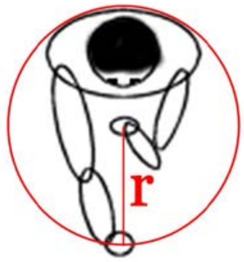
Why in the ZigZag Steps we launch the first punch with the Wu-Sao hand

When the ZigZag steps are executed, the punch that precedes the step in whichever direction, would have to be launched with the rear hand. We analyse scientifically this affirmation using the branch of the mathematics that take care of the figures of a space: geometry.

We imagine to see from the high, perpendicular to the earth, a WT-Man in the advanced position (Advancing Step) with the guard in shape of fists.

Now we trace a circle with center the rear fist and radius the distance that elapses between the two fists[1].

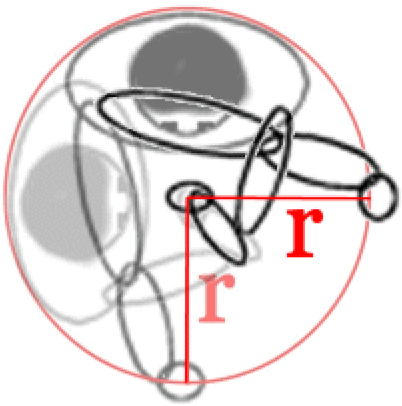


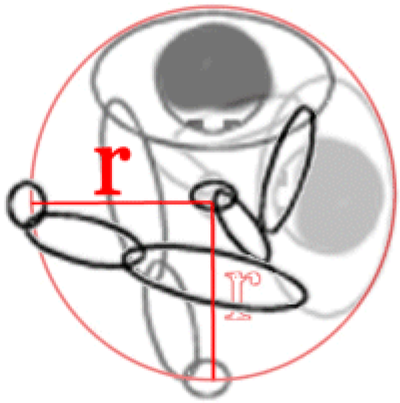
We consider, at first, the case in which the WT-Man wants to make a step to his left or to his right. The correct positions after the first punch, would have to be those illustrating below:

Step to the Left

Step to the Right

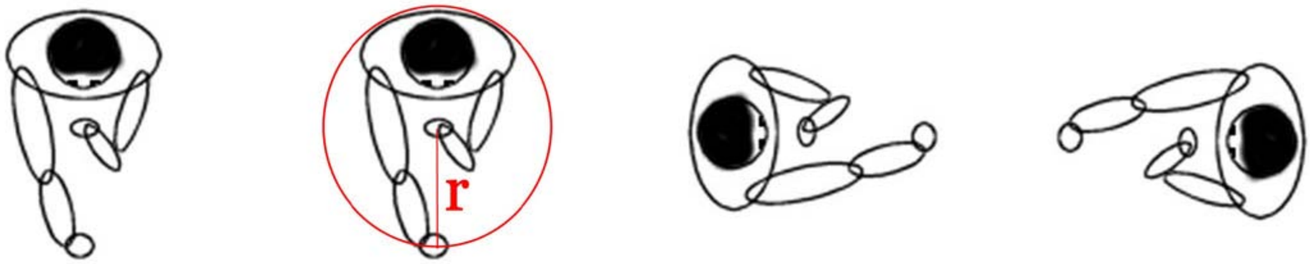
In this way the left fist completes, as distance in order to catch up the target, the shortest possible distance i.e. the radius of the circle. (Figures are meant without the execution of the step)





