ANALIZA WRAŻLIWOŚCI PROBABILISTYCZNYCH SIECI NEURONOWYCH

PIOTR A. KOWALSKI

KATEDRA INFORMATYKI STOSOWANEJ I FIZYKI KOMPUTEROWEJ,
WYDZIAŁ FIZYKI I INFORMATYKI STOSOWANEJ,
AKADEMIA GÓRNICZO-HUTNICZA

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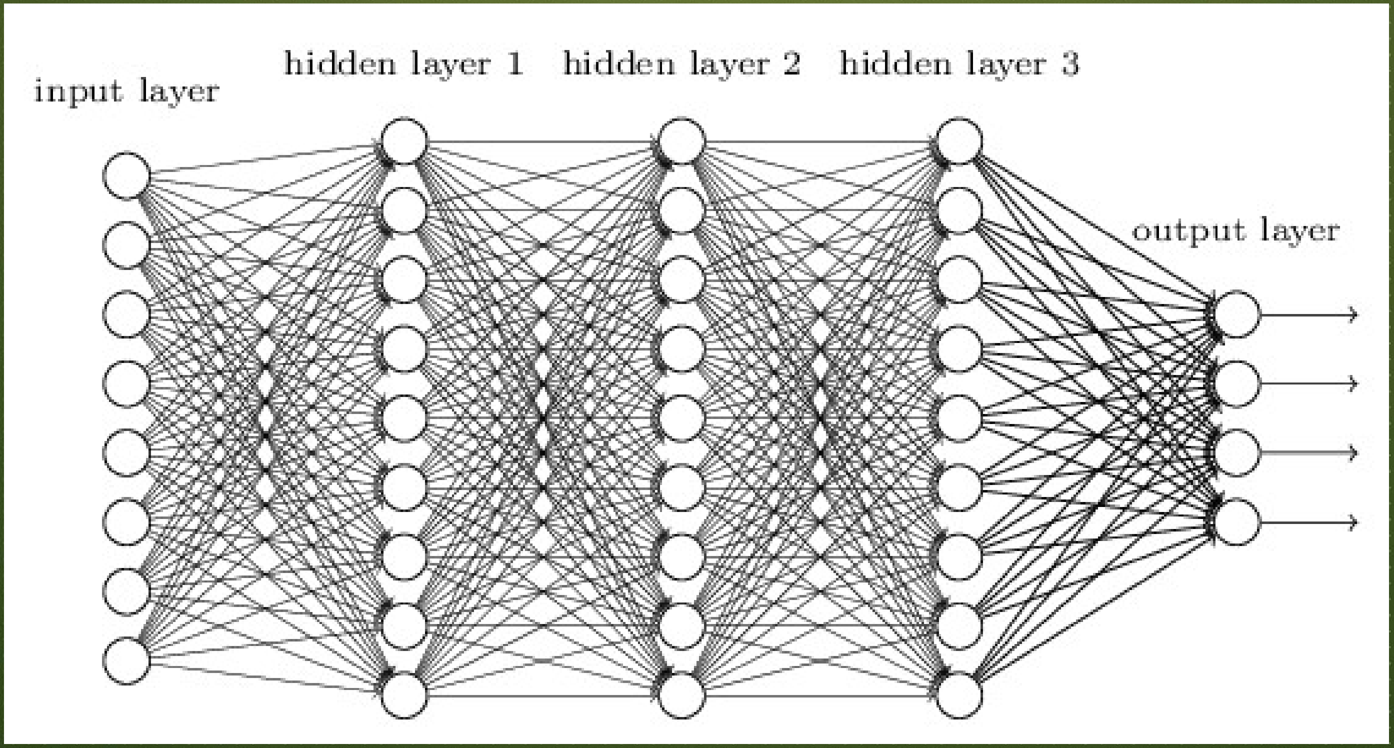
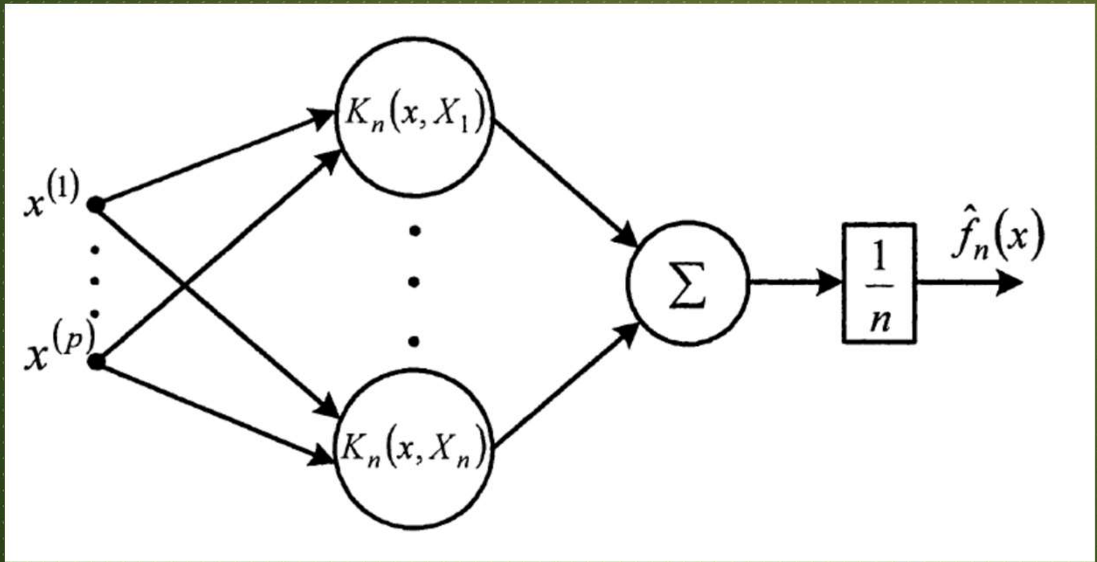
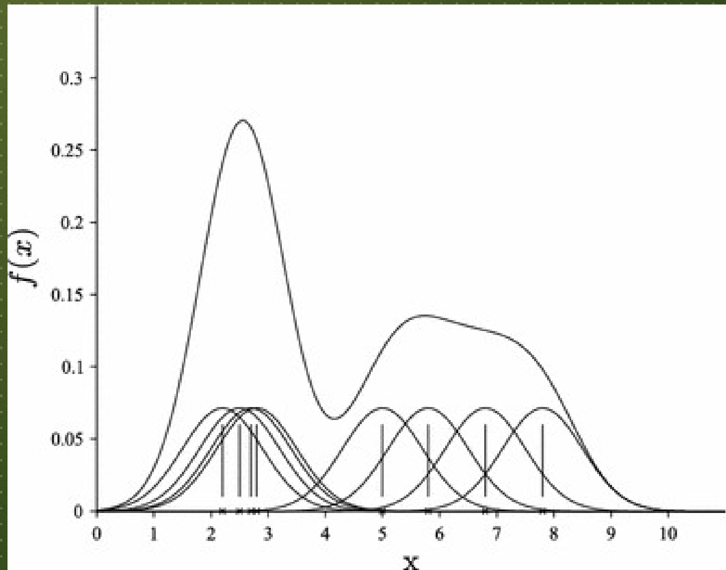
SIECI NEURONOWE
TYPOWA STRUKTURA TOPOLOGICZNA



