\,5 \times 10^{17}$
	$\lvert k - z_k\rvert$	$2.004\,329\,444\,309\,948\,6$
20.84691021519479 + 0.0im	$\lvert P(Z_k)\rvert$	$8.756\,386\,551\,865\,696 \times 10^{12}$
	$\lvert p(Z_k)\rvert$	$1.374\,374\,355\,999\,76 \times 10^{18}$

Obliczone miejsce zerowe	Operacja	Wynik
	$\lvert k - z_k \rvert$	$0.846\,910\,215\,194\,789\,4$

4.2 Wnioski