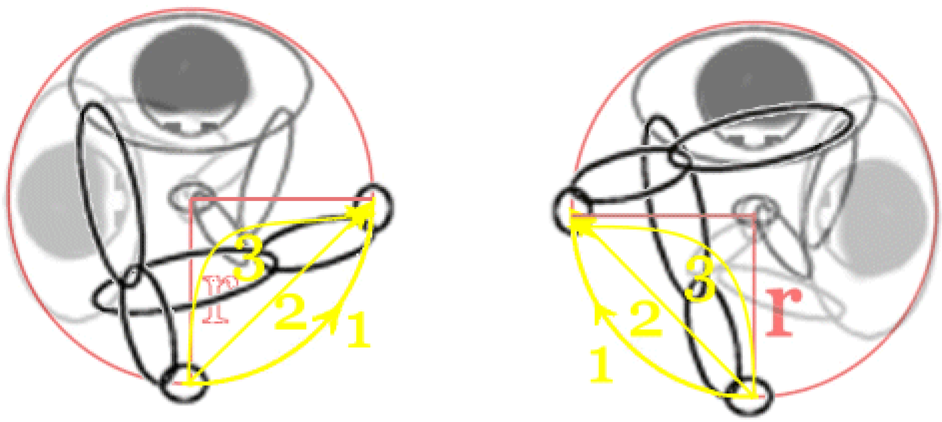
[1] For simplicity of calculation we considered here the center of the circumference in the rear fist. In reality the center is in the head because the attaks are against the head not against the fist.

We analyze now the case in which the punch is launched with the advanced arm. Using the same reasoning, we have the following positions:



Step to the Left Step to the Right

The possible logical trajectories of the fist are those illustrated in the figures below, respective for the step to the left and for the step to the right:



We analyse the **trajectory 2**:

This trajectory covers the chord of the circle. It goes from the point of departure of the punch to the point of arrival of the same one. Since in this case (the step is considered with an angle of 90°) the two radius and the chord forms a right triangle, the chord is given from the following formula:

$$\mathbf{chord} = \sqrt{(r^2+r^2)} = \sqrt{2r^2} = r\sqrt{2}$$ [2]

Now, being $\sqrt{2} > 1$ and $r > 1$ [3] we have

$$\mathbf{chord} > r$$

We can deduce therefore that using as trajectory of the punch the radius instead of the chord, the punch covers a shorter distance.

[2] With the symbol √ we'll mean always the arithmetical square root.

[3] We consider here as international measure system, the CGS system.

We analyise the **trajectory 1**:

This trajectory covers the arc of circle detached from the two perpendicular radius. Therefore the angle between these radius is 90°. Having the circumference an angle of 360°, the arc is the fourth part of the circumference (360° / 90° = 4).

The measure of the circumference of a circle is:

$$\textbf{circumference} = 2\pi r$$

therefore

$$\textbf{arc} = 2\pi r / 4 = \tfrac{1}{2}\pi r$$

Now being $1/2\pi > \sqrt{2} > 1$ we have

$$\textbf{arc} > \textbf{chord} > r$$

therefore

$$\textbf{arc} > r$$

Also in this case, we deduce that using as trajectory of the punch the radius instead of the arc, the punch covers a shorter distance. Really using trajectory 1 more space is covered that using trajectory 2.

We analyse the **trajectory 3**:

We consider the points of departure and arrival of the punch. The shorter distance between these two points is that given by the segment that they detach on the only possible straight line that it joins them. But the segment in question, is exact the chord subtended to the arc of the circle detached from the two perpendicular radius. Now, trajectory 3 goes from the same point of departure of the chord to the same point of arrival of the same one, but passing from other points. Consequently the distance of trajectory 3, whichever it is, is greater then the distance of trajectory 2, i.e. of that one of the chord.

$$\textbf{trajectory 3} > \textbf{trajectory 2} = \textbf{chord}$$

$$\textbf{trajectory 3} > \textbf{chord}$$

But it has been befor demonstrated that

$$\textbf{chord} > r$$

therefore

$$\textbf{trajectory 3} > \textbf{chord} > r$$

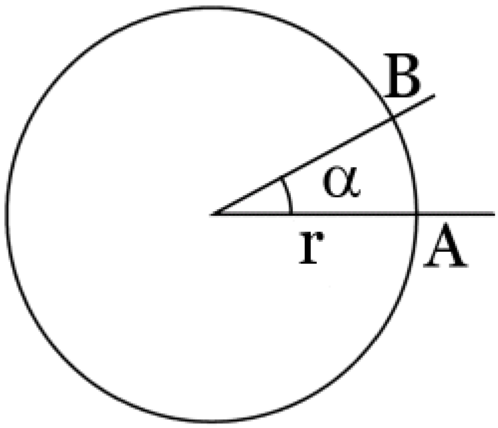
and therefore

$$\textbf{trajectory 3} > r$$

It is also demonstrated therefore that using as trajectory of the punch the radius instead of an any trajectory 3, the punch covers a shorter distance.