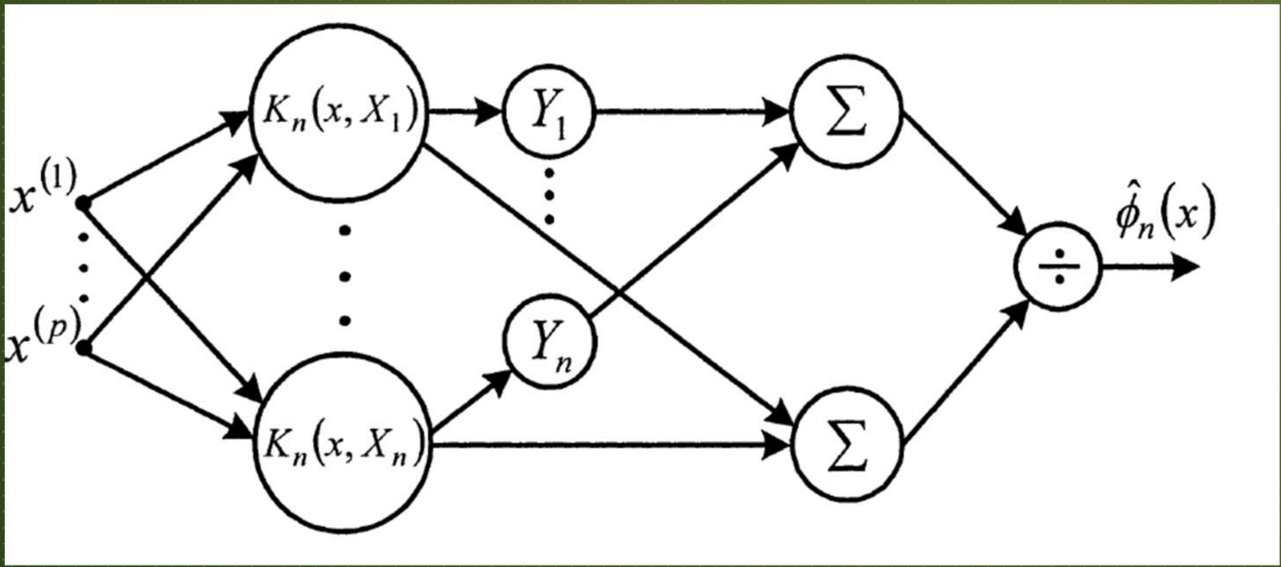
POCZĄTKI PNN - CZYLI OD PARZENA I ESTYMATORA JĄDROWEGO DO SIECI NEURONOWEJ



$$\widehat{f}_n(x) = \frac{1}{nh_n} \sum_{i=1}^{n} K\left(\frac{x - X_i}{h_n}\right)$$