We analyse now trajectories 1, 2 and 3 in the case of the steps executed with angles-shot different of 90°.

Given an angle α, we trace, with center in its vertex, a circle of radius r. The sides of the angle will detach the arc AB on the circumference.



The measure in radians of α is the ratio between arc AB and the radius:

$$\alpha = \text{arc } AB / r$$

Therefore an angle of 1 radian is such that arc AB = r.
Given two angles α and β we call α^0 and β^0 their measure in degrees and α^1 and β^1 their measure in radians. It is true the following formula:

$$\alpha^0 / \beta^0 = \alpha^1 / \beta^1$$

Now the length of the circumference is $2\pi r$, therefore the measure of the turn angle in radians is 2π ($\alpha = 2\pi r / r$), that one of the flat angle is π ($\alpha = [2\pi r / 2] / r$), that one of the right angle is $\pi / 2$ ($\alpha = [2\pi r / 4] / r$).
If fixed β = flat angle I have that $\beta^0 = 180°$ and $\beta^1 = \pi$.
Then for every angle α

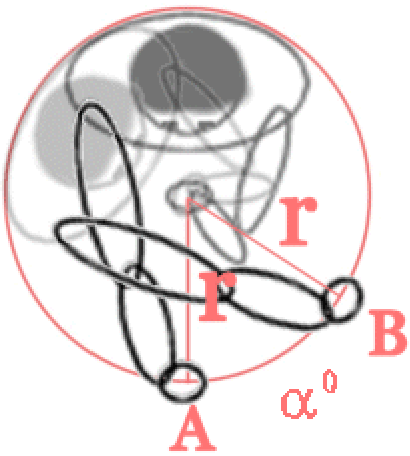
$$\alpha^0 / 180° = \alpha^1 / \pi$$

i.e.

$$\alpha^0 = [180° / \pi]\alpha^1$$

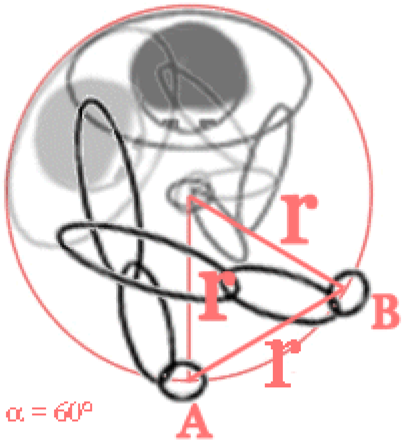
If fixed $\alpha^1 = 1$, then α^0 will give the measure in degrees of the angle for which the arc is equal to the radius. Making the calculations it turns out

$$\alpha^0 = 57°17'44''$$



So it is concluded that if a step is executed in a direction with an angle smaller then 57°17'44", the punch launched with the advanced hand, if it covers trajectory 1 i.e. the arc AB, covers a shorter distance than that one covered from the punch with the rear hand.

We analyse now **trajectory 2**:
An equilateral triangle has his three sides of equal measure. It has also the three angles of equal measure and exactly of 60°. Therefore with $\alpha = 60°$ it turns out r = AB like shown in figure.