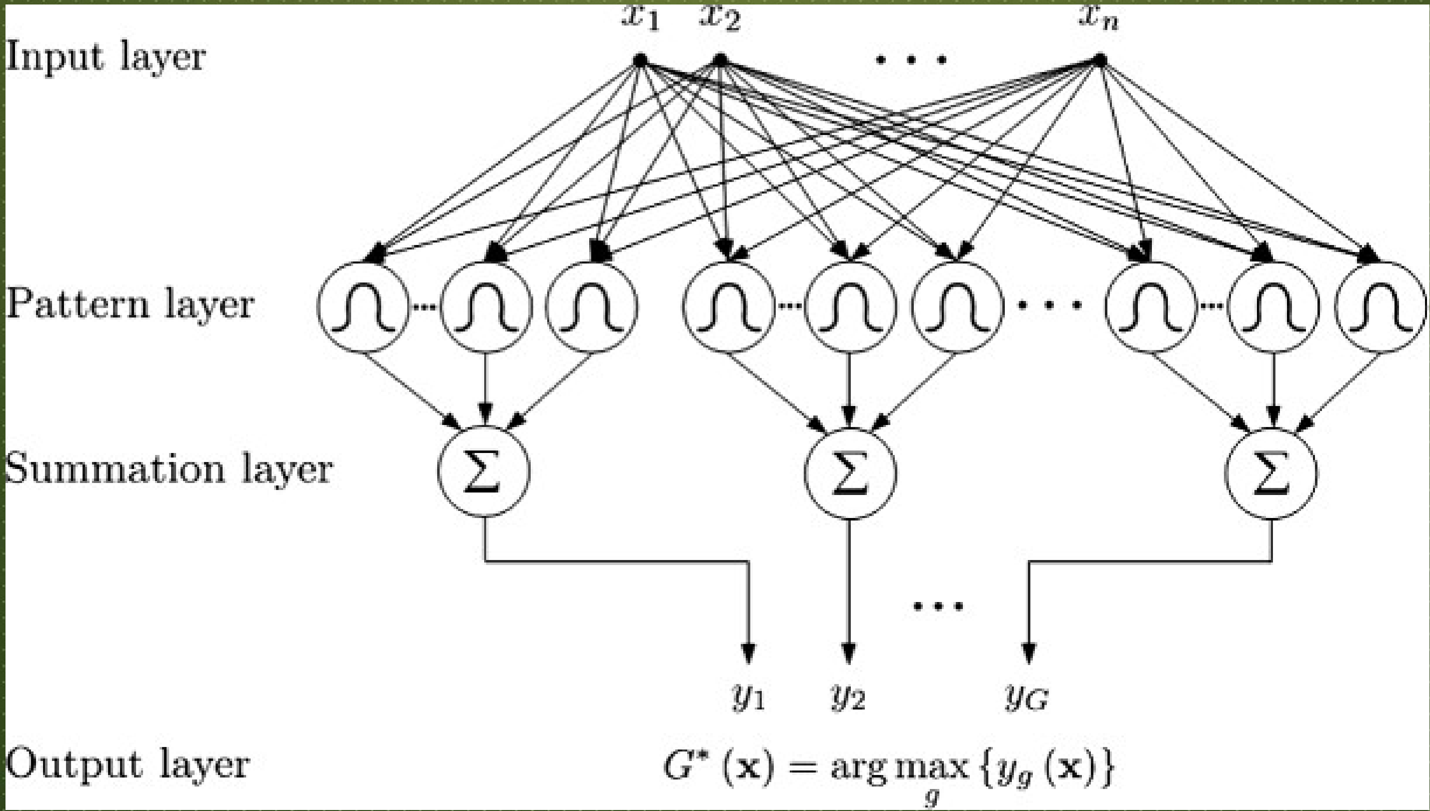


PNN DLA ZAGADNIENIA REGRESJI

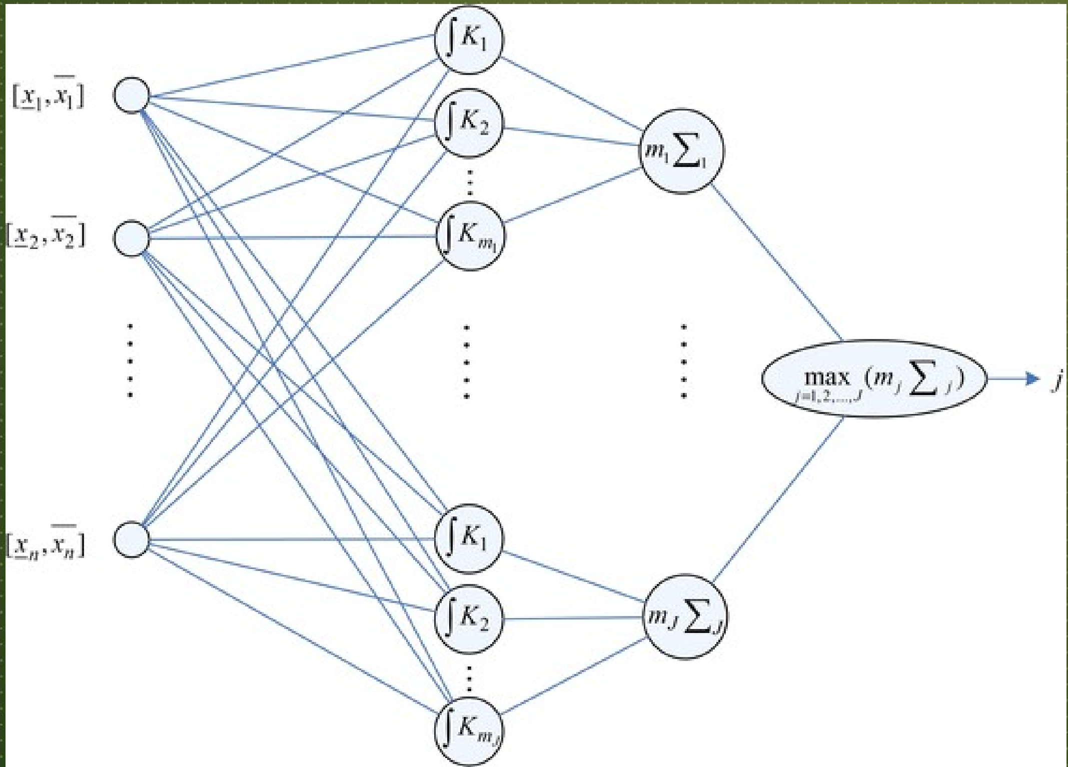


$$\widehat{\phi}_n(x) = \frac{\sum_{i=1}^{n} Y_i K\left(\frac{x - X_i}{h_n}\right)}{\sum_{i=1}^{n} K\left(\frac{x - X_i}{h_n}\right)}$$

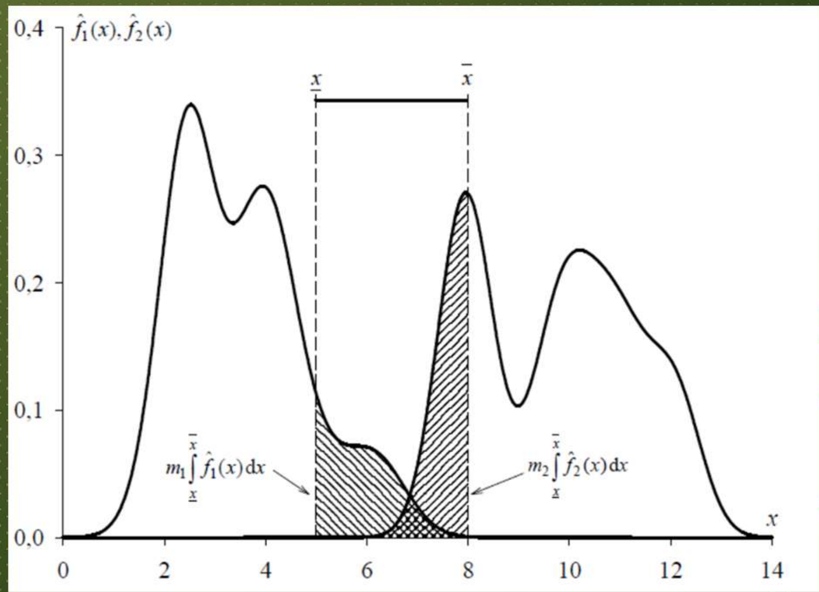
PNN DLA ZAGADNIENIA KLASYFIKACJI



PNN DLA ZAGADNIENIA KLASYFIKACJI INFORMACJI NIEDOKŁADNEJ TYPY PRZEDZIAŁOWEGO



$$m_1 \int_E \hat{f}_1(x)\,\mathrm{d}x,\; m_2 \int_E \hat{f}_2(x)\,\mathrm{d}x, \ldots, m_J \int_E \hat{f}_J(x)\,\mathrm{d}x,$$



UCZENIE PNN

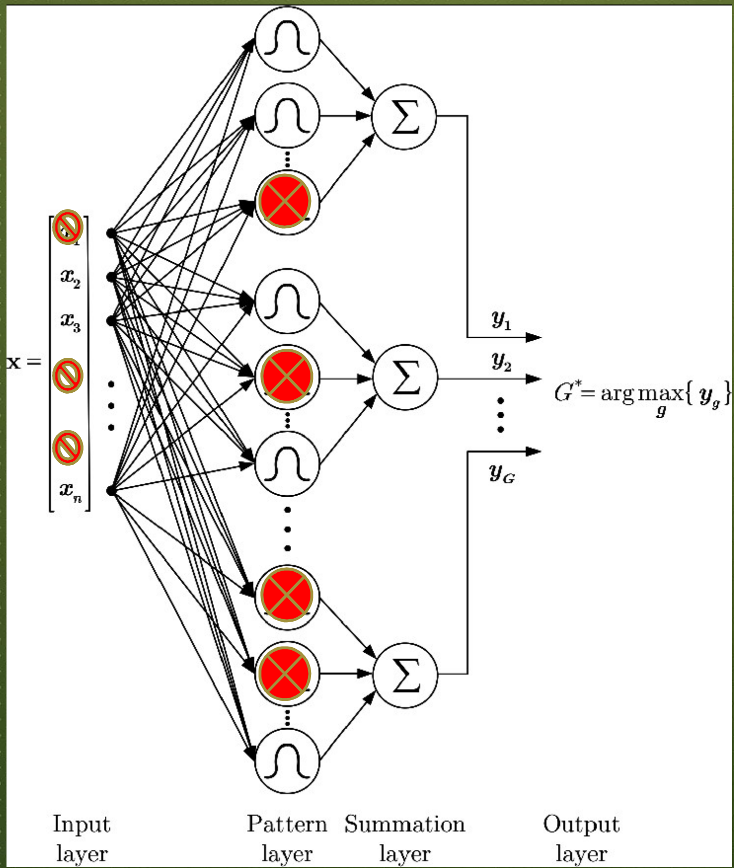
- Ustalenie wartości parametrów wygładzania
  - Metoda plug-in
  - Cross-validation
  - Uczenie ze wzmocnieniem (reinforcement learning)
  - Metody heurystyczne (np. inspirowane zachowaniem roju)
- Zastosowanie procedury modyfikacji parametru wygładzania
- Dodatkowe procedury usprawniające estymacje lub klasyfikacje

ZASTOSOWANIE PNN

- Probabilistyczne sieci neuronowe w modelowaniu degradacji strukturalnej rur deszczowych.
- Probabilistyczne sieci neuronowych do diagnostyki próbek endoskopów żołądka w oparciu o spektroskopię FTIR.
- Probabilistyczne sieci neuronowe w rozwiązywaniu różnych problemów związanych z klasyfikacją wzorów.
- Zastosowanie probabilistycznych sieci neuronowych do farmakokinetyki populacyjnej .
- Probabilistyczne sieci neuronowe do przewidywania klas białaczki i guza zarodkowego ośrodkowego układu nerwowego.
- Identyfikacja statku za pomocą probabilistycznych sieci neuronowych.
- Zarządzanie konfiguracją czujników w bezprzewodowej sieci ad hoc z użyciem probabilistycznej sieci neuronowej.
- Probabilistyczna sieć neuronowa w rozpoznawaniu znaków.
- Teledetekcja i klasyfikacja obrazu.
- …

https://en.wikipedia.org/wiki/Probabilistic_neural_network

GŁÓWNY PROBLEM W SIECIACH PNN

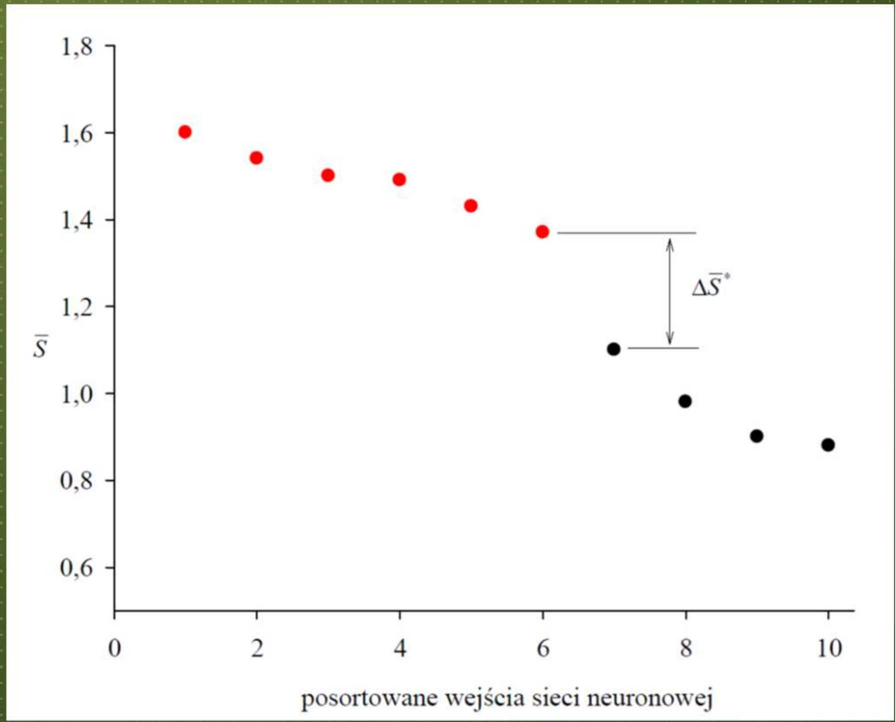


ANALIZA WRAŻLIWOŚCI STRUKTURY SSN

Główne typy algorytmów AW

- Globalne
  - Sobela
  - Fast
  - eFast
- Lokalne

$$S_{j,i}^{(p)} = \frac{\partial \hat{f}_j(x_1, x_2, \dots, x_N)}{\partial x_i}$$



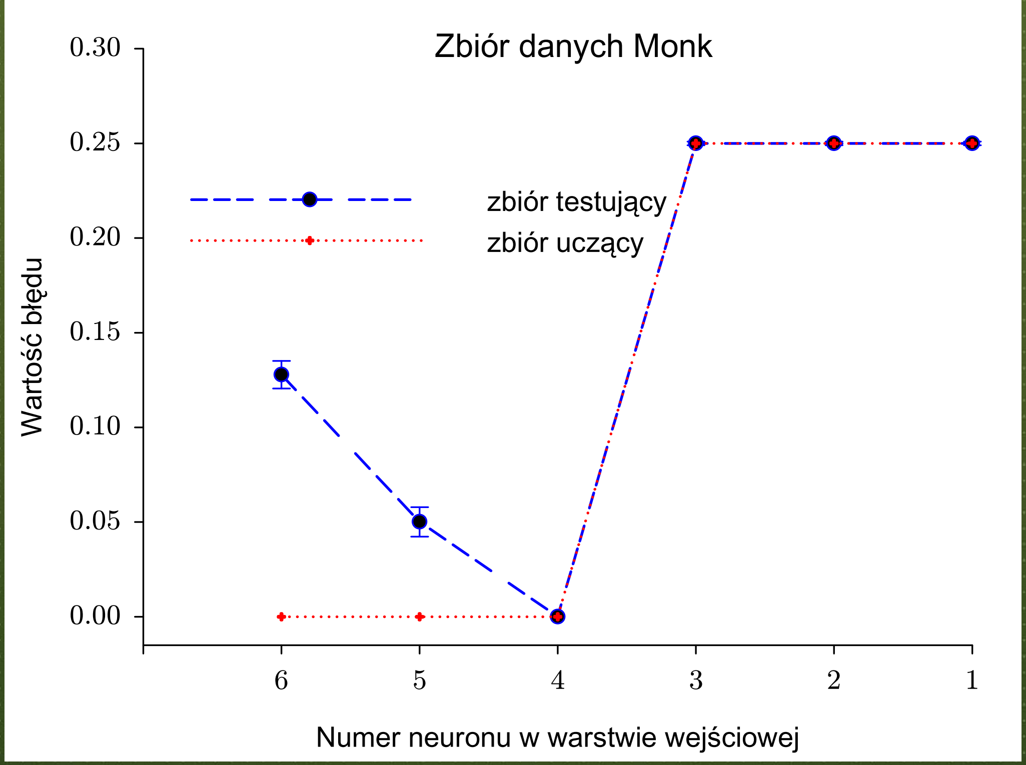
ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WE

Algorithm 1 Algorithm for PNN's Input Layer Reduction

Initialize: $iter := 1$, $N(iter) = N$
Perform CV for full size PNN
for $j := 1$ **to** J **do**
  for $i := 1$ **to** $N(iter)$ **do**
    Calculate coefficient h_i
  end
  for $p := 1$ **to** P_j **do**
    Calculate coefficient s_p
  end
end
Compute PNN quality $q_{cv}(0)$
% Main loop
while $N(iter) > 1$ **do**
  % Sensitivity analysis
  for $p := 1$ **to** P **do**
    for $j := 1$ **to** J **do**
      for $i := 1$ **to** $N(iter)$ **do**
        Calculate $S_{j,i}^{(p)}$ based on (20)–(22)
      end
    end
    Generate matrix $\mathbf{S}^{(p)}$ according to (3)
  end
  Aggregate results in sensitivity matrices: $\mathbf{S}^{\text{mean}}$, $\mathbf{S}^{\text{abs}}$ and $\mathbf{S}^{\text{max}}$ using following norms (4)–(6)
  For vectors: $\mathbf{Q}^{\text{mean}}$, $\mathbf{Q}^{\text{abs}}$ and $\mathbf{Q}^{\text{max}}$:
  for $i := 1$ **to** $N(iter)$ **do**
    Compute elements: Q_i^{mean}, Q_i^{abs} and Q_i^{max}
  end
  Sort elements in each vector: $\mathbf{Q}^{\text{mean}}$, $\mathbf{Q}^{\text{abs}}$ and $\mathbf{Q}^{\text{max}}$ in descending order
  Remove least sensitive feature (l) of input data $\mathbf{X}$ using **Rule** 1 or **Rule** 2
  $\mathbf{X}_{tmp} := \mathbf{X}\{1, \ldots, N(iter)\} \setminus \mathbf{X}\{l\}$
  $N_{tmp} := N(iter) - 1$
  Perform CV for reduced size PNN
  for $j := 1$ **to** J **do**
    for $i := 1$ **to** N_{tmp} **do**
      Calculate coefficient h_i
    end
    for $p = 1$ **to** P_j **do**
      Calculate coefficient s_p
    end
  end
  Compute PNN quality $q_{cv}(iter)$
  $\delta_{quality} := q_{cv}(iter) - q_{cv}(iter - 1)$
  if $\delta_{quality} < \epsilon$ **then**
    Stop main loop
  else
    $\mathbf{X} := \mathbf{X}_{tmp}$
    $iter := iter + 1$
    $N(iter) := N_{tmp}$
  end
end
% End of main loop
Set $N^{\text{red}} := N(iter)$
return $\mathbf{X}$, N^{red}