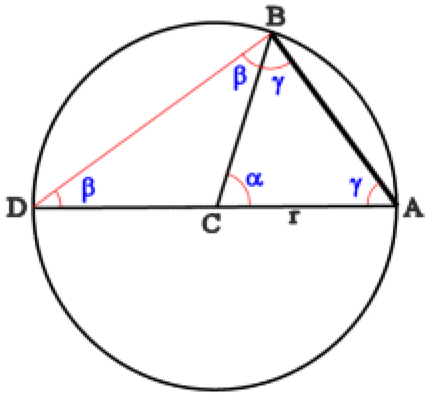


It is concluded therefore that with smaller angles of 60° the punch launched with the advanced hand, if it covers trajectory 2 i.e. the chord AB, covers a shorter distance than that one covered from the punch with the rear hand.

As far as **trajectory 3**, for to be shorter of the radius, the angle must sure be smaller than 60° because this is the angle for having the equality between radius and chord. In fact if the angle were greater, the chord would be longer than the radius and necessarily therefore also trajectory 3 because the chord is the shortest distance that connect the points A and B. Now for every smaller angle of 60°, exists sure one trajectory 3 shorter than the radius and greater than the chord.
But we have to emphasize that for every angle, between the three trajectories 1, 2, 3 the trajectory 2, i.e. the chord, is always the shortest.

For having an idea of how much the measures of the chord go away from the one of the radius as regards to a fixed angle is enough to remember the theorem of the chord of one circle:

The length of a chord of a circle with radius r is equal to the diameter of the circle multiplied by the sine of the angle to the circle that insists on one of the two arches subtended to the chord.



$$\mathbf{AB = AD sen\beta}$$

The angle in B is a right angle, i.e. $\beta + \gamma = 90°$. $\gamma = [180° - \alpha] / 2$.

Therefore

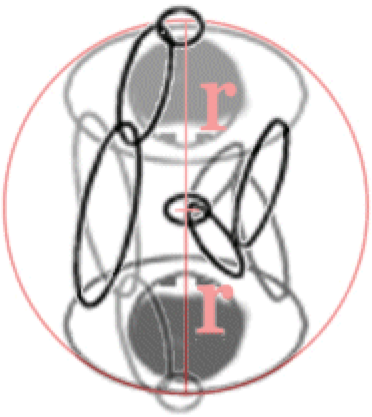
$$\mathbf{\beta = 90 - [180 - \alpha] / 2}$$

We suppose a radius of 30 cm (acceptable distance that elapses between Man-Sao and Wu-Sao) and constructs a table of comparison between chord and radius for some angles:

α	β	radius	chord
60°	30°	30 cm	30 cm
45°	22°.5	30 cm	22.96 cm
30°	15°	30 cm	15.53 cm

It is important to consider, for the specific case of the fight, that if throw a punch with the advanced arm, i.e. covering the chord or the arc, all the concept of the Center-Line gets lost and therefore we are exposed at the enemy's attaks. A too much large risk to run, in the case for example of steps at 45° (ZigZag steps with the same leg), in order to earn approximately 7 cm.

We consider now the steps at 180°.



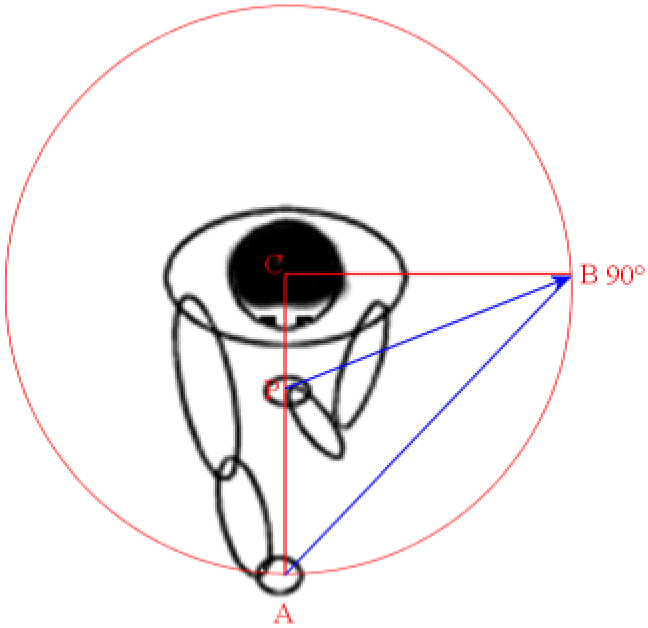
Step launching the punch with the rear arm (the punch is given with the hand of the Wu-Sao)