$$\mathbf{S}_j = \begin{bmatrix} \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)}|\cdot)}{\partial x_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)}|\cdot)}{\partial x_j^{(i)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)}|\cdot)}{\partial x_j^{(P_j)}} \\ \frac{\partial \hat{f}_j(\mathbf{x}_j^{(2)}|\cdot)}{\partial x_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(2)}|\cdot)}{\partial x_j^{(i)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(2)}|\cdot)}{\partial x_j^{(P_j)}} \\ \vdots & & \vdots & & \vdots \\ \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)}|\cdot)}{\partial x_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)}|\cdot)}{\partial x_j^{(i)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)}|\cdot)}{\partial x_j^{(P_j)}} \\ \vdots & & \vdots & & \vdots \\ \frac{\partial \hat{f}_j(\mathbf{x}_j^{(P_j)}|\cdot)}{\partial x_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(P_j)}|\cdot)}{\partial x_j^{(i)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(P_j)}|\cdot)}{\partial x_j^{(P_j)}} \end{bmatrix}$$

ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WEJŚCIOWEGO
ISTOTNOŚĆ POSZCZEGÓLNYCH WEJŚĆ



ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WEJŚCIOWEGO
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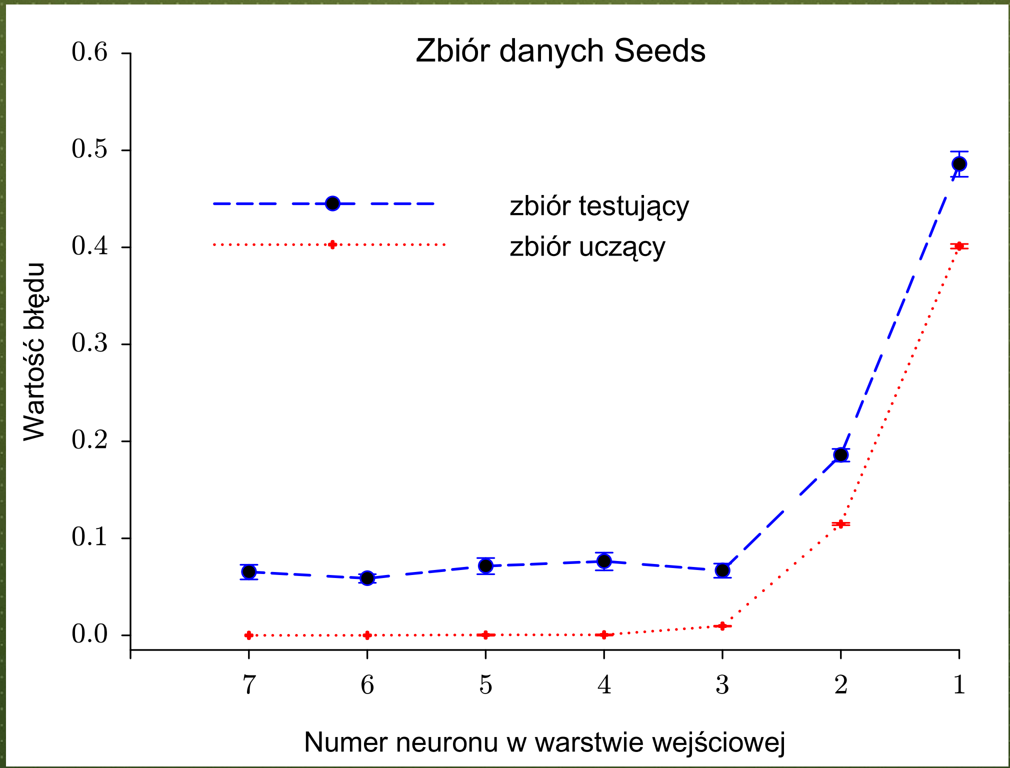
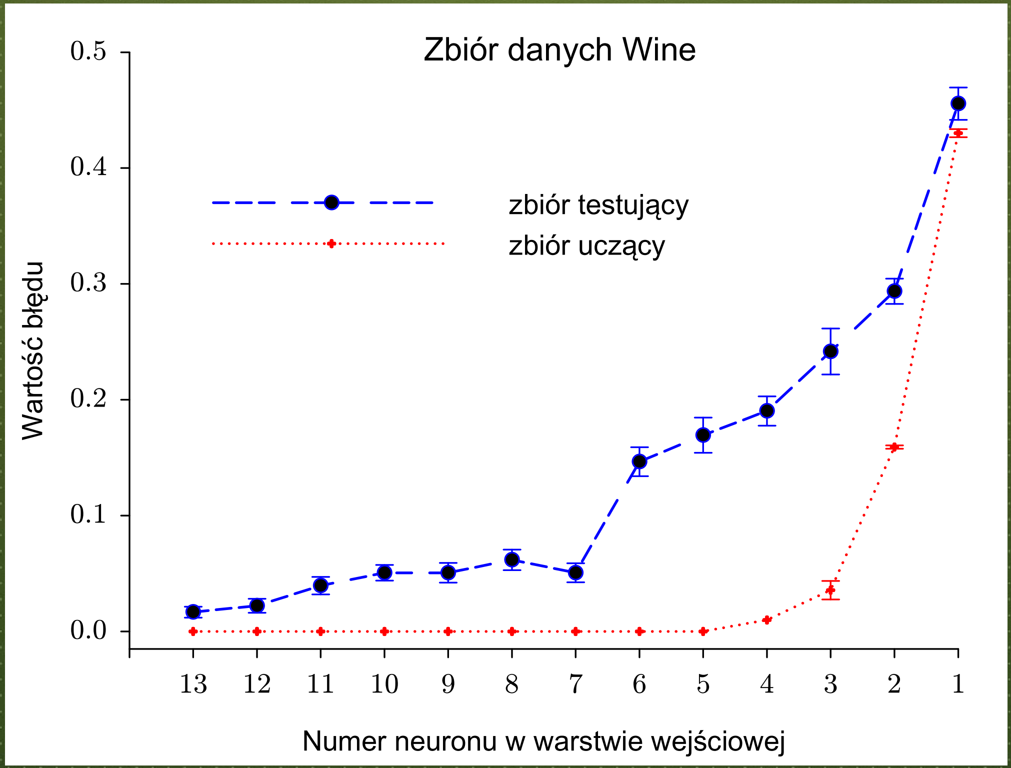


ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WEJŚCIOWEGO
ISTOTNOŚĆ POSZCZEGÓLNYCH WEJŚĆ



ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WEJŚCIOWEGO

Data set	Original data		Algorithm 1								PCA	NPE	LPP	OLPP	ReliefF
			$\epsilon = 0.0$		$\epsilon = 0.01$		$\epsilon = 0.02$		$\epsilon = 0.05$			$k_n = 5$	$k_n = 5$		
	N	q_{cv} sd	N^{red}	q_{cv} sd	N^{red}	q_{cv} sd	N^{red}	q_{cv} sd	N^{red}	q_{cv} sd	q_{cv} sd	q_{cv} sd	q_{cv} sd	q_{cv} sd	q_{cv} sd
Iris	4	0.9460 *0.0080*	2	**0.9467** *0.0054*	2	0.9467 *0.0054*	2	0.9467 *0.0054*	2	0.9467 *0.0054*	0.9667 *0.0044**	0.9405 (3) *0.0061**	0.9405 (3) *0.0070**	0.9660 *0.0049**	0.9467 *0.0123*
WBC	9	0.9680 *0.0023*	7	**0.9693** *0.0013**	7	0.9693 *0.0013**	4	0.9504 *0.0010**	2	0.9280 *0.0053**	0.9661 *0.0042*	0.9647 (7) *0.0043**	— —	0.9613 *0.0027**	0.9705 *0.0022**
SH	13	0.7811 *0.0083*	7	**0.7890** *0.0054**	7	0.7890 *0.0054**	7	0.7890 *0.0054**	6	0.7262 *0.0052**	0.7295 *0.0082**	0.6409 (8) *0.0088**	0.6143 (4) *0.0086**	0.5967 *0.0104**	0.7341 *0.0087**
PID	8	0.6858 *0.0040*	6	**0.6869** *0.0067*	6	0.6869 *0.0067*	2	0.6709 *0.0049**	1	0.6545 *0.0047**	0.6891 *0.0197*	0.6755 (7) *0.0218*	0.6907 (7) *0.0121*	0.6963 *0.0175*	0.6858 *0.0202*
Seeds	7	0.9332 *0.0075*	3	**0.9334** *0.0043*	3	0.9334 *0.0043*	3	0.9334 *0.0043*	3	0.9334 *0.0043*	0.9045 *0.0097**	0.9097 (6) *0.0081**	0.9274 (4) *0.0100*	0.9424 *0.0095*	0.9332 *0.0124*
Ecoli	5	0.8325 *0.0090*	5	0.8325 *0.0090*	5	0.8325 *0.0090*	5	0.8325 *0.0090*	4	**0.7941** *0.0128**	0.8311 *0.0091*	0.8322 (5) *0.0118*	0.8321 (5) *0.0105*	0.8230 *0.0131**	0.7904 *0.0143**
Monk	6	0.8722 *0.0073*	4	**1.0000** *0.0000**	4	1.0000 *0.0000**	4	1.0000 *0.0000**	4	1.0000 *0.0000**	0.9998 *0.0094**	0.7222 (5) *0.0297**	0.8347 (4) *0.0287**	0.9749 *0.0239**	0.8349 *0.0101**
Wine	13	0.9831 *0.0047*	13	0.9831 *0.0047*	12	**0.9771** *0.0060**	11	0.9609 *0.0076**	7	0.9484 *0.0082**	0.9100 *0.0089**	0.8944 (9) *0.0101**	0.9166 (11) *0.0080**	0.8038 *0.0203**	0.9762 *0.0056**

ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA ROZMIARU WEKTORA WEJŚCIOWEGO

METODY GSA

Data set	Original data		Algorithm 1								Sobol		FAST		EFAST	
			$\epsilon = 0.0$		$\epsilon = 0.01$		$\epsilon = 0.02$		$\epsilon = 0.05$							
	N	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd	N^{red}	q_{cv} / sd
Iris	4	0.9460	2	**0.9467**	2	0.9467	2	0.9467	2	0.9467	2	0.9670	2	0.9670	1	0.9587
		0.0080		*0.0054*		*0.0054*		*0.0054*		*0.0054*		*0.0047**		*0.0047**		*0.0028**
WBC	9	0.9680	7	**0.9693**	7	0.9693	4	0.9504	2	0.9280	8	0.9706	8	0.9706	8	0.9551
		0.0023		*0.0013**		*0.0013**		*0.0010**		*0.0053**		*0.0019**		*0.0019**		*0.0020**
SH	13	0.7811	7	**0.7890**	7	0.7890	7	0.7890	6	0.7262	12	0.7863	11	0.7851	8	0.7815
		0.0083		*0.0054**		*0.0054**		*0.0054**		*0.0052**		*0.0087*		*0.0089*		*0.0078*
PID	8	0.6858	6	**0.6869**	6	0.6869	2	0.6709	1	0.6545	7	0.6694	4	0.7305	7	0.6725
		0.0040		*0.0067*		*0.0067*		*0.0049**		*0.0047**		*0.0081**		*0.0061**		*0.0083**
Seeds	7	0.9332	3	**0.9334**	3	0.9334	3	0.9334	3	0.9334	6	0.9381	6	0.9286	5	0.9376
		0.0075		*0.0043*		*0.0043*		*0.0043*		*0.0043*		*0.0074*		*0.0050**		*0.0069*
Ecoli	5	0.8325	5	0.8325	5	0.8325	5	0.8325	4	**0.7941**	4	0.8267	3	0.7934	4	0.7580
		0.0090		*0.0090*		*0.0090*		*0.0090*		*0.0128**		*0.0085*		*0.0102**		*0.0074**
Monk	6	0.8722	4	**1.0000**	4	1.0000	4	1.0000	4	1.0000	5	0.9993	5	0.7684	5	0.7531
		0.0073		*0.0000**		*0.0000**		*0.0000**		*0.0000**		*0.0022**		*0.0150**		*0.0143**
Wine	13	0.9831	13	0.9831	12	**0.9771**	11	0.9609	7	0.9484	12	0.9889	12	0.9722	12	0.9760
		0.0047		*0.0047*		*0.0060**		*0.0076**		*0.0082**		*0.0040**		*0.0073**		*0.0060**

ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA NEURONÓW WARSTWY WZ

Compute full size PNN quality q_{cv}
for $j := 1$ **to** J **do**
  %Reduction in jth class
  for $r := 1$ **to** P_j **do**
    for $i := 1$ **to** N **do**
      Calculate gradient $\nabla \hat{f}_j^{(p,r)}$ in (25) using formulas (27) and (28)
    end
  end
  Determine sensitivity matrix $\mathbf{S}_j$ (29)
  Compute $\mathbf{q}_j$ vector (31) by aggregating results from $\mathbf{S}_j$
  Form vector $\mathbf{Q}_j$ by sorting elements of $\mathbf{q}_j$ in increasing order
  Compute vector of differences $\Delta\mathbf{Q}_j$
  Set $\mathbf{X}_j^{\text{red}} := \mathbf{X}_j \{\mathbf{R}_j\}$ according to **Definition 1**
  Set $P_j^{\text{red}} := |\mathbf{X}_j \{\mathbf{R}_j\}|$
end

$$\mathbf{S}_j = \begin{bmatrix} \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)})}{\partial \mathbf{x}_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)})}{\partial \mathbf{x}_j^{(r)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(1)})}{\partial \mathbf{x}_j^{(P_j)}} \\ \vdots & & \vdots & & \vdots \\ \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)})}{\partial \mathbf{x}_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)})}{\partial \mathbf{x}_j^{(r)}} & \cdots & \frac{\partial \hat{f}_j(\mathbf{x}_j^{(p)})}{\partial \mathbf{x}_j^{(P_j)}} \\ \vdots & & \vdots & & \vdots \\ \frac{\partial \hat{f}_j\left(\mathbf{x}_j^{(P_j)}\right)}{\partial \mathbf{x}_j^{(1)}} & \cdots & \frac{\partial \hat{f}_j\left(\mathbf{x}_j^{(P_j)}\right)}{\partial \mathbf{x}_j^{(r)}} & \cdots & \frac{\partial \hat{f}_j\left(\mathbf{x}_j^{(P_j)}\right)}{\partial \mathbf{x}_j^{(P_j)}} \end{bmatrix}$$

$$\mathbf{S}_j = \begin{bmatrix} \left\|\nabla \hat{f}_j^{(1,1)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(1,r)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(1,P_j)}\right\|_n \\ \vdots & & \vdots & & \vdots \\ \left\|\nabla \hat{f}_j^{(p,1)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(p,r)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(p,P_j)}\right\|_n \\ \vdots & & \vdots & & \vdots \\ \left\|\nabla \hat{f}_j^{(P_j,1)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(P_j,r)}\right\|_n & \cdots & \left\|\nabla \hat{f}_j^{(P_j,P_j)}\right\|_n \end{bmatrix}$$

Algorithm 2 Algorithm for PNN's Pattern Layer Reduction

Perform CV of full size PNN
for $j := 1$ **to** J **do**
  for $i := 1$ **to** $N(iter)$ **do**
    Calculate coefficient h_i
  end
  for $p := 1$ **to** P_j **do**
    Calculate coefficient s_p
  end
end
Compute full size PNN quality q_{cv}
for $j := 1$ **to** J **do**
  %Reduction in jth class
  for $r := 1$ **to** P_j **do**
    for $i := 1$ **to** N **do**
      Calculate gradient $\nabla \hat{f}_j^{(p,r)}$ in (25) using formulas (27) and (28)
    end
  end
  Determine sensitivity matrix $\mathbf{S}_j$ (29)
  Compute $\mathbf{q}_j$ vector (31) by aggregating results from $\mathbf{S}_j$
  Form vector $\mathbf{Q}_j$ by sorting elements of $\mathbf{q}_j$ in increasing order
  Compute vector of differences $\Delta\mathbf{Q}_j$
  Set $\mathbf{X}_j^{\text{red}} := \mathbf{X}_j \{\mathbf{R}_j\}$ according to **Definition 1**
  Set $P_j^{\text{red}} := |\mathbf{X}_j \{\mathbf{R}_j\}|$
end
Perform CV of reduced PNN
for $i := j$ **to** J **do**
  for $i := 1$ **to** N **do**
    Calculate coefficients h_i
  end
  for $p := 1$ **to** P_j^{red} **do**
    Calculate coefficients s_p
  end
end
Compute reduced PNN quality q_{cv}^{*}
return P^{red}, $\mathbf{X}^{\text{red}}$

ANALIZA WRAŻLIWOŚCI SIECI PNN
REDUKCJA NEURONÓW WARSTWY WZORCÓW

Data set	Original data		Algorithm 2		SVM		Random		kNN		WPW	
	P	q_{cv} / sd	$\frac{P^{red}}{P}$, [%]	$q^{\star}_{cv}$ / sd	$\frac{SVs}{P}$, [%]	$q^{\star}_{cv}$ / sd	$\frac{P^{red}}{P}$, [%]	$q^{\star}_{cv}$ / sd	$\frac{P^{red}}{P}$, [%]	$q^{\star}_{cv}$ / sd	$\frac{P^{red}}{P}$, [%]	$q^{\star}_{cv}$ / sd
Iris	150	0.9460 *0.0080*	13.02	**0.9539** *0.0035**	60.42	0.9507 *0.0032**	13.21	0.9415 *0.0032**	81.52	0.9521 *0.0030**	13.76	0.9215 *0.0038**
WBC	683	0.9680 *0.0023**	44.59	**0.9732** *0.0031**	46.13	0.9458 *0.0095**	44.59	0.9652 *0.0018**	90.71	0.9010 *0.0052**	44.31	0.9677 *0.0031*
SH	270	0.7811 *0.0083*	75.66	0.8093 *0.0047**	67.32	0.7822 *0.0135*	74.95	0.7781 *0.0238*	84.69	**0.8131** *0.0151**	75.29	0.6379 *0.0121**
PID	768	0.6858 *0.0040*	66.26	**0.6889** *0.0093*	63.19	0.5579 *0.0125**	65.19	0.6636 *0.0060**	87.26	0.6515 *0.0065**	67.51	0.6411 *0.0049**
Seeds	210	**0.9332** *0.0075*	14.96	0.9275 *0.0098**	62.71	0.9267 *0.0089**	14.77	0.9228 *0.0082**	79.81	0.9061 *0.0105**	14.31	0.9226 *0.0071**
Ecoli	327	0.8325 *0.0090*	54.28	**0.8641** *0.0069**	40.67	0.6964 *0.0126**	54.11	0.8176 *0.0094**	85.22	0.8101 *0.0101**	53.24	0.8211 *0.0062**
Monk	432	**0.8722** *0.0073*	1.34	0.8687 *0.0063*	82.12	0.8506 *0.0067**	1.50	0.8658 *0.0102**	94.61	0.5957 *0.0082**	1.12	0.8624 *0.0054**
Wine	178	0.9831 *0.0047*	88.33	0.9655 *0.0071**	40.09	**0.9854** *0.0129*	85.39	0.9201 *0.0178**	74.99	0.9671 *0.0162**	84.21	0.8612 *0.0121**

ANALIZA WRAŻLIWOŚCI SIECI PNN
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Algorithm 3 Algorithm for the Reduction of the Entire PNN Structure

Use **Algorithm 1** to determine significance feature order set $\mathbf{s}$
Sort indices in $\mathbf{s}$ on the basis of features from least to most significant
$\mathbf{l} := (),\ \mathbf{q}_{cv} := (),\ \mathbf{P}^{\text{red}} = ()$
$\mathbf{l}(1) := \mathbf{s}(1)$
for $l := 2$ **to** $|\mathbf{s}|$ **do**
    Remove input neurons with indices stored in $\mathbf{l}$
    Apply **Algorithm 2**:
        - read reduced PNN quality $q_{cv}^{\star}$
        - read total number of reduced neurons P^{red}
    $\mathbf{q}_{cv}(l-1) := q_{cv}^{\star}$
    $\mathbf{P}^{\text{red}}(l-1) := P^{\text{red}}$
    $\mathbf{l}(l) := \mathbf{s}(l)$
    $l := l + 1$
end
$l^{\star} := \underset{l=1,\ldots,|\mathbf{s}|-1}{\operatorname{argmax}} \ \mathbf{q}_{cv}(l)$
Set $q_{cv} := \mathbf{q}_{cv}(l^{\star}),\ P^{\text{red}} := \mathbf{P}^{\text{red}}(l^{\star}),\ N^{\text{red}} := N - l^{\star}$
return $P^{\text{red}},\ N^{\text{red}}$