Step launching the punch with the advanced arm (the punch is given with the hand of the Man-Sao)

As it is looked in the figures above the punch throwed with the rear arm covers a radius of the circle, while that one throwed with the advanced arm covers a diameter, i.e. covers a double distance compared to the first one.

In truth the circle would go considered with center in the head of the person and not on the fist (see 1st mark). We analyse 4 cases of angles-shot[4].

- Attack coming from 90°

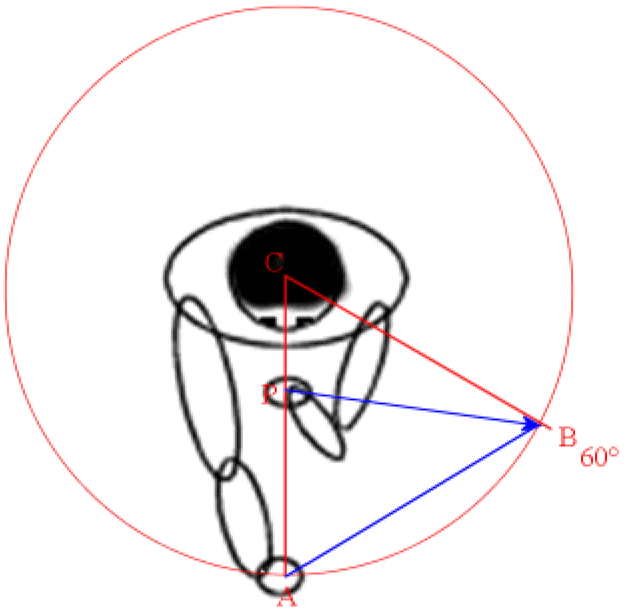


As it is constructed the triangle APB, it turns out

AP = side, PB = side, AB = hypotenuse

Therefore the trajectory of the rear punch is smaller than that one of the advanced punch.

- Attack coming from 60°



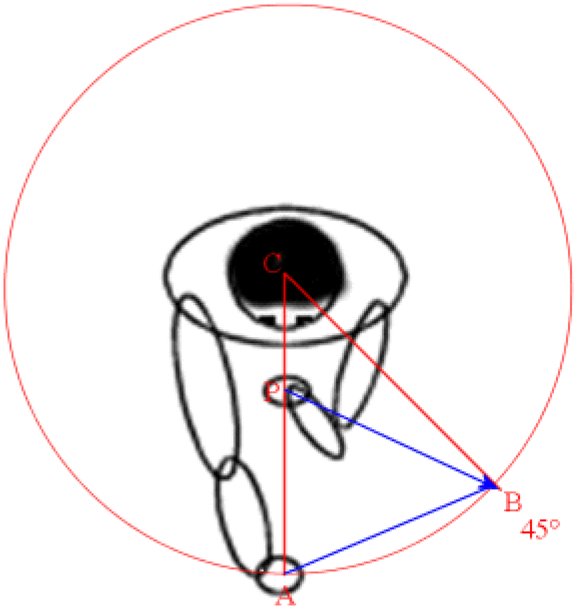
As it is constructed the triangle APB, it turns out

AP = side , PB = side, AB = hypotenuse [5]

Therefore it is true the same reasoning as above.

[4] As trajectory of the advanced fist is considered the chord because is the shortest distance possible between the points A and B.
[5] The ABC triangle is equilateral and has therefore the chord equal to the radius. PB is sure smaller of r because P not coincides neither with C neither with A.