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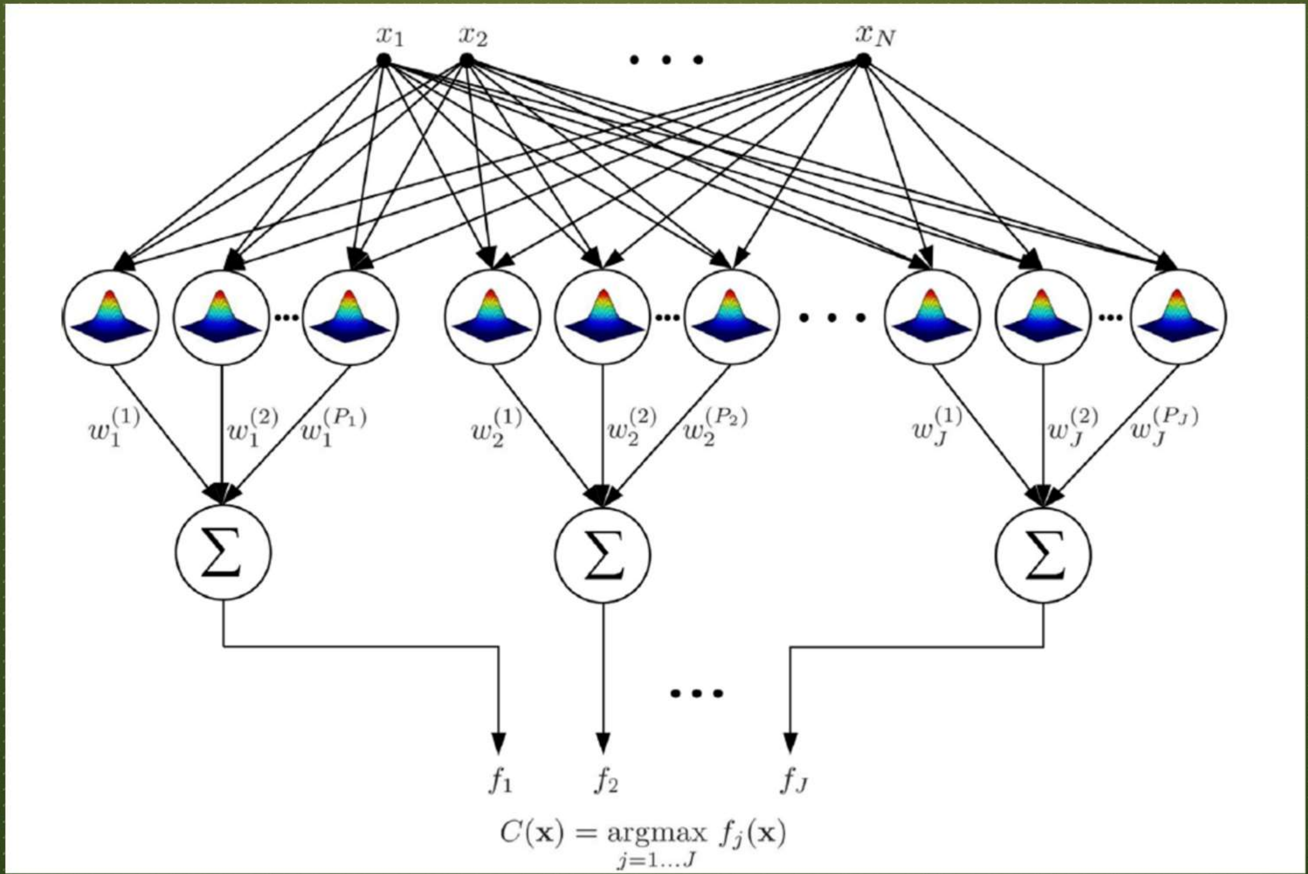
Data set	N	N^{red}	q_{cv}	sd	$\frac{P^{\text{red}}}{P}$, [%]
Iris	4	2	**0.9547**	*0.0056**	4.81
WBC	9	7	**0.9745**	*0.0008**	36.86
SH	13	10	**0.8363**	*0.0055**	58.44
PID	8	2	**0.6914**	*0.0038**	9.94
Seeds	7	3	**0.9343**	*0.0052*	13.07
Ecoli	5	4	0.7859	*0.0029**	4.76
Monk	6	4	**1.0000**	*0.0000**	29.45
Wine	13	7	0.9520	*0.0030**	58.05

WEIGHTED PROBABILISTIC NEURAL NETWORK JAKO NOWY TYP SIECI NEURONOWYCH



WEIGHTED PROBABILISTIC NEURAL NETWORK JAKO NOWY TYP SIECI NEURONOWYCH

Data set	Records	Attributes	Classes	Class distribution
Breast cancer	683	9	2	444–239
Statlog heart	270	13	2	150–120
Diabetes	786	8	2	500–268
Ecoli	327	5	5	143–77–35–20–52
Parkinson	195	22	2	147–48
Iris	150	4	3	50–50–50
Breast tissue	106	9	6	21–15–18–16–14–22
Monk	432	6	2	216–216
Seeds	210	7	3	70–70–70
Cardiotocography	2126	22	3	1655–295–176

WEIGHTED PROBABILISTIC NEURAL NETWORK JAKO NOWY

Data set	WPNN	MPNN	PNN	SVM	MLP	RBFNN	kNN	GEP
Breast cancer	97.22 0.13 7	96.70 2.15 4	96.92 0.17 5	95.02 0.35 1	97.10 0.18 6	96.38 0.32 3	**97.49** 0.15 8	95.31 0.26 2
Statlog heart	**80.85** 0.70 8	78.89 7.07 4	78.15 0.62 2	78.63 1.37 3	80.70 0.93 7	79.04 2.02 5	72.85 0.41 1	80.63 1.92 6
Diabetes	68.82 0.45 3	67.79 4.61 2	67.74 0.36 1	75.70 0.64 6	**77.29** 0.52 8	75.14 1.16 5	76.39 0.32 7	71.07 1.62 4
Ecoli	**88.91** 1.09 8	82.17 6.23 2	83.19 1.19 3	78.75 0.55 1	85.07 0.98 5	86.73 1.11 6	88.68 0.46 7	83.82 1.64 4
Parkinson	**91.20** 1.69 8	90.36 5.49 6	89.64 1.05 4	91.18 0.94 7	89.85 1.33 5	88.26 1.77 3	86.72 0.63 2	86.15 1.43 1
Iris	95.47 0.40 7	95.40 5.16 6	95.06 0.32 2	95.39 0.46 5	95.33 0.42 4	95.27 0.36 3	**97.86** 0.26 8	92.80 1.65 1
Breast tissue	69.53 2.88 7	68.69 1.19 5	**73.35** 4.13 8	68.87 2.92 6	62.36 2.94 1	65.47 3.11 3	64.25 1.81 2	67.45 2.47 4
Monk	87.61 1.39 4	88.51 6.61 5	86.69 1.55 3	99.21 0.46 7	90.02 3.55 6	75.67 0.92 1	**99.75** 0.37 8	79.70 1.88 2
Seeds	93.34 1.78 4	95.24 5.33 7	95.01 0.71 6	**95.62** 0.69 8	92.19 0.88 1	94.57 0.88 5	92.47 0.28 3	92.43 1.45 2
Cardiotocography	85.37 0.09 1	85.85 2.35 3	85.82 0.09 2	97.39 0.06 7	94.58 0.52 6	**97.42** 0.14 8	93.14 0.17 5	90.51 0.47 4
Total ranking points	57	44	36	51	49	42	51	30

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DZIĘKUJĘ ZA UWAGĘ !

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