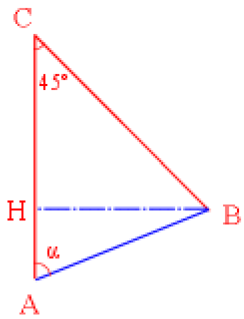
- Attack coming from 45°



PB will be equal to AB only if triangle ABP is isosceles.
From the theorem of cosine (or of Carnot) it turns out

$$\mathbf{AB^2 = AC^2 + BC^2 - 2(AC)(BC)\cos45°}$$
$$\mathbf{AB^2 = r^2 + r^2 - 2r^2\cos45°}$$
$$\mathbf{AB = r\sqrt{[2\ (1-\cos45°)]}}$$
$$\mathbf{AB = r\sqrt{0.59} = 0.77r}$$

We project now B on AC. AHB is a right triangle and α = [180° - 45°] / 2 = 67.5°



From a theorem on the right triangles it turns out that AH = (AB)cosα. Replacing, it turns out

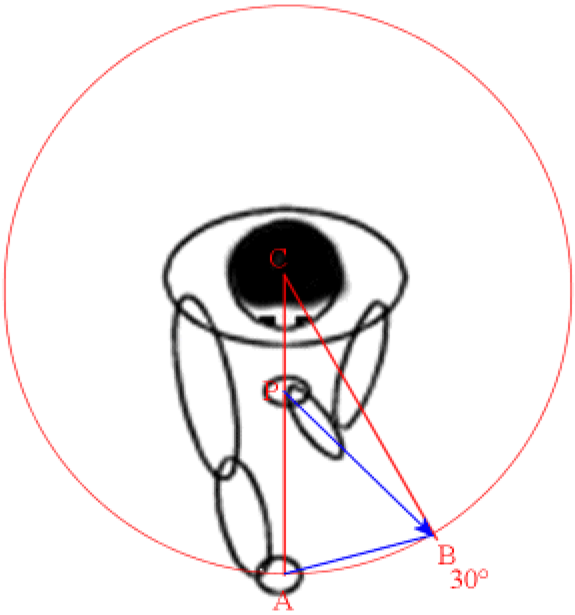
$$\mathbf{AH = r(0.77)(0.38) = 0.29r}$$

Therefore r – 2AH is the measure (CP) from the center of the circle for which the trajectory of the rear punch is equal to that one of the advanced punch. Replacing, it turns out

$$\mathbf{r - 0.58r = 0.42r}$$

This means that if the point P (the Wu-Sao) is found to approximately half away (0.42 ≅ 0.5) between point C (the head) and the point A (the Man-Sao), then the punch launched from the rear arm covers the same distance of the punch launches with the front arm. If the Wu-Sao is more closer to the head the punch relative to it will cover more distance than the punch relative to the Man-Sao; if is more closer to the Man-Sao the punch relative to it will cover a shorter distance than the punch relative to the Man-Sao.

- Attack coming from 30°



Using the same reasoning as before we obtain

$$\mathbf{AB^2 = AC^2 + BC^2 - 2(AC)(BC)\cos 45°}$$
$$\mathbf{AB = r\sqrt{0.26} = 0.51r}$$

AH = (AB)cosα but now α = [180° - 30°] / 2 = 75°

Therefore

$$\mathbf{AH = r(0.51)(0.26) = 0.13r}$$

The measure we are looking for is therefore

$$\mathbf{r - 0.26r = 0.74r}$$

This wants to say that if the point P (the Wu-Sao) is found to approximately at ¾ (0.74 ≅ 0.75) of the distance between point C (the head) and the point A (the Man-Sao), then the punch launched from the rear arm covers the same road of the punch launched with the front arm. If the Wu-Sao is more closer to the head the punch relative to it will cover more distance of the punch relative to the Man-Sao; if it's more closer to the Man-Sao the punch relative to it will cover a shorter distance of the punch relative to the Man-Sao.

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